CONSERVATION ASSESSMENT
FOR

Monadenia fidelis minor
Dalles sideband

Monadenia fidelis minor. Photograph by Bill Leonard, used with permission

Originally issued as Management Recommendations December 1998
By Ted R. Weasma

Revised August 2005
By Nancy Duncan

Updated December 2014
By Sarah Foltz Jordan & Scott Hoffman Black (Xerces Society)

USDA Forest Service Region 6 and
USDI Bureau of Land Management, Oregon and Washington
Interagency Special Status and Sensitive Species Program

Table of Contents

Preface

Summary of 2014 update:

In 2014, the framework of the original document was reformatted to more closely conform to the standards for the Forest Service and BLM for Conservation Assessment development in Region 6 (Washington and Oregon). Additions to this version of the Assessment include NatureServe ranks, photographs of the species, and an Oregon/Washington distribution map based on the record database that was compiled/updated in 2014. Distribution, habitat, life history, taxonomic information, and other sections in the Assessment have been updated to reflect new data and information that has become available since earlier versions of this document were produced. A textual summary of records that have been gathered between 2005 and 2014 is provided, including number and location of new records, any noteworthy range extensions, and any new documentation on FS/BLM land units in Washington and Oregon. A complete assessment of the species' occurrence on Forest Service and BLM lands is also provided, including relative abundance on each unit.

Executive Summary

Species: *Monadenia fidelis minor* Binney, 1885 (Dalles sideband**)**

Taxonomic Group: Mollusks (Phylum Mollusca: Class Gastropoda, Family Bradybaenidae)

Management Status: This subspecies is classified as a Sensitive Species in Washington and Oregon by Region 6 of the Forest Service.

The NatureServe Status for *Monadenia fidelis minor* is as follows:

Global Status: G4G5T2 (2005) (Imperiled)
National Status (United States): N2
State/Province Statuses: California (SNR), Oregon (S1S2), Washington (S1)
(NatureServe 2014).

Range: *Monadenia fidelis minor* is known from watersheds tributary to the Columbia Gorge from Hood River east to the vicinity of The Dalles on both sides of the river and in upland sites in watersheds tributary to the lower Deschutes River in Wasco County, within Mt. Hood National Forest. The subspecies may have occurred historically in the central and part of the Eastern Columbia Gorge and south up the Deschutes River Valley as far as 50 miles from the confluence.

Specific Habitat: The subspecies has been found in moist talus habitat (especially around seeps and springs), and in forested areas in upland sites near, but outside of, riparian corridors. Mollusks which inhabit rocky habitats also utilize the surrounding forest areas during moist, cool conditions. In some forested sites, the subspecies has been found associated with down wood where no rock substrates occur. Down wood may provide temporary refugia used during dispersal in the wet season, while rock substrates provide more stable refugia used for aestivation during summer and winter. Areas with frequent fire return intervals where rock crevice refugia are available may have historically favored this species over other, larger forms of *Monadenia*.

Threats: Habitat alteration and fragmentation leading to isolated populations is considered to be the major threat to this taxon. Land snails cannot tolerate extremely dry (xeric) conditions, have restricted ranges, and are slow to disperse. All activities that directly or indirectly alter a site's ecological parameters outside the range of natural conditions, such as moisture (too dry during spring and/or fall, or too wet), shade, temperature, soil compaction (compacted), food supplies, or dispersal routes can adversely affect a population. Loss of local populations can be caused by severe fire, herbicide use, recreation development, over-collecting, and disturbance during aestivation. Catastrophic wildfire causes direct mortality in high intensity fires and may result in loss of populations over large areas. Road-building and road maintenance have been identified as specific threats.

Management Considerations: Species habitat areas should provide a food supply of leaf and needle litter and fungi, within a cool moist environment during fall and spring active periods; and provide refuge sites used during dormant periods in summer and winter which provide constant

hibernacula conditions as well as protection from fire and predators. This includes maintaining undisturbed talus and rock substrates, and managing the surrounding vegetative cover to provide shade, coarse woody debris, and uncompacted forest litter. Due to the rarity of known populations, sites should be protected from wildfire events to the extent feasible, without degrading the current habitat condition such that the local population is lost.

Data Gaps and Information Needs: Information is needed on the actual range of this subspecies, the location of other populations, the viability and stability of the known populations, and the effects of fire and land management activities on population stability.

I. Introduction

A. Goal

The goal of this Conservation Assessment is to summarize existing information regarding the biology, ecology, known threats, and management considerations for this subspecies, in order to assist managers in the formulation of options for management activities. This subspecies is of concern due to its highly restricted distribution, limited mobility, narrow habitat requirements, and sensitivity to anthropogenic disturbance. Federal management for this subspecies follows Region 6 Sensitive Species (SS) and/or OR/WA BLM Special Status Species (SSS) policies.

For OR/WA BLM administered lands, SSS policy details the need to manage for species conservation. For Region 6 SS policy requires the agency to maintain viable populations of all native and desired non-native wildlife, fish, and plant species in habitats distributed throughout their geographic range on National Forest System lands. Management "must not result in a loss of species viability or create significant trends toward federal listing" (FSM 2670.32) for any identified SS.

B. Scope

The geographic scope of this assessment includes consideration of the known and suspected range of the subspecies in the planning area of the Forest Service Region 6 and BLM in Washington and Oregon, where the subspecies is listed as Sensitive. An emphasis of species-considerations is provided for federal lands; however, species-knowledge compiled from federal lands outside the planning area and non-federal lands is included as it is relevant to the overall conservation of the subspecies. This assessment summarizes existing knowledge of a relatively little known invertebrate. A great deal of new information has been generated regarding this subspecies in the last decade, and is incorporated here, but information updates may be necessary to keep this assessment current with time. Also, threats named here summarize known or suspected existing threats, which also may change with time. Management considerations typically apply to site-specific locations; however some larger scale issues such as population connectivity and range-wide concerns are listed. Uncertainty and inference are acknowledged where appropriate.

C. Management Status

This subspecies is classified as a Sensitive Species in Washington and Oregon by Region 6 of the Forest Service. The subspecies has not been detected on BLM lands in Oregon or Washington.

The NatureServe Status for *Monadenia fidelis minor* is as follows:
Global Status: G4G5T2 (2005) (Imperiled)
National Status (United States): N2
State/Province Statuses: California (SNR), Oregon (S1S2), Washington (S1)
(NatureServe 2014).

Monadenia fidelis minor is considered to be a Category A species under the Survey and Manage Standards and Guidelines, which require surveys for projects that disturb the species' habitat, and site management if found.

II. Classification and Description

A. Systematic and Synonymy
Class: Gastropoda
Family: Bradybaenidae
Species: *Monadenia fidelis minor* Binney, 1885, Dalles sideband

The genus *Monadenia* was first considered to belong to the genus *Aglaia* in part (von Martens, 1860; Binney 1869, Binney 1878). It became *Aglaja* according to Binney (1890). The genus *Monadenia* was established by Pilsbry (1895) with *Helix fidelis* Gray established as the type for this new genus. *Monadenia fidelis minor* (Binney) was described by Henderson (1936), who restricted the subspecies to The Dalles form.

B. Species & Subspecies Description
This taxon belongs to the family Bradybaenidae, a family of medium to small pulmonate land snails. In the Pacific Northwest, this family is represented by a single genus, *Monadenia* (Burke 2013). This is a fairly large and diverse genus, endemic to the Northwest Pacific Rim. The majority of the species and subspecies are found farther south, in California. However, *Monadenia fidelis,* with several subspecies, occurs in the Cascades and westward from Alaska to west-central California, and several others occur in northern California and southwestern Oregon (Burke 2013).

Burch & Pearce (1990) consider the following to be key characteristics for *Monadenia*: embryonic whorl sculpture irregularly granulose, not papillose; embryonic whorls usually carinate and adult shell may be carinate; spiral color band not far above the shell periphery; shell large; and reproductive system with one club shaped mucous gland. Similar genera, such as *Helminthoglypta,* are not carinate, have radial lines or papillae on the embryonic whorl, and have the spiral color band well above the shell periphery.

Monadenia fidelis minor is distinguished from other *Monadenia* species and subspecies by the following combination of characters (see key in Burke 2013): Shells 18 to 30 mm wide by 10 to 15 mm high; spire low to moderately elevated; dorsal color not darker than typical *M. fidelis,* similar to that of *M. fidelis fidelis* (a mixture of dark-brown/chestnut and yellowish/white, but may be mostly creamy or mostly brown) or lighter; umbilicus less than one-quarter covered by the lip margin (as opposed to half-covered).

Monadenia fidelis minor is described as follows (Burke 2013): This is a small subspecies, measuring about 20 to 25 mm wide by 12 to 15 mm high with 5.5 to 6 whorls. It further varies from the typical form by having one or two faintly traced spiral bands between the supraperipheral band and the suture, and rather distinct spiral striae. The animal is grayish-brown with bluish pigment granules (Burke 2013). Further descriptions and illustrations of this taxon are available in Pilsbry (1939).

Monadenia fidelis minor is similar to a race known from the east side of Upper Klamath Lake (Pilsbry 1939) but the two are considered separate races (Frest and Johannes 1995; Burke 2013). Small varieties similar to *M. fidelis minor* are found in various locations through the Oregon

Cascades. There is a population of similar-appearing *Monadenia* southeast of Mount Hood, in forested habitat where they are mostly associated with logs and shrubs (Burke 2013). Many of the *Monadenia* on the east slopes of the Cascades in Washington, Chelan, and Yakima counties are also of this size. Most of these populations occur east of the Cascade Range, where annual precipitation is less than in the western forest habitats of typical *M. fidelis* (Burke 2013). *Monadenia* fitting the size of *M. fidelis minor* have been found among rock outcroppings on Lopez Island, San Juan County, Washington; however, typical *M. fidelis fidelis* were more commonly associated with the same type of habitat, so those small snails are considered to be merely small individuals among the population of *M. fidelis fidelis* (Burke 2013).

III. Biology and Ecology

A. Life History

Information has not been published on the reproductive biology of *Monadenia fidelis minor*. All *Monadenia* have a reproductive system with a dart and a single tubular mucus gland apparatus associated with, or in close proximity to, the vagina (Miller and Naranjo-Garcia 1991). Like most terrestrial gastropods, *Monadenia* are hermaphroditic, having both male and female organs. Although not confirmed specifically for *Monadenia*, self-fertilization has been demonstrated in some species of gastropods, but cross-fertilization is the norm. Bayne (1973) discussed the complexities of the pulmonate reproductive system, and studied mechanisms by which allosperms (sperm from another) exert dominance over autosperms (sperm from oneself) during fertilization. Thus, ". . . self-fertilization is normally avoided, but remains a possible alternative to cross-fertilization." The advantage of this system is in avoiding potentially deleterious inbreeding under most circumstances, yet retaining the option to reproduce if a mate is not available.

Species in the *Monadenia* genus may copulate continuously for more than 23 hours, following which eggs are laid. *Monadenia fidelis* lay eggs on the order of “several tens”; loose soil is considered to be necessary for egg laying. Juvenile snails probably reach maturity in two years and are likely to live six or more years.

B. Activity Pattern and Movements

The species is mainly crepuscular (active only during dawn and dusk) during the moist spring and fall seasons. During the wet seasons, it may be found in the open, away from refugia, foraging for green vegetation and fruit, feces, old leaves, leaf mold, fungi, or microorganisms found on woody debris. Daily refugia used during moist seasons include down wood, rock or accumulations of litter.

During the summer, snails are found deep in talus accumulations which are adjacent to springs or streams and which serve as refuge sites from desiccation and protection from predators while they are immobile. These deep rock refugia also provide the important, environmentally stable sites needed to survive wildfire events and cold winter conditions. The distribution of these stable rock refugia sites across the landscape may determine or at least help to explain the distribution of the species in areas with short fire-return intervals. Mollusks which inhabit talus habitats also utilize the surrounding forest areas during moist, cool conditions, ranging out from the refugia provided by the rocks to forage in the adjacent forest floor litter. Vegetation within the surrounding forest not only moderates the temperature and moisture conditions within the rock

habitats, but provides food, loose soil and litter conditions necessary for egg laying.

Little is known about the dispersal potential of this species. Like most terrestrial mollusks, these snails are probably relatively sedentary and have poor dispersal abilities, as evidenced by the species' scattered distribution throughout its range. Small pockets of greater density and the presence of suitable but unoccupied habitat further suggest this possibility.

C. Food Habits

The diet of *Monadenia fidelis minor* is not known. A variety of green vegetation, subsurface roots, fungi, fruit, feces, leaf mold, woody debris, and microorganisms are found in the talus slopes that this species inhabits, and are the presumed food sources. Small invertebrates that may serve as food sources also inhabit the talus environment. The lack of detail on this snail's diet points towards the importance of a diversity of vegetation within their habitats, to provide a variety of plant, fungi, and other potentially required but as yet unknown elements.

D. Range, Distribution, and Abundance

Monadenia fidelis minor is a local endemic known from watersheds tributary to the Columbia Gorge on both the Oregon and Washington sides of the river in Wasco, Hood River, Klickitat, Skamania and Sherman Counties, from Hood River east to the vicinity of The Dalles, and in upland sites in watersheds tributary to the lower Deschutes River in Wasco County. The species may have occurred historically in the central and Eastern Columbia Gorge as far as the mouth of the John Day River, and south up the Deschutes River Valley as far as 50 miles from the confluence (Frest & Johannes 1995). Farther south up the Deschutes River, an undescribed *Monadenia fidelis* subspecies (the Deschutes sideband) displaces this taxon (Frest & Johannes 1995).

A recent (2012) verified detection of *M. fidelis minor* in the Gifford Pinchot National Forest has extended the known range of this species to the north to Lewis County, Washington (NRIS 2014).

Summary of historic and recent records:

The 1900 type locality for *Monadenia fidelis minor* is The Dalles, Wasco County, Oregon. Frest and Johannes (1995) note that the species has been lost from some historic sites, but survives in a few colonies in the vicinity of The Dalles and in the lower Deschutes River valley, and near Dog Falls, Washington. Burke (2013) also notes that this subspecies is still extant in The Dalles. The majority of recent sightings of *M. fidelis minor* are from Barlow Ranger District of Mount Hood National Forest, where detection of this taxon began in 1999 and continues through 2010 (NRIS 2014).

Distribution on FS/BLM lands: In Washington, this subspecies is Documented on the Gifford Pinchot National Forest, based on a recent (2012) detection whose identification was verified (NRIS 2014). In Oregon, it is Documented on the Mount Hood National Forest (ISSSSP 2011). The species is suspected to potentially occur on the Columbia River Gorge National Scenic Area in both Oregon and Washington.

Further details regarding FS/BLM distribution: The vast majority (79/100) of known records are from the Barlow Ranger District on Mount Hood National Forest (NRIS 2014; GeoBOB 2014). In

addition, there are four records on the Hood River Ranger District of Mount Hood National Forest, one record on the Clackamas Ranger District of Mount Hood National Forest, and one record on the Cowlitz Ranger District of Gifford Pinchot National Forest. Remaining records are from the Columbia River Gorge, primarily from vague localities on non-FS/BLM land.

Summary of Recent Data: Since 2004, there have been just three new records of this subspecies (NRIS 2014, GeoBOB 2014, Johannes 2014, *pers. comm.*, Leonard 2014, *pers. comm.*, Burke 2014, *pers. comm.*). A 2007 record from Tygh Creek in Wasco County was from non-FS/BLM land within the expected range of the species, but where this species was previously undetected. A 2010 record from Barlow Ranger District on Mount Hood National Forest was in the immediate vicinity of previously documented sites. A 2012 record from Cowlitz Ranger District on Gifford Pinchot National Forest represents a range extension of this species to the North.

Species Abundance:
Population density at known sites has not been determined. Only a few individuals have been found at most sites, although 21 individuals were recorded at one historic (1900) Wasco County site (GeoBOB 2014). Known sites are widely scattered across the species' range and often separated by non-habitat.

E. Population Trends
Local extirpations and declines have been documented in the Columbia River Gorge area. Frest & Johannes (1995) note that extinct colonies have been found along the I-84/US 30 corridor, and list the population trend (number of sites, number of individuals) as downward. The vast majority (79/100) of known records are from the Barlow Ranger District on Mount Hood National Forest where most detections have been relatively recent (NRIS 2014), and changes in population number and size through time are not known.

F. Demography
The distribution of the species appears to be highly fragmented and consists of geographically isolated populations. The reasons for the fragmentation are unclear and may reflect a combination of past climatic changes and habitat modification through human activities.

F. Habitat
The parent species, *Monadenia fidelis*, is found in mesic forest habitats or near springs or other water sources in forest situations, generally with rock substrates or large woody debris and logs for refugia (Frest and Johannes 1995, 2000). Many subspecies are known to be arboreal, climbing trees to forage on lichens and using moss accumulations in the canopy as possible refugia sites in winter. It is unknown if the various recognized taxa have significantly different habitat needs, although some distinct habitat associations have been described. Even though an individual taxon may tend to be found in a particular habitat type, that habitat may not define its tolerance range but rather indicate situations where that form has a selective advantage.

The subspecies *Monadenia fidelis minor* is known only from relatively few sites within a limited range. It is associated with talus habitat and seasonally moist rocky areas, especially around seeps and springs, though it is not found in the springs or seeps, nor is it considered to be a talus obligate. In The Dalles, this species lives among rocks and in and under bluffs around springs and

in riparian areas (Burke 2013). Frest & Johannes (1995) emphasize the association of this subspecies with basalt and basalt-derived soils, noting that taluses are often comparatively dry and open, but partial cover by *Celtus*, grasses, *Rhus horribilis, Artemisia, Urtica,* and *Balsamorrhiza* is typical. Surrounding areas, if natural, are sage scrub, with abundant *Artemisia* (several species) and locally common *Balsamorrhiza* and *Celtus.* Rocks and large woody debris serve as refugia during the summer and late winter seasons, as well as during fire events. Generally, the lower one-third of a talus slope contains the largest, most stable habitat elements. Because of the long-term stability in these areas and larger interstitial spaces between the rocks, microsite conditions are more favorable and provide dependable refugia sites. Other sites with rock-on-rock accumulations, such as are common at the base of rock outcrops, may provide similar crevices. Temperature is lower and humidity is higher under talus than in the surrounding environment. While the specific food requirements of this species are not known, a variety of vegetation, subsurface roots, fungi, and organic debris is typically found in talus slopes. Small invertebrates that may serve as food sources also inhabit the talus environment. Forest litter and coarse woody debris are considered necessary to provide food (shelter and substrate for fungi) and temporary cover when foraging or dispersing.

Common large land snails that co-occur with this taxon are *Oreohelix variabilis* and *Vespericola columbiana depressa* (Frest & Johannes 1995). It has also been found with the Larch Mountain Salamander *Plethodon larselli* (Frest & Johannes 1995).

The recent specimen collected in the Gifford Pinchot was found under a mat of *Neckera menzesii* moss growing on *Quercus garryana* (NRIS 2014).

G. Ecological Considerations

Terrestrial gastropods make a significant contribution to the biomass and energy in boreal forests, where they comprise at least 2.5% of the animal biomass and 6% of the animal energy (highly conservative estimates based only on active gastropods on the forest floor) (reviewed in Foltz Jordan & Black 2012).

Decomposition and nutrient cycling: As primary consumers of plant, animal, and fungal matter, gastropods aid in forest decomposition processes and contribute to nutrient cycling, soil formation, and soil productivity (reviewed in Foltz Jordan & Black 2012). For example, the slug *Ariolimax columbianus* speeds up nutrient cycling by ingesting large amounts of living and senescing plants, and subsequently excreting the partially digested plant tissue. Snails and slugs further contribute to the breakdown of forest floor litter by aiding in the dispersal of some fungi, and by physically and chemically altering plant material in ways that appear to promote fungal and bacterial growth.

Food for wildlife: Terrestrial gastropods are an important food source to a vast number of species, including salamanders, frogs, toads, turtles, snakes, lizards, birds, shrews, voles, moles, rats, mice, chipmunks, and squirrels (reviewed in Foltz Jordan & Black 2012). Invertebrate predators of terrestrial mollusks include sciomyzid fly larvae, firefly larvae, parasitic wasp larvae, carabid and staphylinid beetles, ants, spiders, harvestmen, and predatory mollusks. Additionally, the reproductive cycles of some nematodes and trematodes (flatworms) are dependent on snails and slugs as intermediate hosts for their parasitic eggs and larvae (reviewed in Foltz Jordan & Black

2012).

Plant pollination and seed dispersal: Although pollination by snails (malacophily) is a rare and obscure phenomenon, at least one study clearly demonstrates the significant role of a snail (*Lamellaxis gracile*) in the pollination of a flowering plant (Convolvulaceae: *Volvulopsis nummularium),* especially on rainy days when the activity of bees is completely lacking (reviewed in Foltz Jordan & Black 2012). Since some slugs consume fruit and excrete seeds, these animals can play a significant role in seed dispersal (albeit over short distances) and also appear to increase seed germination rates of some flowering plants (reviewed in Foltz Jordan & Black 2012).

Indicators of environmental health: Due to limited mobility, small home ranges, defined habitat preferences, and acute sensitivity to environmental conditions, snails and slugs are excellent and unique indicators of ecosystem health (reviewed in Foltz Jordan & Black 2012). Since terrestrial gastropods cannot easily escape areas that are subjected to disturbance, changes in gastropod abundance and diversity reflect the immediate impact of natural or experimental disturbance in their habitat. As such, gastropods provide managers with a valuable tool for site-specific assessment of environmental and community change (reviewed in Foltz Jordan & Black 2012).

IV. Conservation

A. Threats to Species

Any natural occurrences or anthropogenic activities that reduce the quality, quantity, or connectivity of this species' habitat may threaten this species. Quality habitat, as described above, is important to these snails for maintaining a balanced biotic community to support them, and for escaping predators. Land snails cannot tolerate extremely dry (xeric) conditions, have restricted ranges, and are slow to disperse. All activities that directly or indirectly alter a site's ecological parameters outside the range of natural conditions, such as moisture (too dry during spring and/or fall, or too wet), shade, temperature, soil compaction (compacted), food supplies, or dispersal routes can adversely affect a population. In the past, fuels management that increased the intensity, duration or frequency of fire; forest management activities that affect shade; and road construction or rock-removal that directly disturbed refugia sites have significantly impacted *Monadenia* species in the Pacific Northwest. Specific threats to this species are as follows:

Road, dam, and railroad construction and maintenance- The use of talus in the construction of dams in the Columbia Gorge is considered to have had a significant negative impact on individual populations of this subspecies (Appendix J2. 1994, p. 323). Railroad activities have further fragmented the range and affected colonies in recent years, e.g. disposal of batteries alongside tracks at one site (Frest & Johannes 1995). Road building and modification (e.g. I-84, OR 30 and WA 14) have destroyed or fragmented some colonies on the Washington and Oregon sides of the Columbia River Gorge (Frest & Johannes 1995). Urban expansion in The Dalles has had similar effects. Construction of new roads and maintenance of existing roads is a threat across the subspecies' range. Roadside spraying for weed control is also problem at many sites (Frest & Johannes 1995). In general, roadways can eliminate and degrade snail habitat, cause direct mortality in snails, and hinder snails' ability to disperse (reviewed in Foltz Jordan & Black 2012). Mollusk populations are not only extirpated in the roadway proper, but impacts can extend into

adjacent habitat as well, due to site preparation, road construction, vehicle use, and maintenance activities. For a complete review of ecological impacts of roadways on snails including environmental contaminants, traffic and desiccation-related mortality, roads as distribution barriers, and road-related changes in the direction and intensity of gene flow, see Foltz Jordan & Black (2012).

High intensity fire- *Monadenia fidelis minor* is very vulnerable to wildfire or management activities which increase temperature, decrease moisture, or decrease food supplies available in populated sites. Although natural and anthropogenic fire have played major roles in shaping forest ecosystems in the Pacific Northwest, the impacts of fire management on invertebrate communities are often highly variable. Fire has the potential to negatively influence gastropods in several ways: directly, by fire-related mortality, and indirectly, by altering microclimate conditions, and by reducing, eliminating, or otherwise altering resources, including vegetation, fungi, leaf-litter, duff, woody debris, and other habitat elements pertaining to shelter or food (*reviewed in* Foltz Jordan & Black 2012). The degree of fire-related impact and the potential for animals to rebound post-impact are related to a number of factors, namely, the degree of exposure to lethal temperature, the stress experienced in the post-fire environment, the suitability of post-treatment vegetation as habitat, and the ability to rebuild numbers in the site (from survivors and/or colonizers). Direct mortality due to fire exposure can be avoided by animals either in space (i.e., by escaping/retreating into shelter from fire) or in time (i.e., by being in a physiologically least susceptible stage at the time of burn). In general, less decline has been recorded for species below ground, within or beneath unburned wood, or above flames in treetops, and greater decline for species in the herb (fuel) layer or near the soil surface, particularly for individuals with low mobility. Mobility is important in both fire avoidance (e.g., the ability to escape approaching flames and reach suitable unburned habitat) and in post-fire recolonization (e.g., the ability to reach burned sites from unburned sites) (*reviewed in* Foltz Jordan & Black 2012).

Since *M. f. minor* has limited mobility and poor active dispersal aptitudes, is sensitive to desiccation, and has at least some association with vegetation and litter, this snail is considered highly vulnerable to fire itself and to subsequent habitat changes.

Predation- Concern about predators increases as habitat quality or quantity decreases. Up to three species of *Haplotrema* and *Ancotrema* (predatory snails that feed on snails, slugs, and other invertebrates) occur in the same habitats as *Monadenia*. Ground beetles (*Scaphinotus* sp.), specifically adapted for preying on snails, are common in northwest forests (White 1983; Kozloff 1976), and other insects as well as reptiles, amphibians, birds, and mammals also prey on them. Hiding and escape cover is provided by forest floor litter, including deep leaf packs and fine and large woody debris. When habitat patches are limited in size and number, predators can easily focus hunting efforts and severely reduce native mollusk populations. However, in good habitat with large numbers of hardwood patches, predators are a lesser threat to a population.

Competition from exotic slugs- Exotic slugs are increasing within the range of *M. fidelis minor*. The extent to which these introduced species might compete with the native gastropods or buffer them from predation has not been demonstrated. Exotic species are of concern because of the rapidity with which their populations increase. The mollusk fauna in most urban and suburban areas is now almost exclusively exotic species, and they are spreading into the forests, as

documented in several cases in the Cowlitz Ranger District where this taxon has been recently found.

Harvest of forest products- Harvest of special forest products can be a threat in limited habitat areas. In particular, the harvest of moss mats from trees should be avoided in this snails' habitat, as moss mats provide habitat for this subspecies (NRIS 2014).

B. Conservation Status

1. Overview

Monadenia fidelis minor is considered vulnerable to extinction or extirpation in both Oregon and Washington due to limited range, low number of occurrences, and low detection rate in suitable habitat. The majority of detections are from a small area Mount Hood National Forest, where population trends are not known, and from a small area of the Columbia River Gorge, where population trends are downward (Frest & Johannes 1995).

Due to limited mobility and narrow habitat preferences, this species, like many other terrestrial snails and slugs, cannot easily escape unfavorable habitat changes, and is thus highly impacted by environmental disturbance (*reviewed in* Foltz Jordan & Black 2012). These life history factors suggest that populations are especially vulnerable to habitat change or other changes in the environment.

2. Status History

Monadenia fidelis minor was listed in Table C-3, Survey Strategies 1 and 2 of the Survey and Manage Standard and Guidelines (USDA, Forest Service, and USDI, Bureau of Land Management, 1994). According to the FEMAT analysis made at the time of the Northwest Forest Plan, the options considered in the species assessments were less effective in providing for mollusks than for any other species group. High degrees of endemism, rareness, and habitat specialization account, in part, for the low ratings. Under the selected management option (Option 9), there would be a 43% probability that this subspecies would be well-distributed across Federal lands, a 35% probability that the subspecies would remain viable but with gaps in distribution, a 22% probability that populations would be restricted to refugia, and a 0% probability that it would be extirpated (Appendix J2, 1994). This ranking outcome was completed prior to the inclusion of required riparian reserve protection in the final Northwest Forest Plan decision.

The subspecies was placed in the Survey and Manage Standard and Guidelines, in Category A, which requires surveys to be completed prior to projects that might disturb the subspecies' habitats. In addition, these Standards and Guidelines require the management (protection) of any sites found as a result of those surveys. Although the standard terrestrial mollusk survey methodology was efficient and resulted in discovery of numerous specimens, as a result of the Annual Species Review in 2002, this species was placed in Survey and Manage Category B, due to difficulty in identification of specimens. After the addition of the requirement to collect vouchers, which can be identified by experts, surveys for this species were no longer considered impractical, and the taxon was returned to Category A in 2003.

3. Major Habitat and Viability Considerations

Maintaining deep refuge sites with appropriate microclimate conditions during the summer and winter within and around occupied habitat is considered critical. Retaining large woody debris, leaf litter, uncompacted soil, and canopy cover may assist in maintaining summer shade and dispersal between refuge sites with respect to these habitat conditions.

The survival of mollusk species in semi-xeric (dry) conditions is especially dependent upon the presence of adequate refuge sites during dormancy in the hot summer and cold winter months, and during fire events. Typically these seasonal deep refugia are provided by large scale rock talus piles, which provide access to underground moisture and retain cool, humid conditions deep within their interstitial species. An increase in temperature or decrease in moisture during the hot summer months is much more likely to adversely affect this species than those that live in more mesic (moist) environments, as they may be already living at the extremes of their tolerance limits. The range of environmental conditions that this species can tolerate is not known, but they must be protected from freezing during the winter and from desiccation in the summer. This subspecies seems to be generally found in areas with drier conditions than the other subspecies of *Monadenia fidelis.*

The number of population sites required to maintain species viability is unknown, however, it can be assumed that the likelihood of species viability increases with the number of populations, increasing opportunities for interaction between populations. Landscape management which maintains a distribution of populations and suitable habitat of sufficient quality, distribution, and abundance to allow the species populations to stabilize on federal lands is thought to be necessary for species persistence. The historic distribution pattern for this species is thought to be related to the coincident occurrence of rock outcrops, talus, and other rock refugia with the availability of surface water within forested stands, which has not changed much over time. While the current geographic distribution of rock and water features is probably not very different from the historic pattern, fire suppression in areas with short fire return intervals may have reduced the habitat quality in some areas and single-species plantations of conifer forest have replaced many of the original diverse flora found in late seral forest habitats. Quarry development and road construction through rock talus areas appears to have resulted in loss of some populations, however the use of quarry material in road construction may have resulted in the colonization of new sites in some areas. Timber harvest which results in canopy closure less than 40% is considered to be detrimental to local populations, especially when residual habitat elements are further damaged by prescribed fire. Small gaps in distribution may continue to limit population interaction somewhat, but without causing isolation or extinction of local populations, loss of genetic or ecological diversity, or loss of ecological function.

4. Distribution Relative to Land Allocations

Although much the subspecies' range is on non-federal land, the majority of known records (i.e., occupied areas) are on federal land, primarily on Mt. Hood National Forest. Federal lands on Mt. Hood and Gifford Pinchot National Forests and within the Columbia River Gorge National Scenic Area, as well as in watersheds tributary to the lower Deschutes River, include management for recreational purposes and commercial forest products, as well as for late-successional habitat. Within the Northwest Forest Plan area, approximately 5% of sites on federal land are within

withdrawn or reserved land allocations. It is unknown how many of these occurrences are located within riparian reserves, however an analysis conducted in 2003 showed that 1 in 7 sites fell within estimated riparian reserve boundaries.

Existing protections (land use allocations, Northwest Forest Plan Standard and Guidelines, agency best management practices, etc.) may be in need of supplementation for the long-term conservation of this subspecies, although requirements to conduct surveys prior to habitat-disturbing activities and to manage known sites can provide substantial protection. Given the distribution of this subspecies on Mt. Hood and Gifford Pinchot National Forests, it is expected that Region 6 Forest Service manages sufficient habitat to influence conservation outcomes. Management actions in this region may help alleviate threats to the most viable known populations of *Monadenia fidelis minor*, and maintain habitat conditions for this subspecies.

C. Known Management Approaches and Considerations

1. Management Goals for the Taxon

Management for this subspecies follows Forest Service Region 6 Sensitive Species (SS) policy, and/or Oregon and Washington BLM Special Status Species (SSS) policy. For Oregon and Washington Bureau of Land Management administered lands, SSS policy details the need to manage for species conservation. For Region 6 of the Forest Service, Sensitive Species policy requires the agency to maintain viable populations of all native and desired non-native wildlife, fish, and plant species in habitats distributed throughout their geographic range on National Forest System lands. Management should also not create significant trends towards federal listing, for any identified Sensitive species.

2. Management Recommendations

The disturbance and management response of terrestrial gastropods, in general, may offer valuable insight when managing for *M. fidelis minor*. A recent review of the literature on the effects of forest land management on terrestrial mollusks (Foltz Jordan & Black 2012) suggests the following:

- While some level of exposure in the physical environment is tolerated by certain mollusks, most species are extremely sensitive to temperature and moisture extremes.
- The majority of snails and slugs are dependent on litter from deciduous trees and have higher abundances in multispecies forests with strong broadleaf components. Additionally, mollusks in deciduous forests appear to rebound from disturbance more quickly than in coniferous forests.
- Refugia are critical to gastropod recolonization potential and community resilience following forest disturbance. Since land mollusks are small animals with limited mobility and dispersal capabilities, the maintenance of refugia in disturbed habitat is particularly important for this group. Refugia should include logs, snags, fallen branches, and other forms of coarse woody debris, as well as areas with thick leaf-litter. Woody debris and litter provide islands of habitat, food, and protection from microclimatic extremes, increasing species' tolerance of temporarily inhospitable environments.

- Fragmented habitat limits the dispersal and post-disturbance recolonization potential of gastropods. Tracts of intact forest and connected groups of old trees help provide dispersal corridors for gastropods and can lead to significant increases in the survival of disturbance-sensitive species.
- Techniques that minimize soil compaction and damage to (or removal of) the organic layer favor survival of gastropods. For example, Timberjacks have been found to cause less damage to the organic mat and resident invertebrate populations than feller bunchers, single-grip harvesters, and grapple skidders.
- Due to the tendency of mollusks to avoid non-vegetated and/or dry environments, even narrow, unpaved roads with low traffic densities are barriers to the dispersal of mollusks.
- Numerous studies have found negative and long-lasting responses of gastropods to fire, including population extirpation and reductions in abundance and species richness. Small burns surrounded by unburned plots have been most successful at maintaining gastropod community structure. Although there is little information comparing gastropod responses to differences in burn severity and frequency, it is presumed that a fire regime involving low-intensity burns at infrequent fire-return intervals would best maintain gastropod communities.

There are several management and restoration activities that could maintain conditions for *M. fidelis minor*. Management actions include addressing habitat suitability, providing connectivity among populations, minimizing spread of invasive species, and reducing loss and fragmentation of habitat through management of riparian areas (See Management Within Species Habitat Areas, below). In addition to *M. fidelis minor*, other rare gastropods associated with similar habitat requirements are expected to benefit from these management actions.

3. Identification of Species Habitat Areas

All known sites on federal lands administered by the Forest Service and/or BLM in Oregon and Washington are identified as areas where the information presented in this Conservation Assessment could be applied. A species habitat area is defined as the suitable habitat occupied by a known population plus the surrounding habitat needed to support the species.

This document addresses management at two spatial scales. At the local population scale, a species habitat area is designed to support a functional population of interacting individuals. The size of such areas is based on estimates of dispersal distances in similar-sized terrestrial mollusks and estimates of genetic neighborhood, or deme, size. A species habitat area is generally defined as an area around known site locations that includes all habitat features that provide food resources, refugia, or contribute to environmental conditions important to the species at the known site, and which is of sufficient size to support a population of interacting individuals. Based on the size and moderate dispersal ability of this subspecies, the area required to sustain a population of interacting individuals may range in size depending on amount and condition of the habitat (ie. how many individuals it can sustain per acre), and the amount of surrounding habitat needed to maintain suitable environmental conditions.

At the smallest scale, within each of these species habitat areas, it is important to maintain some habitat elements from disturbance, to provide for the critical periods in the animals' life history (aestivation, hibernation, reproduction). The remainder of the species habitat area may be actively managed to provide suitable foraging and dispersal habitat.

4. Management Within Species Habitat Areas

The objective of species habitat areas is to maintain habitat conditions such that species viability will be maintained at an appropriate scale, in accordance with agency policies.

In general species habitat areas provide for the conditions necessary to maintain cool moist temperatures during fall and spring, refuge sites for summer and winter aestivation, and a food supply including leaf and needle litter and fungi. This includes maintaining undisturbed talus with deep crevices and vegetative cover. The degree of connectivity for dispersal within and between occupied areas depends on the density and arrangement of shaded down wood and other cover objects within forested habitats which provide daily refugia during the wet season. Manage adjacent forested areas to provide shade, coarse woody debris and uncompacted forest litter. Due to the rarity of known populations, protect sites from wildfire events, but manage with prescribed fire to maintain historic conditions. Maintenance of suitable rock-on-rock refugia in areas with short fire return intervals may be critical to allow the species to survive wild fires. Mitigation measures outlined in Appendix J-2 stress the importance of the proper implementation of Riparian Reserves under option 9 (Appendix J2. 1994). Within Species Habitat Areas consider the following:

- Manage undisturbed talus with vegetative cover, within the natural range of variation for the habitat type.
- Protect occupied areas from road construction, quarrying, and other major site disturbing activities that may cause temperature and/or humidity changes within the interspaces or instability within the slope.
- Manage forested areas adjacent to these talus areas to provide shade, coarse woody debris and uncompacted forest litter.
- Maintain or enhance the naturally occurring diversity of plant species. This will increase the range of hosts for a variety of species of fungi and make other food substrates available throughout the season. It will also provide assurance that specific plant species, if found to be critical in the life cycle of these mollusk species, are not inadvertently lost.
- As yet, not enough is known about the needs of this species to identify an optimum mix of tree species, but it appears that mixed stands of conifer and hardwoods provide the best habitat. Maintaining a mix of conifer and hardwood stands would provide a more diverse and complete set of conditions for multiple species and a more fully functioning ecosystem. A range of canopy closure across the habitat area, with some open areas and other areas of closed canopy and deep shade, will provide opportunities for animals to locate appropriate microhabitats. The degree of connectivity and dispersal within and between habitat areas depends on the density and arrangement of shaded down wood and other cover objects which provide daily refugia during the wet season.
- To the extent practical, protect sites from high-intensity wildfire events. This may involve active forest management in the vicinity of species habitat areas to help reduce the risk of these types of events. While other methods of fuels reduction are preferred, prescribed fire may be considered as a tool to be used to reduce the risk of catastrophic natural fire. Design prescribed burning or other treatments to avoid significant impacts to the habitat conditions

within the habitat area. If burning is conducted during seasons when animals are active, care should be taken to ensure that a mosaic of unburned patches is retained. This may provide a measure of confidence that some individuals survive the treatment. When necessary conduct fuels reduction treatments within species habitat areas, however protect cover of critical refugia sites.

- Manage flows from adjacent springs and streams to maintain the moisture regime.
- Manage grazing in species habitat areas, and exclude livestock if possible, especially in areas where they may congregate around water sources or lush vegetation.
- Limit activities which cause soil compaction or disturbance to forest floor litter, rock or woody debris or which release silt or toxic chemicals into the water within species habitat areas.
- Exotic species of both plants and animals are entering habitats occupied by this species. Protect inhabited areas from introductions of non-native species. This includes restricting use of un-washed vehicles that could carry weed seeds or other exotics, and use of hay bales or other nonnative mulching materials and planting mixes used for erosion control. If exotic species are found, measures to control them should be implemented if feasible. Measures to control exotic species should not be adverse to *Monadenia fidelis* and other native species.

5. Other Management Issues and Considerations

The species has been observed to occur at some sites with the candidate Larch Mountain salamander *Plethodon larselli,* and should be managed with this in mind (Frest & Johannes 1995).

V. Research, Inventory, and Monitoring Opportunities

The objective of this section is to identify opportunities for additional information that could contribute to more effective species management. The content of this section has not been prioritized or reviewed as to how important the particular items are for species management. While the research, inventory, and monitoring information is not required, these recommendations should be addressed by a coordinating body at the Regional level.

A. Data Gaps and Information Needs

Current knowledge of this subspecies is limited, and is not based on long-range or site specific studies. Significant data gaps exist in our knowledge of the snails' fossil record, its taxonomic relationship to other members of its parent species, and its biological and environmental needs. The subspecies' current and former distribution, and the factors which have controlled distribution, diet, reproductive rates, and dispersal rates need further investigation. Local and range-wide population trends are not known.

Field research associated with any mollusk often results in detections in different habitats than expected based on prior knowledge. Range extensions are also common. Surveys outside of known habitat conditions may be helpful in determining the full range of habitat conditions in which the organisms can survive.

Specific information needs are as follows:

- What is the specific range of this species?
- What is the range of habitat conditions tolerated by the species? What is the range of conditions required for populations to remain secure and viable?
    - How does this species disperse to other suitable habitat patches, and what limits its dispersal capability? What is the typical dispersal distance in a lifetime?
    - How large are local populations, and how does this affect long-term viability of occupied sites?
- What are the biological, physical, and chemical attributes of this species' habitat?
    - Plant associations
    - Specific plant species required/used
    - Specific foods
    - Amount of large woody debris
    - Optimum forest crown cover to maintain desired conditions
    - Other stand structure and components (e.g., small woody debris, litter, duff, water, etc.)
    - Elevation
    - Soil types, geology, trace elements, pH
    - Temperature & humidity

B. Research Questions

Research questions for this snail are as follows:

- What are the food requirements of these species and are any of these food requirements unique to the species?
- What is the range of environmental conditions that this species can tolerate and how long can extremes be tolerated?
- Are there other populated sites?
- What factors control the species' rate and distance of dispersal?
- What is the species' natural life span?
- What is the actual range of the species?
- How far does an individual range away from its refuge site?
- What are the effects of fire and management activities on population demographics?
- What is the population density of the known sites?

C. Monitoring Opportunities

Monitoring existing populations is considered a critical conservation measure for this subspecies. Monitoring known sites is recommended to track trends in populations (numbers, size and density), reproduction, and quantity/quality of habitats. Monitoring is also recommended to determine impacts on habitats and populations from management activities, natural disturbances, and vegetative succession.

Known sites on public land should be monitored to assess population trends and to attempt to determine the factors which control those trends. Monitoring strategies should be designed to assist in determining if the implementation of the plan is resulting in the protection of habitat for these subspecies. In addition, monitoring should be designed to ensure that site disturbance or collection activities do not extirpate local populations. Specifically, monitoring should:

- Verify existing known populations; describe macro and micro-habitat conditions; and determine the extent of the populations.

- Conduct surveys to locate additional populations in areas identified as potential habitat. Prioritize surveys in areas where management treatments or projects are scheduled or proposed.

- Monitor known populations following land management activities and fire events to determine whether or not recommendations applied for this species protection are effective and sufficient.

VI. References

Appendix J2. 1994. Final Supplemental Impact Statement on Management of Habitat for Late-Successional and Old-Growth Forest Related Species within the Range of the Northern Spotted Owl., Appendix J2, Results of Additional Species Analysis. USDA Forest Service and USDI Bureau of Land Management, i-viii, 476 p.

Binney, W. G. 1869. Land and fresh water shells of North America. Part 1. Pulmonata Geophila. Smithsonian Miscellaneous Collections, 194:13-21.

Binney, W.G. 1878. Terrestrial Mollusks, 5, in Bulletin of Museum of Comparitive Zoology, 4: 350.

Binney, 1890. Bulletin of Museum of Comparitive Zoology, 19: 213.

Burch, J. & T. Pearce, 1990. Terrestrial Gastropoda. Chapter 9, in Soil Biology Guide, Daniel Dindal (ed), John Wiley and Sons (NY, xvii + 1349 pp..

Burke, Tom. 2014. Regional mollusk expert. Personal communication with Sarah Foltz Jordan, Xerces Society.

Burke, T. 2013. Land snails and slugs of the Pacific Northwest. Oregon State University Press, Corvallis, Oregon. 344 pp.

Foltz Jordan, S. and S. H. Black. 2012. Effects of forest land management on terrestrial mollusks: A literature review. Prepared for Interagency Special Status and Sensitive Species Program, USDA Forest Service, Region 6 and USDI Oregon/Washington Bureau of Land Management. 87

pp. Available online at: http://www.xerces.org/wp-content/uploads/2012/04/forest-land-management-and-mollusks.pdf

Frest, T.J., and E.J. Johannes. 1995. Interior Columbia Basin mollusk species of special concern. Final report: Interior Columbia Basin Ecosystem Management Project, Walla Walla, WA. Contract #43-0E00-4-9112. 274 pp. plus appendices.

Frest, T.J., and E.J. Johannes. 2000. Baseline Mollusk Survey of Southwestern Oregon, with Emphasis on the Rogue and Umpqua River Drainages. Prepared for Oregon Natural Heritage Program, Portland, OR.

GeoBOB 2014. GeoBOB Database: Fauna observations. GIS export provided to Sarah Foltz Jordan, Xerces Society, by Diane Stutzman, January 2014.

Henderson, 1936. The Non-marine Mollusca of Oregon and Washington, Suppliment. University of Colorado Studies 23: 253

ISSSSP 2011. FINAL Region 6 Regional Forester and OR/WA State Director Special Status Species List, December 1, 2011. Includes Federal TEP Species, Region 6 Regional Forester Sensitive and OR/WA State Director Sensitive Species, and Strategic Species. Provided to Xerces Society by Carol Hughes, January 2012.
Johannes, E. 2014. Personal communication with Sarah Foltz Jordan, Xerces Society.

Leonard, Bill. 2014. Personal communication with Sarah Foltz Jordan, Xerces Society.

Miller, Walter B. and Edna Naranjo-Garcia. 1991. Familial relationships and biogeography of the Western American and Carribian helicoidea (Mollusca:Gastropoda: Pulmonata) American Malacolological Bulletin Vol. 8(2): 147-153

NatureServe. 2014. *Cryptomastix devia*. NatureServe Explorer: An online encyclopedia of life [web application]. Feb. 2009. Version 7.1. NatureServe, Arlington, Virginia. Available at: http://www.natureserve.org/explorer/ (Accessed 11 Sep. 2013).

NRIS 2014. Forest Service NRIS Database: Wildlife observations. GIS export provided to Sarah Foltz Jordan, Xerces Society, by Diane Stutzman, January 2014.
Pilsbry, H. 1895. Manual of Conchology., 9: 198.

Pilsbry, Henry A. 1939. Land Mollusca of North America (North of Mexico). Acad. Nat. Sci. Philadelphia, Monogr. 3, V.1(1): i-xvii, 1-573, i-ix.

USDI and USDA Forest Service. 2004. Final Supplemental Impact Statement to Remove or Modify the Survey and Manage Mitigation Standards and Guidelines.

von Martens, E.. 1860. Die Heliceen nach natürlicher Verwandtschaft systematisch geordnet von Joh. Christ. Albers. Zweite Ausgabe. W. Engelmann, Leipzig. p. 122.

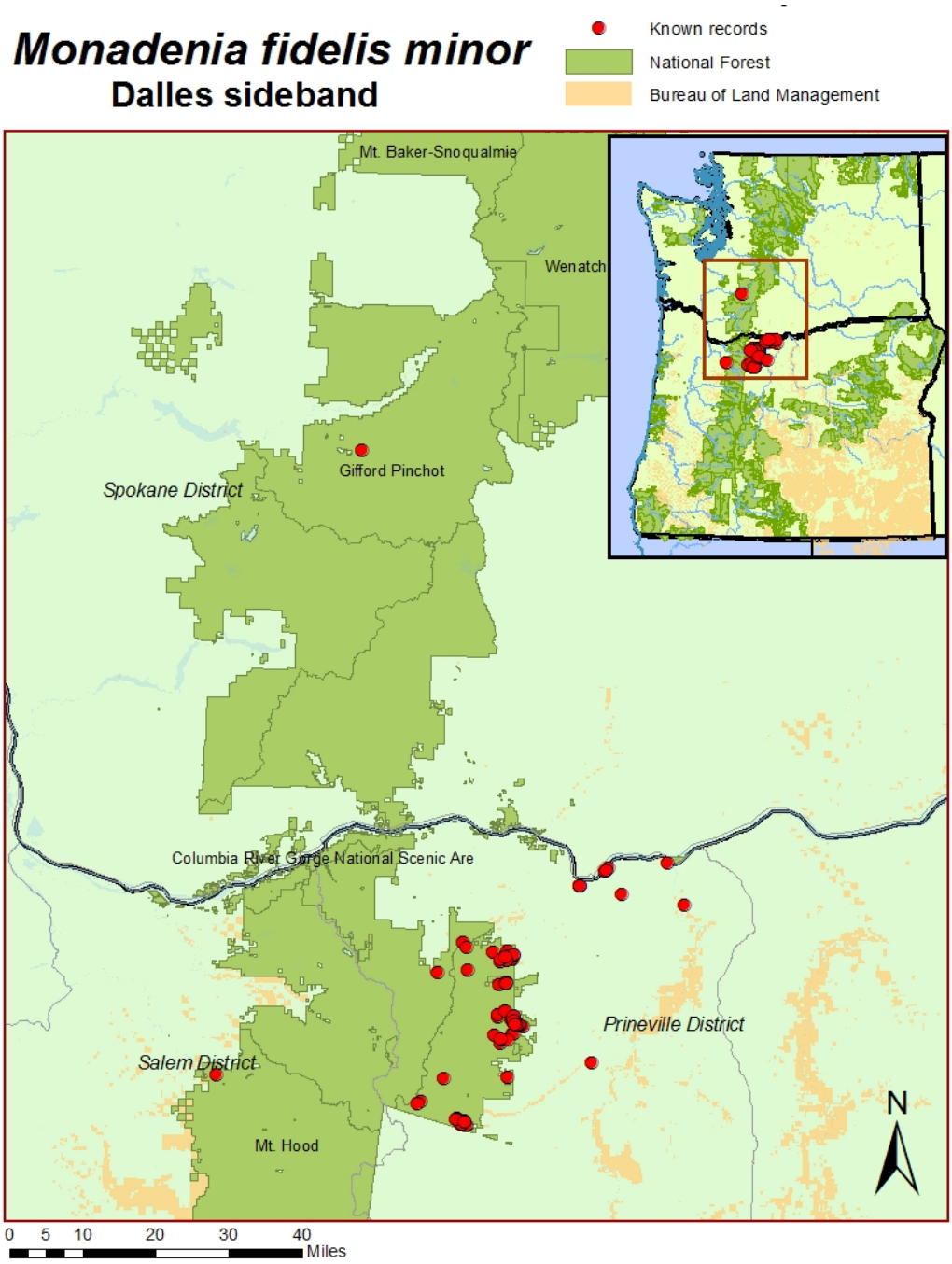
VII. PHOTOGRAPHS

Monadenia fidelis minor, ventral view. Photograph by Bill Leonard, used with permission.

Monadenia fidelis minor, dorsal view. Photograph by Bill Leonard, used with permission.

Monadenia fidelis minor, lateral view. Photograph by Bill Leonard, used with permission.

VIII. DISTRIBUTION MAP



Map showing *Monadenia fidelis minor* records in Washington and Oregon relative to Forest Service and BLM land.