Conservation Assessment

for

Cryptomastix devia,
Puget Oregonian

Cryptomastix devia. Photograph by Tom Kogut, used with permission.

Originally issued
as Management Recommendations
September 1999
By Thomas E. Burke
With contributions from Nancy Duncan & Paul Jeske

Revised September 2005
By Tom Kogut & Nancy Duncan

Updated March 2015
By: Sarah Foltz Jordan & Scott Hoffman Black (Xerces Society)
Reviewed by: Thomas E. Burke

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

Table of Contents

Preface

Summary of 2015 updates:

In 2015, 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 Oregon and Washington. Additions to this version of the Assessment include NatureServe ranks, photographs of the species and Oregon/Washington distribution maps 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 documentations on FS/BLM land units. A complete assessment of the species' occurrence on Forest Service and BLM lands in Oregon and Washington is also provided, including relative abundance on each unit.

Executive Summary

Species: *Cryptomastix devia* (Gould 1846), Puget Oregonian

Taxonomic Group: Mollusks (Phylum Mollusca: Class Gastropoda)

Management Status: Both Region 6 of the Forest Service and OR/WA BLM classify this species as a Sensitive Species. The NatureServe Status for this species is as follows:

Global Status: G3 (2005)
National Status (United States): N3 (2005) (Note, the ISSSSP Master Spreadsheet shared with Xerces in December 2011 lists N2 as the National Rank for this species.)
National Status (Canada): NX (2013)
State/Province Statuses: Oregon (S1), Washington (S2S3), British Columbia (SX) (NatureServe 2014).

Range: *Cryptomastix devia* inhabits areas of the western Cascade Range and Puget Trough at low to moderate elevations from western Washington into northwestern Oregon, between The Dalles and Salem, south to Yamhill County, Oregon (Burke 2013). There is a single record from the eastern Cascades near Cle Elum, Kittitas County, Washington (Burke 2013). This species historically inhabited British Columbia, Canada but has not been observed alive in B.C. since 1905, is now listed as an extirpated species in Canada (COSEWIC 2005).

Habitat: *Cryptomastix devia* inhabits moist, conifer forest habitats. Although often occurring within riparian areas, and possibly confined to the riparian zone in some dry landscapes or less densely forested areas, it is not generally a riparian obligate. *C. devia* is usually absent from riparian zones prone to regular or occasional flooding. It is strongly associated with bigleaf maples (*Acer macrophyllum*) growing among conifers (usually Douglas-fir, western hemlock and western redcedar) or in groves of maples and other hardwoods such as black cottonwood and red alder. This species is often found on or under hardwood logs or other woody material, maple leaf litter, or under the lowest fronds of swordfern plants (*Polystichum munitum*) that are growing near or under the maple crowns. Maples on flat or gentle slopes are more suitable habitat than steeper slopes, perhaps because they offer more stable environments. Large diameter, older bigleaf maples provide a deep leaf litter layer and are highly suitable habitat for this species, although they may also be found under smaller diameter maples, particularly when they occur in patches or are frequently interspersed within upland conifer stands. Young *C. devia* may be found among or under mosses (including the long lichens and mosses growing on the trunks of bigleaf maples), or in leaf litter or under swordfern fronds with adult animals.

Threats: Primary threats to this species are the loss of habitat due to forest management practices, conversion for agricultural, urbanization and other uses, and fire. Other threats may include vertebrate and invertebrate predators (i.e., predatory snails, and beetles), which can concentrate in isolated, small habitat patches where snails are vulnerable. In some forest stands, bigleaf maples can be suppressed by Douglas-fir and other conifers or lost as a result of selective commercial thinning of the maples, leading to a long-term loss of habitat for this species.

Harvest of special forest products (i.e., raking for mushrooms, firewood gathering, moss harvest from maple sites, collection of swordfern plants for ornamental transplant) are potential threats in limited habitats. Large numbers of invasive slugs have been documented in several *C. devia* sites on the Cowlitz Valley Ranger District, Gifford Pinchot National Forest, but the effects to this native snail have not been documented.

Management Considerations: The primary goal of site management is to provide habitat sufficient for continued occupancy by the species; moderating fluctuations in temperature and humidity by maintaining shade, protecting key habitat features, and limiting adverse impacts of fire.

Research, Inventory, and Monitoring Opportunities: The primary questions remaining about this species are:

- What stand characteristics (canopy cover, tree species, stand age, large woody debris, litter and duff, elevation, slope, aspect etc.) are required to support the species?
- What stand size is required to provide sufficient area of suitable habitat for populations to remain secure and viable?
- What is the dispersal ability of this species, particularly related to the patchy nature of its suitable, bigleaf maple habitat?
- What impacts, if any, are non-native mollusks having where they occur with *C. devia*?
- Clarification of the status, rarity and distribution of this species, particularly outside of the Cowlitz and Cispus river drainages on the Gifford Pinchot National Forest.

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 species, in order to assist managers in the formulation of options for management activities. This species is of concern due to its highly restricted distribution, limited mobility, narrow habitat requirements, and sensitivity to anthropogenic disturbance. Federal management for this species 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 species, in the planning area of the Forest Service Region 6 and/or Oregon and Washington BLM. 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 species. This assessment summarizes existing knowledge of a relatively little known invertebrate. A great deal of new information has been generated regarding this species 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 species is classified as a Sensitive Species by Region 6 of the Forest Service and OR/WA BLM.

The NatureServe Status for this species is as follows:
Global Status: G3 (2005)
National Status (United States): N3 (2005)
National Status (Canada): NX (2013)
State/Province Statuses: Oregon (S1), Washington (S2S3), British Columbia (SX) (NatureServe 2014).

Cryptomastix devia is a Category A species under Survey and Manage, based on the low number of occurrences, its low detection rate in suitable habitat and its small range. *Cryptomastix devia* has also been under review for listing under the Endangered Species Act (ESA). since the fall of 2011.

II. Classification and Description

A. Systematic and Synonymy
Family: Polygyridae
Species: *Cryptomastix devia* (Gould, 1846)

This species was first described by Gould as *Helix devia* in 1846. The genus name has been changed over time by various authors, as listed below. Considered a subgenus of the genus *Triodopsis* in 1940, *Cryptomastix* is now recognized as a full genus, based on reproductive anatomy and distribution.

Synonyms:
Triodopsis (Cryptomastix) devia (Gould) in Pilsbry, 1940.
Polygyra devia Gld., Dall, 1905.
Mesodon devia Gld., Taylor 1891; W.G. Binney, 1878.
Odotropis devia Gld., J.G. Cooper, 1868.
Helix baskervillei Pfeiffer, 1850.
Helix devia Gould, 1846.

B. Species Description
This taxon belongs to a genus in the land snail family Polygyridae. This family is composed of small- to large-sized snails with distinctly reflected lip margins and aperatural teeth varying in size and number from zero to three (Burke 2013). The periostraca (shell membranes) in this family range from various shades of yellow, tan, or brown, without markings. Peristrocal hairs/bristles adorn the shells of many polygyrid species in the immature stages. Although a few species of *Cryptomastix* retain peristrocal setae at maturity, these hairs are generally lost in the adult stage, or evident only as hair-scars or scales (Burke 2013).

The *Cryptomastix* genus is distinguished from other members of the Polygyridae family as follows (Burke 2013): medium to moderately large snails (10 to 25 mm in diameter), with sub-globose to low-conic, narrowly umbilicate to imperforate shells. The peristome is distinctly reflected and often recurved or revolute. Dentition consists of a parietal tooth, a basal cusp, usually at the outer end of a basal ridge or fold on the inside of the basal lip margin, and one inside the palatal or the outer lip margin. The teeth, however, may be reduced to a mere callus or lamina, or may be absent, so any combination from zero to three may occur. The young of many *Cryptomastix* are hirsute, but few species retain the hairs in adulthood. Hair-scars or associated papillae can sometimes be found on the periphery or on the penultimate whorl in front of the aperture. The shells may be sculptured with spiral striae, although these are often faint or indistinct (Burke 2013).

Cryptomastix devia is significantly larger than any others in the genus, and is readily distinguished from other *Cryptomastix* by the shell size (20 to 24 mm wide by 12.5 to 16 mm high, with about 6 whorls) (Burke 2013). In addition, the shell of this species has a small but prominent white parietal tooth and usually a very low, blunt basal cusp or lamina inside the median half of the basal lip margin. The umbilicus is partly covered. The shell spire is moderately elevated; the periphery is rounded. The color of the shell is medium to dark brown; the peristome is white to tan (Burke 2013). The lip is well-reflected and slightly recurved, particularly in mature shells. Immature shells lack the reflected lip margin and have short, moderately spaced, microscopic bristles on the shell (difficult to see with a 10x lens and readily lost from collected shells).

Two other *Cryptomastix* (*C. germana* and *C. hendersoni*) are found within the same range as *C. devia*, but are significantly smaller and also differ in shell characteristics. *Cryptomastix germana* is the smallest species of the genus (8 mm diameter), and usually retains long, curved bristles on its shell as an adult; *C. hendersoni* is somewhat smaller than *C. devia* (up to 18 mm diameter), and usually lacks apertural teeth, although it sometimes has a very small parietal tooth. Other species with which *C. devia* could be confused with are: *Allogona townsendiana* form *frustrationis*, which occurs within the same range as *C. devia* but is larger and lacks a parietal tooth (Burke 2013), and *A. ptychophora*, which can be about the same size as *C. devia*, but differs in that the adult shells lack the parietal tooth, and shells of the immature are without the short, hooked bristles of immature *C. devia*. In addition, *Allogona ptychophora* are not usually found within the range of *C. devia*.

Immature *C. devia* can be confused with immature *Monadenia fidelis*. Immature *M. fidelis* is more angular at the periphery, lacks the short bristles of fresh immature *C. devia* shells, and the peripheral bands of *M. fidelis* are usually apparent, though not always obvious in small living snails (Pilsbry 1940). The young *M. fidelis* also have rather straight edged maleations on the dorsal surface of the whorls.

III. Biology and Ecology

A. Life History

Like most terrestrial gastropods, *Cryptomastix* are hermaphroditic, having both male and female organs. Although not confirmed specifically for *C. devia*, 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 is in normally avoiding potentially deleterious inbreeding, yet retaining the option to reproduce if a mate is not available.

Cryptomastix devia hatch from eggs and live for more than one year. However, little is known regarding the oviposition behavior, number/appearance of eggs, development, generation time, or potential longevity of this species, or of other members of the *Cryptomastix* genus (Applegarth & Duncan 2005). Other members of the Polygyridae family have been found to live for 8 or more years in captivity after reaching maturity. Applegarth & Duncan (2005) note that if *Cryptomastix* species have a potential life span of several years after reaching maturity, then individuals should have multiple opportunities to reproduce.

B. Activity Pattern and Movements

Little is known about the movement patterns of this species. According to Pilsbry (1940), “the young [Polygyridae] snails wander abroad more freely than adults, and are often found on plants where the adults are under cover."

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

Nothing was found in literature sources on the ecology or diet of *Cryptomastix devia*, but Pilsbry (1940) states of the family Polygyridae, "Their food is chiefly the mycelia of fungi." Although the natural foods of *C. devia* have not been specifically documented, one immature specimen was observed to eat lettuce, reluctantly, in captivity. While it is suspected that mycophagy is the primary life style of this species, it appears that at least the young may be partially herbivorous on green plants during certain seasons, and that other microorganisms associated with decaying leaf litter, such as molds, yeasts and bacteria, form the bulk of the diet. Other *Cryptomastix* snails appear to be both herbivorous and mycophagous; for example, *C. hendersoni* is reported to be herbivorous, feeding on the decaying remains of herbaceous plants as well as algae from wet surfaces at the edge of streams and seeps (Applegarth & Duncan 2005).

D. Range, Distribution, and Abundance

The global range of *C. devia* extends from southern British Columbia through the Cascade Range and Puget Trough of western Washington to the Oregon side of the Columbia Gorge between The Dalles and Salem, south to Yamhill and Clackamas Counties (Burke 2013, NRIS 2014). One isolated record exists from the eastern Cascade Mountains near Cle Elum, Washington (Burke 2013). In Washington, known records are from Clark, Cowlitz, Grays Harbor, King, Klickitat, Kittitas, Lewis, Mason, Pierce, Skamania, and Thurston Counties. In Oregon, records exist from Clackamas, Multnomah, Columbia, Wasco, Washington, and Yamhill Counties.

The majority of sites and records are from the Cowlitz and Cispus River drainages in the western Cascade Range of Washington. There are no recent locality records north of the Seattle area. The species has a patchy and scattered distribution throughout most of its range.

According to Tom Kogut, the previous district biologist and taxa specialist for *Cryptomastix devia* “the maple snail has a fairly wide distribution, ranging from northwestern Oregon through western Washington, although at most locations it is only known from a handful of individuals. The exceptions are the Cowlitz and Cispus River drainages of the Gifford Pinchot National Forest in western Washington, where the species is relatively common and widespread wherever its ecological associate, bigleaf maple tree (*Acer macrophyllum*) is found. The reason for this localized abundance is speculative, but is perhaps related to several factors such as habitat quality and the connectivity of maple habitat patches in these drainages” (Kogut 2014, *pers. comm.*).

<u>Summary of historic records</u>: Pilsbry (1940) gave locations at Vancouver Island, B.C., "Puget Sound, type locality", Seattle, King County; Carson, Skamania County; Freeport, Cowlitz County

(Henderson 1929); and Nisqualie flats, Thurston/Pierce counties, Washington, and Hayden Island, Oregon, opposite Vancouver, Washington. Frest and Johannes (1993) reported locations from King, Clark, Skamania, and Thurston counties, Washington, and Multnomah County, Oregon. Branson (1980) reported it from Lake Chelan State Park, Chelan County, a record that needs to be confirmed. Other unidentified *Cryptomastix* have been found in that vicinity, but it is an unlikely habitat for *C. devia*. Henderson (1936) says there are *Polygyra devia* (Gould) in the Hemphill-Hannibal collections at Stanford University from Kalama, Clark County, Clearwater, (Jefferson County, apparently), Freeport, Cowlitz County, and Seattle, King County, Washington; Portland, and Hayden Island, Multnomah County, Oregon. He also cites but questions the validity of a record from Yakima, Washington. Frest questions the validity of the Clearwater Co. record, considering it as being more likely an Idaho species from Clearwater, Idaho. In Canada, the species is known from three historical records (1850–1905) from B.C.; two from southern Vancouver Island (Pfeiffer 1850; Taylor 1889), and a third (Dall 1905) from the Sumas Prairie area of the Lower Fraser Valley, near present-day Chilliwack (British Columbia Ministry of Environment 2008). However, the species has not been observed alive in Canada since 1905, and surveys between 1984 and 2006 within the historic range have not located any new populations or old shells (see British Columbia Ministry of Environment 2008 for a summary of recent surveys). In 2002, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated Puget Oregonian snail as Extirpated from Canada.

<u>Distribution on FS/BLM lands</u>: In Washington, this species is Documented on Gifford Pinchot, Okanogan-Wenatchee, and Olympic National Forests. It is Suspected on Spokane District BLM land based on close proximity to a few 2004-2005 King County records, Suspected on Columbia River Gorge NSA in Washington, based on proximity to known records, and suspected by the Mt. Baker-Snoqualmie NF. In Oregon, this species is Documented on Columbia River Gorge NSA, Mt. Hood National Forest, and Salem District BLM land.

<u>Further details regarding FS/BLM distribution:</u> The vast majority of known records are from the Cowlitz Valley Ranger District on the Gifford Pinchot National Forest (Cowlitz and Cispus River watersheds), where the species is relatively common in appropriate habitat (e.g., stands containing bigleaf maple trees below approximately 2500 feet in elevation). Outside of this area, the species is very rare. The current number of records for each Forest and BLM District where this species has been documented is as follows:

Gifford Pinchot National Forest (165 records, 158 on Cowlitz Ranger District, 7 on Mt. Adams Ranger District).
Salem District BLM (3 records, 2001-2013)
Columbia River Gorge NSA (1 record, 1999)
Olympic National Forest (1 record, 1999)
Mt. Hood National Forest (1 record, 1999)
Okanogan-Wenatchee National Forest (1 record, 2000)

<u>Summary of Recent Data:</u> In 2004, 178 locations were identified in the Interagency Database, with 141 of these occurring in the Cowlitz and Cispus River drainages of the Gifford Pinchot National Forest. Between January 2005 and March 2014, 63 new records of this species were recorded, none of which represent significant range extensions for this species. One new detection of this species was made on Salem District BLM land in Oregon where this species was

previously documented by a small number of records. The majority (58/63) of the new records were from the Gifford Pinchot National Forest, including 54 from Cowlitz Ranger District (where the majority of this species records occur); and four from Mt. Adams Ranger District (where this species was previously documented by a small number of records). See distribution map in Appendix displaying recent (post-2005) records of this species in the Gifford Pinchot National Forest. As of March 2014, there are 212 records in the database of this species, with the vast majority of these still occurring in the Cowlitz Ranger District of the Gifford Pinchot National Forest. Although the number of records has increased in recent years, neither the range nor habitat use has significantly expanded.

<u>Species Abundance:</u>
Based on surveys conducted on the Cowlitz Valley Ranger District, this species occurs in low densities, with one to three individual snails found at most documented localities. Typically, one or two adult *C. devia* are located under or near a bigleaf maple tree during a 20 minute (average) search effort. Although relatively large, this species can easily be overlooked due to its cryptic brown coloration, which matches the leaf litter and decaying fern fronds where it usually is found. Therefore, estimates of abundance based on time-constrained surveys may be misleading.

E. Population Trends
Although detection of this species has increased since the mid-1990's, this likely reflects increases in survey effort rather than increases in population number and size through time. Twenty years ago, according to Frest and Johannes (1995), the species had been extirpated from many historical locations and was considered to be in "strong decline throughout its range" in terms of number of sites and numbers of individuals. Following extensive survey effort in British Columbia, this species has recently been listed as extirpated from Canada (British Columbia Ministry of Environment 2008). In Washington, much of the former range of this species is now urban or has been developed for agriculture; for example, ten of 42 records from prior to 1994 are from the metropolitan Seattle area, where most sites can be expected to have been developed for housing, business, industry, streets, and highways (although the species still occurs in a few protected forested parks in this area). The vast majority of known detections are from a small area in the Gifford Pinchot National Forest, where most detections have been relatively recent, and changes in population number and size through time are not well known.

F. Demography
Current knowledge of this species indicates that it is widespread across its range, but of quite spotty distribution. It is relatively common only in the Cowlitz and Cispus River drainages on the Gifford Pinchot N.F.; elsewhere it is quite rare and local. It is unknown if this is a result of a lack of survey effort in bigleaf maple habitats in other areas, or if the Cowlitz and Cispus drainages are, in fact, the center of this species current distribution and abundance. The latter scenario appears most likely, given extensive mollusk survey efforts on other Forests (e.g., Mount Baker-Snoqualmie and Olympic) with no, or very limited, detection of this species.

G. Habitat
Cryptomastix devia occurs in mature to old growth moist forests and riparian habitats, where it is found under logs, in leaf litter, around seeps and springs. It almost always occurs under or near bigleaf maple (*Acer macrophyllum*) trees and may be found under sword ferns growing under

those trees, or on the underside of bigleaf maple logs. It is often associated with coarse woody debris and leaf litter, and occasionally talus. Canopy cover over natural occupied habitats is usually greater than 70%, with rare exceptions on wetter sites. Juveniles of this snail may also be found under or among mosses such as grow on the trunks of old bigleaf maples. The deep layers of decaying leaves which accumulate under late seral trees form the optimal microhabitat for the species.

Tom Burke, regional mollusk expert, notes "During my surveys in the Lower Cispus Watershed, I found old-growth stands within the Late Successional Reserves (LSR's) to support the greatest populations of *C. devia,* as well as total gastropods. Microsites for *C. devia* were mostly under the crowns of old big-leaf maples on or under large woody debris (e.g. maple logs), or among sword ferns under these trees" (Burke 2014, *pers. comm.*).

Large diameter, older bigleaf maples provide a deep leaf litter layer and are highly suitable habitat for this species, although they may also be found under smaller diameter maples, particularly when they occur in patches or are frequently interspersed within upland conifer stands. Of the 39 recent (post 2004) records of this species in the Gifford Pinchot National Forest with habitat data provided, all were associated with bigleaf maple trees, ranging from 7 to 31 inches in diameter (NRIS 2014).

Pilsbry (1940) reports habitat for this species at the bases of east-facing slopes along the lake north of Seattle, near damp places with maples and sword ferns. Frest and Johannes (1993) report the habitat as low to middle elevations (i.e., from near sea level upwards through the Western Hemlock Series). This species is classified as an old growth and riparian associate; habitat includes leaf litter along streams, under logs, seeps, and springy areas. However, despite the riparian association, this species is rarely found in riparian areas prone to regular or occasional flooding. North of the Cispus River, Lewis County, Washington, this species has been found in mature and old growth forest, seldom in riparian habitat (Burke 1996). Some occupied sites in this area were quite rocky, one overlaying a talus scree slope, while other sites contained almost no surface rock. The plant association was old-growth western hemlock/sword fern, but *C. devia*, *Monadenia fidelis,* and *Prophysaon dubium* appeared associated with bigleaf maple logs or leaf litter within that association. Most of the *C. devia* were found on the underside of bigleaf maple logs that were sound but with the bark loose and falling away. They were most often found on logs greater than 12 inches in diameter, but which were broken into smaller chunks. The larger logs in the area were too heavy to move for examination. Pieces as small as 3 feet long by 5-6 inches in cross-section were found with this snail on them. Other *C. devia* were found in forest floor litter often under sword ferns growing among or near the base of living mature big-leaf maples. Canopy cover in occupied forest sites was usually greater than 80% mixed conifer and hardwoods. Wetter sites with a greater component of bigleaf maple sometimes had more open canopies. Possibly additional water compensates for the reduced shading by moderating temperature fluctuations as well as maintaining humidity.

Flat or gentle slopes generally provide better habitat for this species than steep slopes, probably due to more stable environmental and soil conditions. Although large diameter, older bigleaf maple trees provide optimal suitable habitat for this species, patches of smaller diameter maples, or numerous individual maples interspersed in an upland conifer stand, can also contain relatively high densities of *C. devia*.

A draft Bayesian belief network model has been developed for *Cryptomastix devia* (Kogut et al. in prep., Kogut 2014, *pers. comm.*). This model attempts to predict habitat suitability for this species based on occurrence of bigleaf maple trees, leaf litter, coarse woody material, and other factors. This model has not been field verified (as of March 2014) but can provide some insights into possible habitat components and preferences associated with *C. devia*.

Note that what is known of the habitat and ecology of this species has changed significantly since the Northwest Forest Plan (NFP) decision in 1994. Prior to the NFP, knowledge about the species was from few, generally poorly documented, observations. Literature sources (Pilsbry 1940; Branson 1977, 1980; Branson and Branson 1984; Frest and Johannes 1993, 1995, 1996) give general site information at best, but detailed records of specific plants or other microhabitat elements are primarily from personal knowledge (Burke, 1994). However, since the beginning of the NFP, biologists from several federal land management units took the initiative to conduct surveys and study habitat conditions of the species. As a result, we have learned more about the range and habitat of this species over the past twenty years than the total that was known prior to that time.

H. 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 and calcium 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, and harvestmen. 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).

Since snail shells are very high in calcium, terrestrial snails have an important role in storing, releasing, and cycling calcium in the ecosystems they inhabit (reviewed in Foltz Jordan & Black 2012). Snail shells are the primary calcium source for the eggs of some bird species, and declines in mollusk abundance in forest ecosystems have been significantly linked to eggshell defects, reduced reproductive success, and population declines in the song bird, *Parus major* (reviewed in Foltz Jordan & Black 2012). Empty snail shells are used as shelters and egg laying sites by insects and other arthropods, and broken down shells return calcium to the soil (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 activities that reduce the quality and/or quantity of this species' mature to old-growth forest habitat may threaten this species. In particular, natural and anthropogenic reductions in bigleaf maple, with which this species is strongly associated, are of primary concern. Specific threats to this species are as follows:

Urbanization and agriculture- Much of the formerly known range of *C. devia* has been developed for urbanization or agriculture. Outside of the Gifford Pinchot, the greatest concentration of sites for this species is in the Seattle area, including ten historic records from what is now the metropolitan Seattle area. Although the species has been found occasionally in certain forested parks in the Seattle area in recent years, most sites are considered extirpated.

Timber Management- Logging and clearing of relatively intact forest and grazing of logged areas has occurred across the species' range (Frest & Johannes 1995). Herbicide spraying on private commercial forest lands to remove hardwoods has resulted in widespread loss of this habitat component across the landscape. *Cryptomastix devia,* like other forest snails, depend on numerous forest attributes that are frequently associated with old growth or intact forests, including shadiness and humidity, a stable microclimate, adequate calcium content, diverse vegetation, a sufficient amount of litter and coarse woody debris, and habitat continuity (*reviewed in* Foltz Jordan & Black 2012). These habitat dependencies, coupled with limited mobility with which to escape unfavorable conditions, suggest that silviculture activities and associated microhabitat changes would negatively impact this species at logged locations. Foltz Jordan & Black (2012) identify numerous ways in which tree harvest can significantly impact terrestrial gastropods, including increases in microclimate extremes; changes in forest vegetation and litter; reductions in coarse woody debris; soil compaction and other changes in microhabitat structure; population fragmentation; and changes in genetic population structure.

Forest succession- In some mid-seral stands where this species occurs (e.g. "Cispus burn" sites on the Gifford Pinchot National Forest), bigleaf maple trees are often overtopped and outcompeted by faster growing conifers such as Douglas-fir. Management of forest stands which selects against hardwoods also may result in a loss of this habitat component. The loss of bigleaf maple trees in these areas will reduce future habitat suitability for *C. devia*, and strategies to retain this maple habitat component should be explored.

Recent maple tree dieback in Western Washington- Over the past several years, bigleaf maple dieback in the Gifford Pinchot National Forest (GPNF), as well as elsewhere in western Washington and Oregon, has been documented by the USDA United States Forest Service (USFS), Washington Department of Natural Resources (WA DNR), and others (Omdal & Ramsey-Kroll 2012, Kogut 2014 *pers. comm.*). Reports range from declining crowns in individual trees to mortality of entire stands (Kogut 2014, *pers. comm.*, Omdal & Ramsey-Kroll 2012, Chadwick 2014 *pers. comm.*). From a stand level perspective, both the declining crowns (Chadwick 2014, pers. comm.) and stand mortality (Kogut 2014, *pers. comm.*) are most alarming in localized areas of the Cowlitz Valley area of the GPNF. Elsewhere across the GPNF, observational road side surveys suggest that many bigleaf maple stands remain healthy, especially south and east of Mount Saint Helen's (Chadwick 2014, pers. comm.).

Symptoms of the disease include yellow flagging of large branches, small leaf size, partial or entire crown dieback, and premature leaf scorching in the fall (Omdal & Ramsey-Kroll 2012). Once symptoms are observed, it has been suggested that tree death may occur in two to three years (Kogut 2014, *pers. comm.*), although some stands that have exhibited disease symptoms for approximately four years are still persisting, despite excessive crown dieback (Chadwick 2014, *pers. comm.*). Chadwick (2014, *pers. comm.*) notes that the dying trees at some sites (private land immediately adjacent to Randle) are located in areas that frequently flood.

To date, research efforts aimed at identifying the disease agent of this dieback have been inconclusive (Ramsey-Kroll 2014, *pers. comm.*). The most formal investigation of this issue was conducted in 2011 by Daniel Omdal & Amy Ramsey-Kroll (WA DNR), who examined 60 different sites across western Washington where bigleaf maple trees were exhibiting symptoms of dieback and decline. Damage agents that could be observed with the naked eye and through some minor root excavation were noted, and samples were collected and tested for *Verticillium*. All results came back negative for *Verticillium* and no other damage agent trends (e.g., *Armillaria* or *Ganoderma* root diseases, insects, abiotics) were found (Omdal & Ramsey-Kroll 2012). A small number of foliage samples tested preliminarily positive for the bacteria *Xyllela fastidiosa*, however these results have not been reproducible during follow up studies by Holly Kearns and Kristen Chadwick (USFS) on the GPNF (Ramsey-Kroll 2014, *pers. comm.*). In addition to the *Xylella* and *Verticillium* tests described above, the USFS has conducted tests to look for *Phytophthora* species on bigleaf maple foliage, again with negative results (Ramsey-Kroll 2014, *pers. comm.*). In 2014, another survey funded by the USFS will be conducted in western Oregon and Washington to further investigate biotic and abiotic factors that may be contributing to the dieback and decline of bigleaf maples. Specifically, this survey will examine the role of *Armillaria* and *Phytophthora* root diseases (Ramsey-Kroll 2014, *pers. comm.*).

Regardless of the disease vector, the bigleaf maple dieback and mortality in localized areas described above is quickly reducing one of the most valuable wildlife tree species for a wide variety of rare Pacific Northwest species, including mollusks, amphibians, arthropods and migratory birds (Kogut 2014, *pers. comm.*). The bigleaf maple mortality has already affected entire stands of maple in the Cowlitz and Cispus drainages of the GPNF (the center of this snails' distribution), including high quality pure maple stands that once had excellent mollusk diversity (Kogut 2014, *pers. comm.*). Given the well-documented association between *Cryptomastix devia* snails and bigleaf maple litter, the decline and dieback in bigleaf maple populations is now considered to be the greatest threat to the long-term survival of *C. devia* (Kogut, *pers. comm.* 2014). It is expected that when maples die from a site, populations of this snail will be unable to persist as well, since the deep maple leaf litter will decay without replenishment, resulting in widespread habitat loss for the snail (Kogut 2014, *pers. comm.*). It is possible that bigleaf maple forest regeneration may occur successfully via stump sprouting and/or natural seeding post dieback (Chadwick 2014, pers. comm.), however even under this scenario, declines in litter production would be expected for a number of years, and it is unclear how this species and other bigleaf maple litter-dependent mollusks would respond to these habitat changes.

<u>Road construction and maintenance-</u> Construction of new roads and maintenance of existing roads is a threat across the species' range. Roadways 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 contaminents, 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). Roads also provide access for introduction of exotic species through human activities.

<u>Predation-</u> 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 and in greater numbers than *C. devia*. 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 *C. devia* populations. However, in good habitat with large numbers of hardwood patches, predators are a lesser threat to a population. A well balanced, good quality ecosystem will also support greater populations of other prey species to buffer against over predation on these gastropods or other species (Burke 2014, *pers. comm.*). The importance of thick layers of litter and duff and uncompacted soils as a component of these habitats should not be overlooked. These are important habitat for many invertebrate buffer species ie., earthworms, insect larvae, and other gastropods, as well as small

mammals, reptiles and amphibians (Burke 2014, *pers. comm.*).

Competition from exotic slugs- Exotic slugs are increasing within the range of *C. devia*. To what extent these introduced species might compete with the native gastropods or buffer them from predation has not been demonstrated. Exotic species should be 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 and Cispus River drainages at sites containing *C. devia* populations.

High intensity fire- 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 *C. devia* lives for the most part on vegetation and in litter, has limited mobility and poor active dispersal aptitudes, and is sensitive to desiccation, this species is considered highly vulnerable to fire itself and to subsequent habitat destruction. Prescribed burning of slash piles can be a threat to *Cryptomastix devia* in bigleaf maple areas; there is at least one documented example of an escaped slash pile burn that resulted in the mortality of numerous *C. devia* adults at a bigleaf maple patch. This species generally appears to be lacking from areas that were burned for site preparation after timber harvest.

Harvest of forest products– Harvest of special forest products can be a threat in limited habitat areas. Raking the forest floor for mushrooms, or removal of hardwood logs for firewood could be particularly damaging, as well as harvest of swordfern plants for ornamental transplants. The harvest of moss mats from bigleaf maple trees should be strongly discouraged, as these provide potentially important habitats for juvenile snails.

B. Conservation Status

1. Overview

Cryptomastix devia is considered vulnerable to extinction or extirpation in both Oregon and Washington due to its limited distribution, low number of occurrences, extirpation of many historic sites, narrow habitat requirements, and a number of threats that are expected to impact the long-term survival of this species across its range, including sites in the Gifford Pinchot National Forest where this species is most common and abundant (see Threats section, above). This species has been extirpated from Canada, and much of the former range in Washington is now urban or developed for agriculture, and logging has also impacted known sites (British Columbia Ministry of Environment 2008; Frest & Johannes 1995). The vast majority of recent detections are from a small area in the Gifford Pinchot National Forest, where population trends are not known, and forest management practices and widespread mortality of bigleaf maple are known threats.

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

The FEMAT analysis conducted in 1993 for *C. devia* determined that under the preferred management option, insufficient habitat would remain to allow the species to stabilize well distributed across Federal lands; there would be 7% probability that it might remain viable but with gaps in its distribution; there would be 50% probability that populations will remain viable in refugia; and 43% probability that it would be extirpated from federal lands. These ratings were based on "past actions" that have caused the species to decline due to forest management and urban area development, and the limited range and sites known at that time

3. Major Habitat and Viability Considerations

Cryptomastix devia occurs in moist forest habitats, such as mid- to late-successional hemlock/sword fern associations, and it appears to be associated with hardwoods- particularly bigleaf maple- within these stands. Such stands have been reduced by timber harvest, conversion of forest land for agricultural and urban development, and, more recently, by bigleaf maple mortality due to an unknown disease agent. Hardwood components may also be lost during forest succession, especially if stands are thinned or otherwise managed to promote conifer growth at the expense of hardwoods. Pre-commercial thinning which selects against hardwoods may result in reduction or loss of the critical habitat components used by this species.

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 hardwood forests, which were once widespread in the western Washington lowlands. The current distribution of this species is sparse and patchy; it is not generally abundant in known habitats relative to populations of other associated gastropods. For species with patchy distribution, concerns for viability increase as habitat areas decrease in number and size toward a critical threshold. As population size decreases, the probability of catastrophic loss of local or limited habitats increases; the quality of remaining habitats may decrease (especially if management is directed toward maintaining minimum quality or quantities); potential for deleterious effects of inbreeding increases; and chance of population loss from predation, pathogens, or other causes increases.

4. Distribution Relative to Land Allocations:

Approximately two thirds of documented sites for *C. devia* occur outside of reserves in the Matrix allocation and within Adaptive Management Areas (AMAs) of the Olympic and the Gifford-Pinchot National Forests. Approximately one third of known sites occur within Late-Successional Reserves (LSR) and administratively withdrawn land allocations in the Upper and Lower Cispus, Upper and Clearfork Cowlitz Watersheds, in the Cowlitz Valley Ranger District of the Gifford Pinchot N.F. Many of the historic sites are in the area of Seattle and its suburbs and it apparently still occurs in a few parks where natural forest stands exist, but it is expected that most of those historic sites have been developed. Occurrence on private lands has not been documented in recent years.

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 central distribution of this species on Gifford Pinchot National Forest, it is also expected that Region 6 and OR/WA BLM manage sufficient habitat to influence conservation outcomes. Management actions in this region may help alleviate threats to the most viable known populations of *C. devia*, and maintain habitat conditions for this species.

C. Known Management Approaches

In fiscal year 2013, Gifford Pinchot National Forest conducted revisit surveys for *C. devia* snails in harvested units where this species was previously found in pre-disturbance surveys (Jakubowski 2014, DRAFT). The objective of the resurveys was to determine if the protection buffer that was applied to the original locations was effective in enabling the snail to persist at the site post-treatment (after timber harvest activity was completed). The resurveys were conducted in 8 units within 4 timber sale project areas that included Cispus Hazard Tree Removal, Cowlitz Thin, Dry Jackpot and Smooth Juniper that were originally surveyed in the period from 1999 to 2001. These sales are located in the Cowlitz and Cispus River drainages of eastern Lewis County and all of them are commercial thin sales in the western hemlock zone. Results of these surveys are in progress (Jakubowski 2014, DRAFT), and therefore not summarized here.

In addition to the species specific information that may be revealed by the resurveys discussed above, the disturbance response of terrestrial gastropods, in general, may also offer valuable insight when managing for *C. devia*. 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.
- Research suggests that 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.
- Forests with old-growth characteristics supply microhabitat and microclimate conditions capable of supporting a diversity of mollusks, and forest age is often positively correlated with mollusk richness and abundance.
- Numerous studies stress the importance of refugia in 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.
- Research suggests that in order to reduce microclimate extremes and protect gastropods, partial cuts should be favored over clearcuts, aggregated (group) retention over dispersed retention or thinning, and larger group retention over smaller group retention. In particular, harvesting with large group retention helps to maintain preharvest boreal gastropod assemblages and will likely conserve boreal gastropod species if used as a tool for biodiversity management.
- 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.
- Research suggests that 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 forest 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.

Burke (1999, Version 1 of this Assessment) offers additional "lessons from history" with regard to gastropod response to fire:

> Once extirpated from a site, populations of most gastropods are slow to recover... Sites that appear to be suitable habitat for many gastropods, but which have been burned in the past, support few if any species or individuals even after 50 years and longer. Some of the more abundant, larger species begin repopulating these sites from adjacent stands after suitable habitat for them is restored, which may take many years. The first species to reappear in western Washington stands are usually the *Haplotrema* and *Vespericola*. These species are the most abundant of the large snails in a variety of forest habitats. The time required for the abundance and diversity of the molluscan fauna to be restored to these sites is indicated by the much greater numbers of species and individuals found in old growth than in stands in which signs of fire (and other management in some cases) are still evident but not necessarily obvious. In these burned stands, the ecosystem is lacking the habitat components and functions provided by the mollusk fauna.
>
> An intense burn leaves the biotic community under moist conifer stands with only a small fraction of its mollusk fauna for many years (possibly a century or more). In contrast to severely burned areas, stands in which numerous large logs were left, and which were not severely charred during the fire, have been found to retain a portion of their mollusk fauna after an undetermined number of years but within a time that evidence of the burn was still apparent at the site. Remaining logs at these types of sites are estimated to be greater than 1000 linear feet per acre, and greater than 20 inches average diameter (both dimensions estimated). Whether gastropods remained through the burn, protected by the abundant logs, or they were able to more rapidly disperse back into the stand because of the cover provided by the logs has not been determined. What is apparent is that an abundance of large logs is important to many forest snails and slugs. Zero to two or rarely three species may be expected in burned stands without abundant logs remaining; five to seven species may be expected to be found in stands similarly treated but with the logs remaining; and in unburned stands 13 to 20 or more species may be found. In one of the prime habitat areas in the Lower Cispus Watershed, after the bigleaf maple logs were removed from along the road, *C. devia* became very difficult to find in the area where it was previously most abundant (Burke, 1996).

D. Management Considerations

1. Management Goals for the Taxon

Management for this species 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:

There are several management and restoration activities that could maintain suitable conditions for *C. devia*. Management actions include addressing habitat suitability, providing connectivity among populations, minimizing spread of invasive species, and reducing loss and fragmentation of habitat through forest management practices. In addition to *C. devia*, other rare gastropods associated with bigleaf maple litter in this area apparently face similar threats, and are expected to respond similarly to 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.

Management within the Habitat Area should focus on maintaining or enhancing habitat for the species in a small area immediately surrounding a single site. Under this approach, the size and quality of the Species Habitat Area should be sufficient to maintain favorable environmental conditions at the site location, conserve (or restore) the identified associated habitat features, and provide conditions that allow the species to survive at this site. The size and shape of the Species Habitat Area depends on site specific conditions and estimates of dispersal distances in similar-sized terrestrial mollusks and estimates of genetic neighborhood, or deme, size. Based on the size and moderate dispersal ability of this species, 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. Site features (such as slope position, aspect, cover, moisture, topographic breaks, vegetation types, ecotones, habitat elements) and management operations (such as ownership boundaries, roads and logging requirements) can both be incorporated into the size and shape of the unit needed. Drier, more open stands, southerly or westerly aspects, upper slopes, etc., generally indicate the need for larger Species Habitat Areas (Burke 2014, *pers. comm.*). Consideration should also be given to daily and annual movement cycles of the animals. Several research articles provide information about maintaining site conditions and reducing edge effects and are listed in the reference section (Chen et.al., 1990, 1992, 1993, 1995, 1997; Song et. al., 1977; Dong et. al., 1998; Saunders et. al., 1998).

4. Management Within Species Habitat Areas

<u>General Considerations</u>: Consider the following:

- Maintain the favorable daily and seasonal temperature and moisture regimes of the microsites in which these gastropods occur (i.e., ground level microclimates and cover components):
    - Retain a sufficient amount of overstory crown cover and understory vegetation to shade the ground, provide humidity through evapotranspiration, and impede air movement that would tend to displace the cool moist air.
    - Encourage the maintenance and recruitment of woody debris and a layer of litter and duff. These components provide cool moist places in which the animals spend the days, hide from predators, deposit their eggs, and find food.
- When found within riparian reserves, consider increasing the width of occupied riparian reserves as potential management for this mollusk species.
- Attempt to maintain habitat contiguity by extending boundaries of Species Habitat

Areas to meet other reserve areas such as Riparian Reserves, other Habitat Areas etc., to minimize fragmentation of populations.

Specific considerations: Within the Species Habitat Areas consider the following as a way of maintaining or enhancing habitat conditions for the species:

- Minimize disturbance of the forest floor litter, duff, and woody debris.
- Maintain existing canopy closure within a large enough area to moderate fluctuations of temperature and humidity.
- Maintain hardwood trees and shrubs, including bigleaf maple trees (oldest preferred) and other hardwoods, to provide a constant supply of logs, leaves, and leaf mold.
- Manage for a diversity of hardwood and conifer tree species on the site. Place emphasis on the species that the mollusk species is observed to be using in the area. The desired mix could be determined by the sites supporting the greatest populations of the mollusk species in the area.
- Maintain or enhance the naturally occurring diversity of plant species. This will increase the range of hosts for a variety of fungi species and make other food substrates available throughout the season. This also provides assurance that specific plant species, if found to be critical in the life cycle of this mollusk species, are not inadvertently lost.
- Maintain important cover and microhabitats by maintaining dead and downed woody debris (especially Class 2 - 4), including all size classes, in its natural abundance. Falling trees where insufficient numbers of logs occur may be done, but is not encouraged unless the resulting canopy cover provides sufficient shade to maintain cool, moist conditions.
- Avoid prescribed burning within the Species Habitat Area.
- As feasible, manage to control exotic snails and slugs, as well as noxious weeds and other exotic animal species.
- Avoid road construction, quarrying, and other major site disturbing activities within occupied rockslides and talus areas.

5. Additional Considerations:

Exotic species of both plants and animals are entering habitats occupied by this species. If exotic species are found, measures to control them should be implemented if feasible. Measures to control exotic species should not be adverse to *Cryptomastix devia* and other native species (Burke 2014, *pers. comm.*).

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

Additional data could help resolve several questions. These include:

- What is the specific range of this species? In particular, surveys should be conducted at the eastern Cascades site (near Cle Elum) to confirm the presence of this snail in this region. The identification of the specimen collected from this site is not in question (Burke 2013, Kogut 2014, *pers. comm.*), however the habitat at this site is very atypical (in talus, above the elevation where bigleaf maple occurs), and it is possible that the specimen was transported there by a bird (Kogut 2014, *pers. comm.*). Resurveys of the site are recommended (Kogut 2014, *pers. comm.*). Being the only confirmed specimen on the east slope, it is important to know whether or not there is actually a population there to determine if management for the species in that area is reasonable (Burke 2014, *pers. comm.*).
- 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? Are habitats used by the species at the apparent center of its distribution in the Cowlitz and Cispus River drainages on the Gifford Pinchot N.F. consistent with those used elsewhere, particularly at the edges of its range and at more xeric sites?
  - How does this species disperse to other suitable habitat patches, and what limits its dispersal capability?
  - How large are local populations, and how does this affect long-term viability of occupied sites?
- What are the biological attributes of the species' habitat?
  - Plant associations;
  - Specific plant species required/used;
  - Specific foods;
  - Amount of large woody debris desired;
  - Optimum forest crown cover to maintain desired conditions;
  - Other stand structure and components (e.g., small woody debris, litter, duff, water, etc.)?
  - Distance moved in a lifetime?
- What are the physical and chemical attributes of the species' habitat?
  - Soil types, geology, trace elements, pH;
  - Temperature, humidity.

B. Research Questions

Bigleaf maple ecosystems, a preferred habitat of this snail, would benefit from a detailed evaluation of the quality of these habitats and an assessment of potential natural and anthopogenic threats/conflicts facing them (British Columbia Ministry of Environment 2008). Mixed-wood stands with a high proportion (>15%) of this species including groves of old trees are relatively uncommon in the Pacific Northwest, and often have high biodiversity values. For example, older bigleaf maples support remarkable and luxuriant epiphyte (moss, lichen, liverwort, fern) communities on their trunks, stems, and branches; they contribute significantly to nutrient cycling and calcium sequestration through the weight of their leaf fall, high nutrient content, and relatively rapid decay rates; and they provide abundant coarse woody debris and nurse logs when they fall (Peterson et al. 1999; British Columbia Ministry of Environment 2008).

Further research on the dieback and decline of bigleaf maple in Washington and Oregon is needed. Very little work has been done on this issue since 2011, and although several diseases (e.g., *Verticillium, Phytophthora,* and *Xylella fastidiosa*) have been ruled out, the disease agent is still unknown (Ramsey-Kroll 2014, *pers. comm.*).

Additional research questions are as follows:

- What stand characteristics (canopy cover, age, large woody debris, litter and duff, etc.) are required to support the *optimal* conditions for this species?
- Can mid-seral, conifer forest habitat for this species be enhanced through commercial thinning or other practices (e.g. snag creation), specifically to maintain and stimulate growth of bigleaf maple trees for *C. devia* habitat? If so, which method(s) are the most effective?
- How do the required stand characteristics vary under different circumstances (elevation, slope, aspect, geographical location, etc.)?
- What is the response of the species to fire under various intensities and seasons?
- What stand size is required to provide sufficient area of suitable habitat?
- How long is required for recolonization of a site by species from adjacent populations? How does this recolonization occur, and what are its limits?
- What are the effects of herbicides and other chemicals used in forest management on mollusk species, particularly at roadside locations where *C. devia* sometimes occurs adjacent to noxious weed populations?
- What effects are non-native gastropods having, if any, where they occur with *C. devia*?

C. Monitoring Opportunities

- Post-treatment monitoring is desired to evaluate the success of management at maintaining viable populations of the species (Burke 2014, *pers. comm.*). Since the response of *C. devia* to disturbance is expected to be long term, monitoring should ideally be farther out than 3 years. If possible, monitoring is recommended 4 to 5 years post-treatment and again 10 to 15 years post-treatment (Burke 2014, *pers. comm.*). At least two monitoring visits should be made during each period-- one in spring and one in fall. For detailed survey protocols for terrestrial mollusks, see Duncan *et al.* (2003).
- Monitoring of known sites could track trends in populations (numbers, size and density), reproduction, quantity and quality of habitats, and effects of management on populations.
- Monitoring could also help to determine impacts on habitats and populations from management activities, natural disturbances, and vegetative succession.
- For both surveys and monitoring, a standardized set of parameters should appear on the field forms, including standard definitions of all biological parameters.
- Where a species is rare, consider disturbing no more than 5% of its occupied habitat during surveys or monitoring.
- Record all environmental conditions where this species are found to better understand its habitats and management needs.
- Monitor natural sites for conditions and trends of populations.
- Monitor managed sites for implementation and effectiveness of prescriptions.

VI. References

Applegarth, John. 1995. Invertebrates of special status or special concern in the Eugene District. USDI BLM, Eugene, Or. 126 pp.

Bayne, C. J. 1973. Physiology of the pulmonate reproductive tract: location of spermatozoa in isolated, self-fertilizing succinid snails (with a discussion of pulmonate tract terminology). The Veliger 16(2):169-175.

Binney, W.G., 1878. Terrestrial Molluscs, Volume 5:337, fig 220.

Branson, B. A. 1977. Freshwater and terrestrial Mollusca of the Olympic Peninsula, Washington. The Veliger 19(3):310-330.

Branson, B. A. 1980. Collections of gastropods from the Cascade Mountains of Washington. The Veliger 23(2):171-176.

Branson, B. A. and R. M. Branson. 1984. Distributional records for terrestrial and freshwater Mollusca of the Cascade and Coast ranges, Oregon. The Veliger 26(4):248-257.

British Columbia Ministry of Environment. 2008. Recovery Strategy for Puget Oregonian Snail (*Cryptomastix devia*) in British Columbia. Available at: www.env.gov.bc.ca/wld/documents/recovery/rcvrystrat/puget_oreg_snail_rcvry_strat_160108.pdf (Accessed 19 March 2014).

Burke, T. E. 1994. (unpublished report). Survey of the Taneum Watershed for species of the phylum Mollusca. Report to the District Ranger, Cle Elum RD., Wenatchee National Forest, October 25, 1994.

Burke, T. E. 1996. (unpublished report) Mollusk surveys of the Lower Cispus Watershed and other areas of the Randle Ranger District, Gifford Pinchot National Forest, Washington.

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.

Chadwick, Kristen. 2014. Forest Pathologist, USDA-FS Forest Health Protection. Personal communication with Sarah Foltz Jordan, Xerces Society.

Chen, J. and J. Franklin. 1997. Growing season microclimate variability within an old-growth Douglas fir forest. Climate Research 8(1):21-34.

Chen, J., J. Franklin and T. Spies. 1995. Growing season microclimate gradients from clearcut edges into old growth Douglas fir forests. Ecological Applications 5(1):74-86.

Chen, J., J. Franklin and T. Spies. 1993. Contrasting microclimates among clearcut, edge and interior of old growth Douglas fir forest. Agricultural and forest Meteorology 63(3-4):219-237.

Chen, J. and J. Franklin. 1992. Microclimate and its variability in the old growth Douglas fir forest. Bulletin of the Ecological Society of America 73 (2 Suppl):132.

Chen, J., J. Franklin and T. Spies. 1990. Microclimatic pattern and biological responses at the clearcut edges of old growth Douglas fir stands. Northwest Environmental Journal 6(2):424-425.

Chen, J., J. Franklin and T. Spies. 1990. Edge phenomena in old growth Douglas fir forests microclimatic pattern. Bulletin of the Ecological Society of America 71(2Suppl):117-118.

Cooper, J.G. 1868. American Journal of Conchology, Philadelphia, PA. Vol.4:230.

COSEWIC. 2005. Canadian Species at Risk. Committee on the Status of Endangered Wildlife in Canada. 64 pp., page 8. Available at: http://www.sararegistry.gc.ca/virtual_sara/files/species/clwsa_0505_e.pdf (Acessed 19 March 2014).

Dall, W.H. 1905. Land and fresh water mollusks. Harriman Alaska Expedition 8:i–xii, 1–171.

Dong, J., J. Chen, K. Brodofske and R. Naiman. 1998. Modeling air temperature gradients across small streams in western Washington. Journal of Environmental Management 53 (4):309-321.

Duncan, N., Burke, T., Dowlan, S. and P. Hohenlohe. 2003. Survey protocol for survey and manage terrestrial mollusk species from the Northwest Forest Plan. Version 3.0. U.S. Department of Interior, Bureau of Land Management, Oregon/Washington and U.S. Department of Agriculture, Forest Service, Region 6, U.S. Fish and Wildlife Service. 70 pp. [Available on ISSSSP intranet site].

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. 1993. Mollusc species of special concern within the range of the northern spotted owl, final report for: Forest Ecosystem Management Working Group. Deixis Consultants, Seattle. 39 pp.

Frest, T. J., and E. J. Johannes. 1995. Interior Columbia Basin mollusk species of special concern. Final report prepared for: Interior Columbia Basin Ecosystem Management Project. Deixis Consultants, Seattle: 274 pp. + Table and Maps.

Frest, T. J., and E. J. Johannes. 1996. Comments on and additions to Appendix J2, order No. 1422H952-P5-4298, prepared for USDI Bureau of Land Management. Deixis Consultants, Seattle: 78 pp.

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

Gould, 1846. U.S. Exploratory Expedition - Mollusks and Shells, 12:69, pl. 5 figs 74-74b., Procedings of the Boston Society of Natural History, 2:165.

Henderson, J. 1929. Non-marine Mollusca of Oregon and Washington. U. Colorado Studies 17(2): 190 pp.

Henderson, 1936. The non-marine Mollusca of Oregon and Washington--Supplement. University of Colorado Studies, 23(4):251-280.

Huff, Rob. 2014. Conservation Planning Coordinator, ISSSSP. Personal communication with Sarah Foltz Jordan, Xerces Society.

Jakubowski, J. 2014. Results of 2013 post-treatment Puget Oregonian Snail (*Cryptomastix devia*) revisit surveys at previously found sites in project areas. *Draft document provided to Sarah Foltz Jordan, Xerces Society, by John Jakubowski, North Zone Wildlife Biologist, Gifford Pinchot NF, 19 May 2014.*

Kelley, R.S., N. Duncan, and T. Burke. 1999. Field guide to survey and manage terrestrial mollusk species from the Northwest Forest Plan. Oregon Bureau Land Manage. 114 p.

Kogut, T., B.G. Marcot, and K. Mellen. In preparation. Bayesian belief network model for the terrestrial snail *Cryptomastix devia*. Vers. Alpha 0.10a. USDA Forest Service, Pacific Northwest Research Station, Portland, OR.

Kogut, Tom. 2014. Retired wildlife biologist. Personal communication with Sarah Foltz Jordan, Xerces Society.

Kozloff, E. N. 1976. Plants and Animals of the Pacific Northwest, an Illustrated Guide to the Natural History of Western Oregon, Washington, and British Columbia. U. of Washington Press, Seattle and London: 264 pp.

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.

Omdal, D. and Amy Ramsey-Kroll. 2012. Assessing the role of Verticillium wilt in Bigleaf Maple (*Acer macrophyllum*) dieback in Western Washington. Research Poster. Available at: www.fs.fed.us/foresthealth/fhm/posters/posters12/Omdahl_maple_poster.pdf

Peterson, E.B., N.M. Peterson, P.G. Comeau, and K.D. Thomas. 1999. Bigleaf maple managers' handbook for British Columbia. B.C. Min. For., Research Program, Victoria, BC.

Pfeiffer, L. 1850. Descriptions of twenty-four new species of Helicea, from the collection of H. Cuming, Esq. Proc. Zool. Soc. Lond. 17:126–131, p. 130.

Pilsbry, H. A. 1940. Land Mollusca of North America (north of Mexico). The Academy of Natural Sciences of Philadelphia Monographs No. 3, Vol. 1(2).

Ramsey-Kroll, Amy. 2014. Forest Pathologist. Resource Protection Division, Washington State Department of Natural Resources (DNR). Personal communication with Sarah Foltz Jordan, Xerces Society.

Saunders, S., J. Chen, T Crow and K. Brosofske. 1998. Hierarchical relationships between landscape structure and temperature in a managed forest landscape. Landscape Ecology, 13 (6):381-395

Song, B., J. Chen and M. Rudnicki. 1997. The relationship between canopy structure and the pattern and process of the understory. Bulleting of the Ecological Society of America, 78 (4 Suppl):189

Taylor, G.W., 1891. Land Snails of Vancouver Island, The Nautilus, 5: 8, p 91-92.

Taylor, G.W. 1889. The land snails of Vancouver Island. Ottawa Nat. 3:84–94.

USDA, Forest Service, and Department of the Interior, Bureau of Land Management. 1994. Final Supplemental Environmental 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 and Appendix A, Forest Ecosystem Management: An Ecological, Economic, and Social Assessment. Portland OR.

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

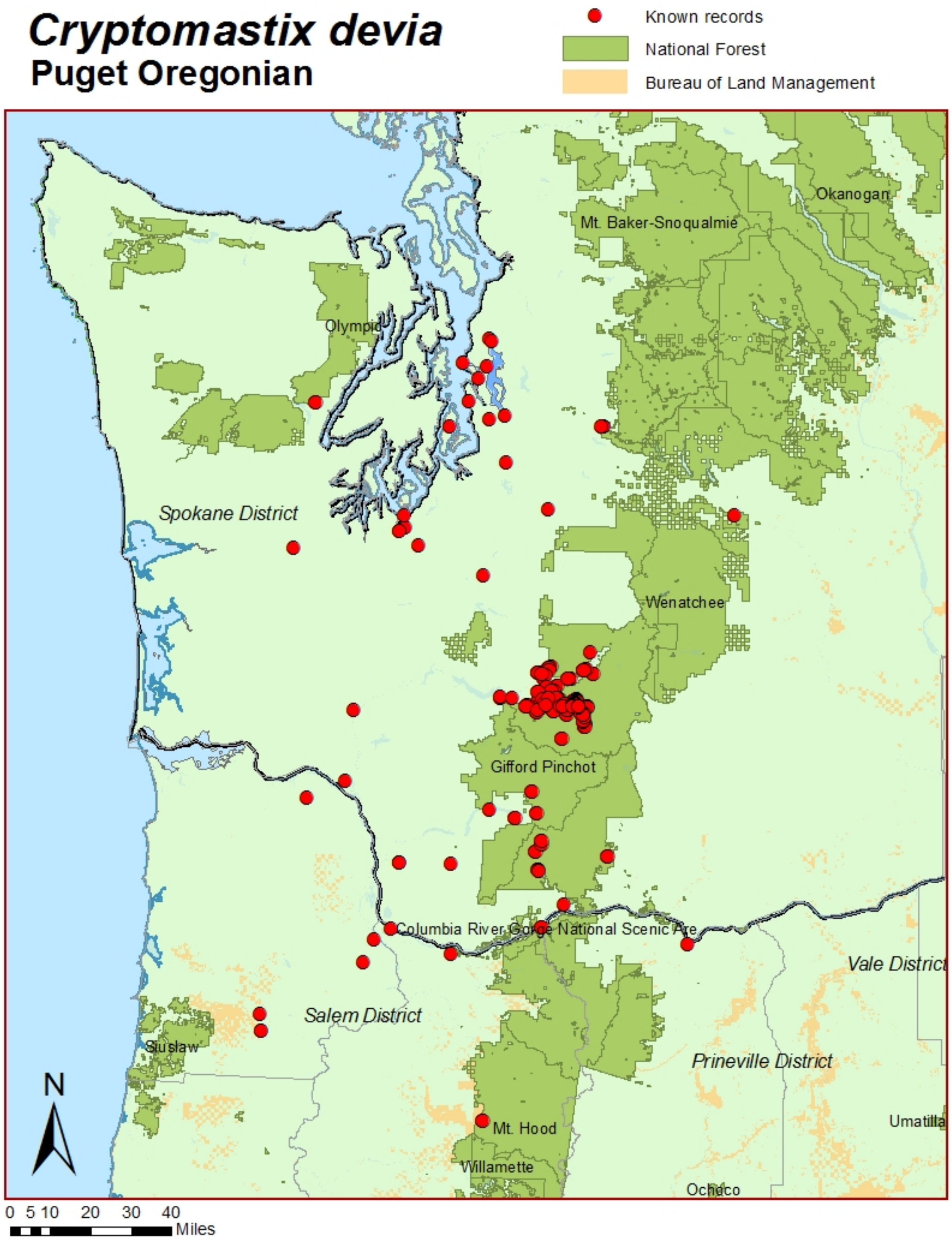
White, R. E. 1983. A Field Guide to the Beetles of North America. Houghton Mifflin Co., Boston: 368 pp.

VII. PHOTOGRAPHS

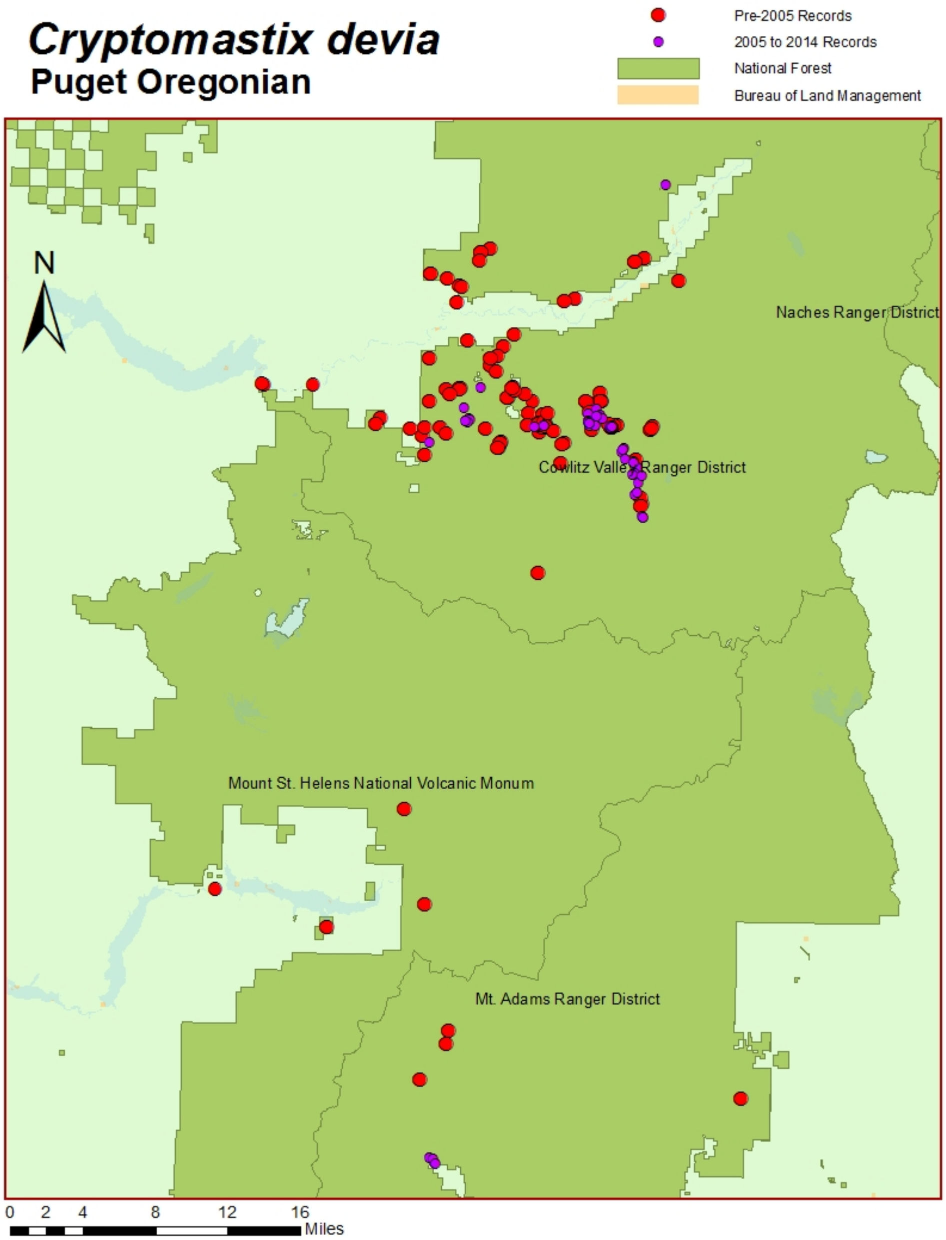
Cryptomastix devia shells. Photograph by Bill Leonard, used with permission.

Cryptomastix devia. Photograph by Bill Leonard, used with permission.

VIII. DISTRIBUTION MAP



Map showing recent *Cryptomastix devia* distribution relative to Forest Service and BLM land. Note: due to data inconsistencies that are still in need of resolution, this map does not include Jakubowski (2014, DRAFT) records of 25 individuals from eight units within four timber sale project areas (Cispus Hazard Tree Removal, Cowlitz Thin, Dry Jackpot and Smooth Juniper) in the Cowlitz and Cispus River drainages that were resurveyed with positive detections in 2013, (although the *original* detections at these sites *are* included on the map).



Sixty-three new *Cryptomastix devia* records were collected between the latest (2005) and current (2014) versions of this Conservation Assessment. The majority (58/63) of these new records were collected from the Gifford Pinchot National Forest, the apparent "center" of the species' distribution, shown here. This map illustrates how the majority of the new (2005-2014) records were found in the immediate vicinity of previously documented (pre-2005) sites. Although total detections of this species have increased, no major changes in distribution or population number were found (e.g., to indicate the need to revise earlier assumptions about the management needs of this species). Note: due to data inconsistencies that are still in need of resolution, this map does not include Jakubowski (2014, DRAFT) records of 25 individuals from eight units within four timber sale project areas (Cispus Hazard Tree Removal, Cowlitz Thin, Dry Jackpot and Smooth Juniper) in the Cowlitz and Cispus River drainages that were resurveyed with positive detections in 2013, (although the *original* detections at these sites *are* included on the map).