Conservation Assessment

for
Four Species of the Genus Hemphillia

Burrington Jumping-slug	**(*Hemphillia burringtoni)***
Warty Jumping-slug	**(*Hemphillia glandulosa*)**
Malone Jumping-slug	**(*Hemphillia malonei*)**
Panther Jumping-slug	**(*Hemphillia pantherina*)**

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Preface:

Converting Survey and Manage Management Recommendations into Conservation Assessments

Much of the content in this document was included in previously transmitted Management Recommendations developed for use with Survey and Manage Standards and Guidelines. With the removal of those Standards and Guidelines, the Management Recommendations have been reconfigured into Conservation Assessments to fit Special Status/Sensitive Species Program (SSSSP) objectives and language. Changes include: the removal of terminology specific to Survey and Manage Standards and Guidelines, the addition of Oregon Natural Heritage Information Center ranks for the species, and the addition of USDA Forest Service and USDI Bureau of Land Management (BLM) Special Status/Sensitive Species status and policy. Habitat, range, and taxonomic information have also been updated to be current with data gathered since the Management Recommendations were initially issued. The framework of the original document is maintained in order to expedite getting this information to field units. For this reason this document does not entirely conform to recently adopted standards for the Forest Service and BLM for Conservation Assessment development in Oregon and Washington.

Assumptions about site management

In the Final Supplemental Environmental Impact Statement (FSEIS) and Record of Decision (ROD) to Remove or Modify the Survey and Manage Standards and Guidelines (USDA and USDI 2004), assumptions were made as to how former Survey and Manage species would be managed under Agency Special Status/Sensitive Species policies. Under the assumptions in the FSEIS, the ROD stated "The assumption used in the final SEIS for managing known sites under the Special Status Species Programs was that sites needed to prevent a listing under the Endangered Species Act would be managed. For species currently included in Survey and Manage Categories A, B and E (which require management of all known sites), it is anticipated that only in rare cases would a site not be needed to prevent a listing. For species currently included in Survey and Manage Categories C and D (which require management of only high-priority sites), it is anticipated that loss of some sites would not contribute to the need to list. Authority to disturb special status species sites lies with the agency official who is responsible for authorizing the proposed habitat-disturbing activity". *Hemphillia burringtoni* and *Hemphillia glandulosa* were in Category E, *Hemphillia malonei* was in Category C, and *Hemphillia pantherina* was in Category B at the time of the signing of the ROD, and the above assumptions apply to these species' management under the agencies' SSSSP.

Management Considerations

Within the following Conservation Assessment, under the "Management in Species Habitat Areas" section, there is a discussion on "Management Considerations". "Management Considerations" are actions and mitigations that the deciding official can utilize as a means of providing for the continued persistence of the species' site. These considerations are not required and are intended as general information that field level personnel could utilize and apply to site-specific situations. Management of the species covered in this Conservation Assessment follows Forest Service 2670 Manual policy and BLM 6840 Manual direction. (Additional information, including species specific maps, is available on the Interagency Special Status and Sensitive Species website.)

EXECUTIVE SUMMARY

Species:

Hemphillia burringtoni	(Pilsbry 1948)	Burrington Jumping-slug
Hemphillia glandulosa	(Binney & Binney 1872)	Warty Jumping-slug
Hemphillia malonei	(Pilsbry 1917)	Malone Jumping-slug
Hemphillia pantherina	(Branson 1975)	Panther Jumping-slug

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

Management Status:

- *Hemphillia burringtoni*: Regional Forester's Sensitive Species List, Region 6 (Washington only); Washington Natural Heritage Program (WNHP) G1G2, S1S2.
- *Hemphillia glandulosa*: Regional Forester's Sensitive Species List, Region 6 (Washington only); Oregon Natural Heritage Program (ONHP) G3, S2 List 2; WNHP S2S3.
- *Hemphillia malonei*: Regional Forester's Sensitive Species List, Region 6 (Washington only); ONHP G3, S3 List 4; WNHP S1S2.
- *Hemphillia pantherina* : Regional Forester's Sensitive Species List, Region 6 (Washington only); WNHP G1, S1.

* G1G2 and S1S2 species are defined as "critically imperiled both globally and within the state because of extreme rarity or because it is somehow especially vulnerable to extinction or extirpation", ONHP list 2 species are imperiled because of rarity or because other factors make them very vulnerable to extinction or extirpation. ONHP list 4 species are not rare and apparently secure but with cause for long-term concern, usually with more than 100 occurrences.

Range:
Hemphillia burringtoni - Throughout the Olympic Peninsula, the Willapa Hills area and into the Southwest Washington Cascades in Washington State. Also form Vancouver and other islands in British Columbia.
Hemphillia glandulosa - Northern Oregon Coast Range; southwestern Washington Cascades and coastal Washington through the Olympic penninsula to British Columbia, Canada.
Hemphillia malonei – Benton County, Oregon, northward in the western Oregon Cascades through the Columbia Gorge and into the southwestern Cascades of Washington and the southern Olympic penninsula. In Washington, the majority of the documented sites are in Skamania County. There are scattered sites documented in Lewis, Pacific, Thurston, Grays Harbor, Mason, and Pierce Counties.
Hemphillia pantherina **-** Known from a single site near the Lewis River, Skamania County, Washington. It is suspected throughout the Cascade Range of western Washington from the Snoqualmie watershed south.

Specific Habitat: This group of 4 slugs inhabits moist, conifer forest habitats. *Hemphillia burringtoni* and *H. glandulosa* inhabit moist forests dominated by conifers, with an occasional hardwood component. Although often occurring within riparian areas, these species are not considered to be riparian obligates. The forest floor is moist, and sometimes wet or saturated. Large woody debris, both conifer and hardwood, is abundant. Logs of decomposition class 3-5 are most often used. Litter and duff layers may be deep and generally continuous. Understory and herbaceous vegetation is quite variable, from depauperate to patchy, consisting of sword ferns (*Polystichum munitum*) and other plants of cool shaded forests. *Hemphillia glandulosa* is often found in association with *H. burringtoni*, particularly on the Olympic Peninsula.

Some specific microsite habitat elements for all species include conifer logs and/or heavy ground cover of low vegetation, litter, and debris. *Hemphillia malonei* but may be found at higher elevations if sufficient ground cover is available. *Hemphillia pantherina* is assumed to use the same habitats as other Hemphillia; however, the only recorded site for *H. pantherina* is near a creek crossing. It is not known whether this species is more strongly associated with riparian or if this is merely coincidental.

Threats: Loss or degradation of habitat leading to loss or isolation of populations at sites occupied by this group of species is considered to be the major threat. Primary causes of habitat loss include forest management, conversion

for agricultural, urbanization and other uses, and fire. Natural threats may include vertebrate and invertebrate predators (i.e., predatory snails, and beetles) especially in locally restricted areas.

Currently *Hemphillia pantherina* is the least known of this group. It is known from one site which has not been relocated; it is not known if this species may be extinct, or if other populations exist but have not been discovered.. The other three species in this group are more widespread and have been found more recently, although their populations are widely disjunct.

Management Considerations:

Consider the following when managing a site for the four species listed in this Conservation Assessment:

- Maintaining microsite characteristics, including areas large enough to moderate fluctuations in humidity, temperature, and other environmental characteristics.
- Providing cover by preserving and recruiting dead and downed woody debris. Within habitats for these species an abundance of large woody debris may be necessary; the quantity naturally available for a given site could be determined by use of the DecAID model or other predictor of down wood amounts for the plant community.
- Avoiding disturbance to occupied rockslides and talus areas from road construction, quarrying, and other activities.
- Maintaining adequate canopy closure of trees to moderate fluctuations of temperature and humidity on the site.
- Maintaining the hardwood tree component (i.e., maples, cottonwood, red alder, aspen) and native plant diversity to provide a constant supply of logs, leaves, fungi and leaf mold.
- Managing riparian sites by increasing Riparian Reserve widths if necessary, to maintain microclimate.
- Managing fuels near sites to protect from adverse effects of fire.
- Avoiding compaction of the soil or disturbance of the litter layer.

Information Needs:

What is the range of environmental conditions tolerated by each species?

What morphologic or genetic differences (if any) exist between *H. glandulaosa* and *H. burringtoni*?

What are the stand characteristics required to support the species?

- 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;
- Soil types, geology;
- Temperature, humidity.

How do the required stand characteristics vary under different circumstances (elevation, slope, aspect, etc.)?

What stand size is required to provide sufficient area of suitable habitat?

How long is required for recolonization of a site by individuals from adjacent populations?

Monitoring of known sites is needed to:

- track trends in populations (numbers, density and distribution, reproduction) and compare to quantity and quality of habitats;
- determine impacts on habitats and populations from management activities, natural disturbances, and vegetative succession;

Note:
Natural history and current species situation accounts for each of the four species addressed in this document are described separately in the following sections I and II. Management goals, habitat management, information, and monitoring needs sections III-V are combined for all species and follow these accounts on page 25.

General information for genus *Hemphillia*

Hemphillia are a unique group of slugs endemic to the Pacific Northwest. Evolutionarily, they appear between snails and slugs, retaining the visceral mass in a raised hump under the mantle, and a shell plate that is not completely enclosed as it is in all other slug species of western North America. This shell is visible through a slit in the back of the mantle. The pneumostome (breathing pore) is in the right side of the mantle about or slightly posterior to the middle. The tail is relatively narrow and a little tapered, and there is a caudal fossa (mucous pit) near the tip where the pedal furrows converge. Over the caudal pit is a triangular flap of tissue, referred to as the "horn", which is developed to different degrees in the different species.

The common name is derived from their habit of flipping their tails and writhing when disturbed, causing them to flip off of objects such as shrubs to avoid predators.

Branson (1975) provides the best key currently available for identifying species of *Hemphillia*.

Species: *Hemphillia burringtoni* (Keeled Jumping-slug)

I. NATURAL HISTORY

A. Taxonomic/Nomenclatural History

Family: Arionidae
Subfamily: Binneyinae
Hemphillia burringtoni Pilsbry, 1948

Pilsbry (1948) described *Hemphillia glandulosa burringtoni* as a new subspecies. Branson (1972) elevated it to full species based on, ". . . consistent differences of genitalia and external pigmentation patterns."

Recently, molecular DNA analysis work was undertaken by Thomas Wilke and Joan Ziegltrum to determine if *H. burringtoni* and *H. glandulosa* are in fact separate species. Their work indicates that these two may be divided into two clades that are part of a single species complex. There is still uncertainty between these two species, and morphological characters previously used to distinguish between these two species do not allow for a reasonable differentiation between them. (Wilke, 2004)

B. Species Description

1. Morphology

The following description is condensed from Pilsbry (1948) and Branson (1972): *H. burringtoni* is a relatively small slug, 8-20 mm long. Its body is depressed under the visceral pouch, then the tail is raised into a prominent keel. The head and tentacles are black. The mantle lacks the distinct papillae found on the very similar *H. glandulosa*, and is speckled with gray and black. There is a row of distinct gray to black dots along the sides just above the pedal furrows. Below the pouch, the body is marked posteriorly by 7 to 9 broad, dark gray diagonal bands. The penial stimulator of *H. burringtoni* is smooth within while that of *H. glandulosa* is rugose (wrinkled).

The following direct quotes are included in the likelihood that they may be helpful to personnel attempting to distinguish between slugs of this genus. All of these quotes refer to *H. burringtoni* or its relationship to *H. glandulosa*.

"The body is depressed under the pouch, raising behind it to form a high compressed keel; the horn over the caudal pit is lacking or very small. Visceral pouch nearly smooth; penial stimulator smooth within" (Branson 1975). In an earlier description Branson (1972) said, "Posteriorly, the moderately developed hornlike protuberance above the caudal mucous gland is bluntly rounded behind, but is rather triangular in lateral view."

"Externally it resembles *H. glandulosa* except that there is no trace of papillae on the mantle, which is smooth. The spaced oblique lines on the sides of the foot terminate in gray dots above the pedal groove, and back of the middle these lines are somewhat pigmented. On the elevated tail they break into a coarse network and are pigmented" (Pilsbry 1948).

Early survey efforts between fall 1998 and spring 2000 by Forest Service and Bureau of Land Management employees, using the pattern of dots as the defining species character, resulted in 195 Burrington jumping slug sites, all with distinctly *papillose* mantles. The row of distinct gray to black dots along sides above pedal furrows follows Pilsbry and Branson's descriptions. However, the presence of the papillose mantle character in these specimens indicated the need for these records to be further examined or changed to *H. glandulosa*, especially in light of the DNA evidence. Burrington jumping slugs have been observed in copulation with *H. glandulosa* (Ziegltrum 2000). Numerous intermediate morphological forms have been found on the Olympic Peninsula and other locations. These include jumping slugs that appear to be *H. burringtoni*, but have only a slight row of dots on one side of the tail, and not the other side. Many variations of intermediates have been observed. The development of new species descriptions and keys may be required.

2. Reproductive Biology

Nearly all of the terrestrial gastropods in the Pacific Northwest, including the *Hemphillia*, are hermaphroditic, having both male and female organs. Self-fertilization has been demonstrated in some species, although cross-fertilization is probably the norm. Bayne (1973) discussed problems encountered with self- and cross-fertilization in Pulmonates, and the dominance of allosperms (sperm from another) over autosperms (sperm from oneself). *Hemphillia* are oviparous (egg layers); the clutches are generally small, consisting of only a few eggs. *H. malonei* have been reared in captivity and eggs hatched Burrington jumping slugs have been observed in copulation with *H. glandulosa* (Ziegltrum 2000).

Reproduction in *H. malonei* has been studied in captivity. Details can be found in the reproduction section for that species. Eggs were laid 1 to 6 days after copulation in clutches of 19 to 61 eggs, each individual producing up to 4 clutches. Development time at 14°C ranged from 47 to 63 days from oviposition to hatching (Leonard & Ovaska 2002).

3. Ecology

Hemphillia burringtoni is a species of low to mid elevation rain forests. Particular foods and cover types are not documented, but most *Hemphillia* are usually found within or under rotting logs, or forest floor litter, apparently feeding on decaying wood, fungi, vegetation or micro-organisms associated with decaying matter. Thus these slugs assist in decomposition of forest floor debris and contribute to organic matter in the soil. The species probably has a digestive efficiency rate in the high forties for assimilation of food materials, a low rate that allows viable spores and fragments of fungal hyphae to be excreted with the feces. Thus, snails and slugs represent an important dispersal mechanism for fungal species throughout the year when these mollusks are active.

Specific enemies of the jumping-slugs have not been documented, but as with other mollusks, they are preyed upon by a variety of predators. Their unique "jumping" habit is assumed to be an adaptation for defense against some type or types of predators, the specifics of which were not found documented.

C. Range, Known Sites

Hemphillia burringtoni, as currently recognized, is known from the Olympic Peninsula, Washington, south along the Washington coast to the Columbia River, extending east to southern Puget Sound and the western Cascade Mountains south of Mt. St. Helens, Washington, in the Gifford Pinchot National Forest. The type locality is Rialto Beach, Olympic National Park, just north of the Quillayute River mouth, Clallam County, Washington (H. B. Baker 1929; cited in Pilsbry 1948).

Branson (1977) reported 9 specimens from 7 locations on the Olympic Peninsula in Clallam, Jefferson, Mason, and Grays Harbor counties, and 1 from Bush State Park, Pacific County, Washington. Branson and Branson (1984) reported a probable immature specimen from Clatsop (Tillamook) County, Oregon.

Recent survey efforts by USDA Forest Service and USDI Bureau of Land Management personnel resulted in additional locations in Washington State on the Olympic and Gifford Pinchot National Forests. The majority of these new sites are on the Olympic Peninsula. Other new locations are in Clallam, Jefferson, Grays Harbor and Mason Counties on the Peninsula and in Skamania County in the western Washington Cascades. Approximately 5 -10% of the Olympic specimens are intermediates, having characteristics of both *H. burringtoni* and *H. glandulosa*. Leonard (Ziegltrum 2000) reported 3 new locations on the southern Washington coast in Pacific County. He noted that these specimens appeared to be hybrids between *H. glandulosa* and *burringtoni*. He also found one location of the Burrington jumping-slug in Clallam County, Washington.

D. Habitat Characteristics and Species Abundance

1. Habitat Characteristics

The general habitat for all Hemphillia species in this document is moist forest dominated by conifers but with a moderate hardwood component. The forest floor is moist but not wet or saturated. Large woody debris, both conifer and hardwood, is abundant. Logs of decomposition class 3-5 are probably most often used. Litter and duff layers are deep and generally continuous. Low vegetation may be patchy and consist of sword ferns and other plants of cool shaded forests.

Hemphillia burringtoni inhabits rainforests and other wet forest areas in western Washington to northwestern Oregon from sea level to at least 1050 meters (3445 feet) elevation, the point at which Branson (1977) called "transition zone." Habitat descriptions are not extensive, but they imply general rain forest, or other moist to wet forest conditions with heavy shading or vegetative cover, or (as with many gastropods) talus. Logs and/or other woody debris are important to the *Hemphillia*.

Branson (1977 & 1984) found this species in dense rain forests including hemlock, spruce, western red cedar, pines, ferns and mosses, sometimes associated with fallen logs, talus, and/or shrubs. Branson (1972 & 1977) reported it from elevations ranging from 166 to 1050 meters (545 to 3435 feet), in rain forests, with heavy Pacific dogwood growth in one site, in talus at one site, and with ferns and fallen logs.

USDA, Forest Service, and USDI, Bureau of Land Management (1994: J2-347) says, "Species is a riparian associate." This may be true in the

sense that moist riparian forests support many snails and slugs, but no references found indicate that *H. burringtoni* has any particular affinity to riparian habitat over other moist forest conditions. Frest and Johannes (1993) called it an "Old growth and riparian associate . . .", which better aligns with the meager descriptions of the locations by Branson (op cit).

The most recent survey efforts by the Forest Service (FS) and Bureau of Land Management (BLM) indicate that *Hemphillia burringtoni* shares similar habitat with *H. glandulosa*. *Hemphillia burringtoni* has been documented in a wide range of forest conditions. These include several old-growth sites and many in second growth conifer forests between 40 - 80 years old. Only a small number of old-growth sites have been located, due to the focus on project surveys for commercial thinning timber sales (Ziegltrum 2000). It is important to note that most records are the results of surveys conducted for project clearances, which were mostly proposed commercial thinnings in young, second growth forests of Douglas-fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), western redcedar (*Thuja plicata*), Sitka spruce (*Picea sitchensis*) and occasionally Pacific silver fir (*Abies amabalis*). Therefore, only a small portion of potential *H. burringtoni* and *H. glandulosa* old growth habitat was inventoried, and the importance of this type of habitat for the species may be understated.

Burrington jumping slugs were found in elevations ranging from 300 to 2700 feet, with an average elevation of 833 feet. Slopes ranged from 0 to 75%. Sixty percent of the sites were on flat ground, and the average slope on the remaining sites was 19%. The mean aspect was SSE (149 degrees), however the full range between zero and 360 degrees was represented. Canopy cover on the sites ranged between 2 - 100%, with a mean of 78%.

2. Species Abundance

Hemphillia burringtoni is a local endemic of western Washington. It appears to be more common and well distributed in parts of the range (Olympic Peninsula), and less abundant within other parts. There are currently 23 records for this species in the Interagency species database.

Pilsbry (1948) reported it only from the type locality. Branson (1977) found 9 specimens at 7 of 269 sites surveyed on the Olympic Peninsula, plus 1 specimen from near Willapa Bay. In their surveys of the Oregon Cascades and Coast Range, Branson and Branson (1984) found one specimen that may have been this species. Frest and Johannes (1993) said they had not found it at their Washington sites in 1986 through 1991.

The difference in abundance between the early work and current FS and BLM surveys, may be due to different interpretations of the morphology of Burrington jumping slugs (e.g. papillose vs. smooth mantle). In many

cases, specimens that were recorded as *H. burringtoni* may be actually *H. glandulosa*, because earlier it was considered to occur with a papillose mantle. In 2002, most records that did not have details indicating specimens had a smooth mantle have been edited to be *H glandulosa*, Another complication is the presence of intermediates between *H. burringtoni* and *glandulosa*.

II. CURRENT SPECIES SITUATION

A. Status History

Findings under the FEMAT assessment implied that, under the preferred alternative (Option 9), this species had a 33% chance of being well distributed across Federal lands, a 27% chance of being locally restricted (i.e., with significant gaps between populations), a 20% chance of being restricted to refugia, and 20% of being extirpated. Based on current knowledge there are significant gaps between populations. If additional surviving populations are discovered, as seems likely, the probability of a more favorable outcome might increase. "The rating for the species is based on the possible reduction from its historic distribution, the lack of knowledge of its current status, and the lack of specific protection in the Olympic AMA" (USDA, Forest Service, and USDI, Bureau of Land Management, 1994: J2-347).

In 2001, it was considered to be a rare species, under Survey and Manage Category A, based on the low number of occurrences, its low detection rate in suitable habitat and its small range. After the Annual Species Review in 2002 this species was placed in Category E, due to difficulties in taxonomy and identification, and uncertainty about management needs. It is listed by the Washington Natural Heritage Information Center with Global ranking G1, State ranking S1 (Critically imperiled globally and within the state because of extreme rarity or because it is somehow especially vulnerable to extinction or extirpation). In 2004, Region 6 of the Forest Service classified this species as Sensitive in Washington.

B. Major Habitat and Viability Considerations

Habitat of the Burrington jumping-slug is in rainforests and riparian habitats, which have been heavily logged on the Olympic Peninsula. Some of the habitat for this species is in the Olympic National Park and is mostly all protected there. Other habitat may be managed as Late-Successional Reserve (LSR) or Adaptive Management Area (AMA) on the Olympic National Forest. Since AMAs are to be managed experimentally, habitat may be adversely modified or lost as projects are implemented. Occupied habitat in LSRs is more likely to remain suitable, as thinning projects in mid- successional stands (40-80 years of age) are designed to accelerate the development of late-successional conditions.

Occurrence and distribution needs to be clarified for *H. burringtoni* and *H. glandulosa*. While both are species of interest, there may be confusion over distribution based on past species or subspecies determinations. In order to understand population trends, species status, and habitat relationships, it will be necessary to understand the differences and similarities between ranges, habitats, ecology, and biology.

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. In general, the more heterozygous (differing between genes of the two sets of chromosomes) a species or population is, the more adaptable to change or adverse circumstances it will be. Therefore, loss of heterozygosity in a population is considered deleterious to its survival, and the smaller the population, the less likely it will be for it to recover its genetic diversity.

C. Threats to the Species

Threats to Burrington's jumping slug include loss of habitat and resulting isolation of populations through timber harvest, and development for housing, recreation, and other uses. Habitat fragmentation reduces sizes of populations; reduction in habitat quality reduces density of populations.

The Olympic National Forest, the Gifford Pinchot Forest and the Olympic National Park support most of the currently known populations of this species. The amount of forest disturbed by management on the Forests is minor, with a predominance of thinning operations. The population segments in the National Park may be secure, but without additional surveys, little is known about the percentage of the historic range that occurs within the Park. Based on the much broader range of the species, it is speculated that the populations within the Park are a relatively small portion of the total.

There are fewer sites on the Gifford Pinchot National Forest, and populations in this region may be more at risk for isolation due to the potentiqal for an increased level of forest management and the lower density of existing sites. Smaller, more isolated populations will be less likely to maintain genetic diversity.

There is also a threat when exotic and introduced species compete or predate these jumping slugs.

D. Distribution Relative to Land Allocations

Most of the *H. burringtoni* sites on the Olympic National Forest are in an Adaptive Management Area, while the remaining sites are in Late Successional Reserves. Other sites on the Olympic Peninsula are located within the Olympic National Park, the Quinault Indian Reservation, and one is in a State Park. Most sites on the Gifford Pinchot National Forest are in Matrix lands and 2 are in Late

Successional Reserves. The land ownership of the 2 sites in Pacific County reported by Leonard is unknown.

Species: *Hemphillia glandulosa* (Warty Jumping-slug)

I. NATURAL HISTORY

A. Taxonomic/Nomenclatural History

Family: Arionidae
Subfamily: Binneyinae
Hemphillia glandulosa Bland & Binney, 1872

Recently work was undertaken by Thomas Wilke and Joan Ziegltrum to determine if *H. burringtoni* and *H. glandulosa* are in fact separate species. Their work indicates that these two may be divided into two clades that are part of a single species complex. There is still uncertainty between these two species, and morphological characters previously used to distinguish between these two species do not allow for a reasonable differentiation between them.(Wilke, 2004)

B. Species Description

1. Morphology

As with all *Hemphillia*, this species has a distinct visceral hump covered by the mantle, and the shell is visible through a slit in the back of the mantle. There is an obvious caudal mucous pit at the posterior confluence of the pedal furrows.

The following description is condensed from Pilsbry (1948) and Branson (1972): It is a rather small slug, 12 to 30 mm. long. As with *H. burringtoni*, the body is depressed under the pouch, then the tail is raised into a prominent keel. The horn over the tail is lacking or very small. Pilsbry's description varies from Branson's in saying, ". . . keel declining and terminating in a prominent horn-like process at the end." (Pilsbry 1948). The type description of Bland and Binney, quoted by Pilsbry, also states, "Caudal process very large, triangular in profile, dark brown with a few coarse granulations."

The most distinguishing feature of *H. glandulosa* is the numerous distinct papillae, which cover the mantle. The color is whitish with dark markings, the head and tentacles being dark blueish with white sides below. The mantle also dark, but light on the edges and posteriorly. The inside of the penial stimulator is wrinkled. "Visceral pouch bearing numerous papillae; penial stimulator rugose within" (Branson 1975).

Hemphillia glandulosa is similar in appearance to *H. burringtoni* except that its mantle is covered with distinct papillae. Branson (1972) showed that the penial stimulator of *H. burringtoni* is smooth within, while that of *H. glandulosa* is rugose (wrinkled).

2. Reproductive Biology

See discussion under *Hemphillia burringtoni*, above.

3. Ecology

Hemphillia glandulosa is found in relatively moist, generally low to middle elevation forests and riparian areas in various seral stages. The majority of the documented sites are in second growth forests between 35 and 80 years in age. *H. burringtoni* occupies similar habitat, and *H. glandulosa* is often found in association with *H. burringtoni*, particularly on the Olympic Peninsula.

Warty jumping-slugs are usually found within or under rotting logs, or forest floor litter (including hardwood leaf litter), apparently feeding on decaying wood or vegetation, fungi or micro-organisms associated with that decaying matter. These slugs assist in decomposition of forest floor debris, thereby contributing to organic matter in the soil. The species probably has a digestive efficiency rate in the high forties for assimilation of food materials, a low rate which allows viable spores and fragments of fungal hyphae to be excreted with the feces. Thus, they represent an important dispersal mechanism for fungal species throughout the year when these mollusks are active.

Specific enemies of the jumping-slugs have not been documented but, as with other mollusks, they are preyed upon by a variety of predators, including other mollusks and arthropods. Their unique "jumping" habit is assumed to be an adaptation for defense against some type or types of predators, the specifics of which were not found documented.

C. Range, Known Sites

The range of *H. glandulosa* is in the Coast Range of northwestern Oregon (Tillamook, Lincoln, and Yamhill Counties), north into British Columbia; and in the western Washington Cascades and west to the Pacific Coast and Olympic peninsula in Washington. It has not been reported from the northwestern Oregon Cascades. Washington locations include: Clallam, Grays Harbor, Jefferson, Mason, Thurston, and Pacific Counties, as well as King, Pierce, Lewis, Cowlitz, Skamania, and possibly Whatcom counties.

Branson (1972) says *H. glandulosa* "occupies mainland Washington west of the Cascades and adjacent British Columbia westward to the Olympic and Gray Wolf mountains and southward to northern Oregon." He did not report it in any of his

surveys of the Washington Olympic or Cascade Range (1977, 1980) or Oregon Cascades and Coast Range (Branson and Branson 1984).

Pilsbry (1948) cites 8 locations from Washington and Oregon and 2 from British Columbia. Oregon: Astoria & Portland; Washington: Tacoma, Olympia, Grays Harbor, Point Ellis, Pacific County, Neah Bay, 10 miles north of Hoquiam; British Columbia: 3 miles up Naniamo River, and on the Corvichan River.

Burke (personal notes) has found it in the Hoh River Watershed, Olympic National Park, Jefferson County, Washington and in the South Fork Snoqualmie Watershed in King County.

Recent survey efforts by USDA Forest Service and USDI Bureau of Land Management personnel resulted in 948 new locations in Washington and Oregon, between fall 1998 and spring 2000.

The Washington sites include 197 on the Olympic Peninsula and the Olympic National Forest (Clallam, Jefferson, Grays Harbor and Mason Counties). Leonard (personal communication) reported an additional 5 locations, one on the southern Washington coast in Pacific County, two on the Olympic Peninsula and two in the Olympia area.

Forty-seven of the new sites were in the southwestern Cascades of Washington, on the Mt. St. Helens Ranger District of the Gifford Pinchot National Forest (Cowlitz and Skamania Counties).

The majority of the new warty jumping-slug sites, 685, were in 35 to 80 year old forests in the northern Oregon Coast Range, on the Hebo Ranger District of the Siuslaw National Forest. These sites were located in the following watersheds: Nestucca River, Three Rivers/Nestucca River, Little Nestucca River, South Yamhill River and Schooner/Drift (Siletz Bay). The coastal Oregon counties included: Tillamook, Yamhill and Lincoln (Bickford, personal communication).

The Tillamook Resource Area of the Salem Bureau of Land Management reported an additional 13 *Hemphillia glandulosa* sites. Eleven of these were on the west side of the Coast Range summit, near the crest, in the upper end of the Nestucca River Drainage, WNW of McMinnville, Oregon. Two were mid-drainage of Coast Creek, NW of Willamina, Oregon. Two other *H. glandulosa* were recently found in an eleven year old, previously burned conifer plantation (Pampush, personal communication).

D. Habitat Characteristics and Species Abundance

1. Habitat Characteristics

The general habitat for the warty jumping slug is moist forest dominated by conifers, with an occasional hardwood component. The forest floor is moist, and sometimes wet or saturated. Large woody debris, both conifer

and hardwood, is abundant. Logs of decomposition class 3-5 are most often used. Litter and duff layers may be deep and often continuous. These substrates appear to be common between sites in the Olympic Peninsula, the Washington Cascades and the Oregon Coast Range.

Hemphillia glandulosa has recently been documented in a wide range of forest conditions. Warty jumping-slugs have been found in an eleven year old previously burned conifer plantation in the Oregon Coast Range, and numerous second growth conifer forests between 35 - 80 years old. Only a small number of old-growth sites have been located; few surveys have been conducted in these types of stands, as most projects and hence surveys have focused on commercial thinning timber sales in younger forests.

According to Frest and Johannes (1993), *Hemphillia glandulosa* inhabits relatively moist and undisturbed coniferous forest, generally at low to middle elevations. Some sites may be riparian (USDA, Forest Service, and USDI, Bureau of Land Management (1994: J2-347)). It is generally found under forest floor litter or debris and on or under logs. G. W. Taylor found it in British Columbia under ferns, and A. W. Hanham found it ". . . among dead leaves of thickets in pastures" (Pilsbry 1948).

On the Olympic Peninsula, Warty jumping-slugs were found in elevations ranging from 300 to 2700 feet, with an average elevation of 833 feet. Slopes ranged from 0 to 75%, with 7% being the average. The mean aspect was SSE (149 degrees), however the full range between zero and 360 degrees was represented. The majority of the sites were in 40 - 60 year old second-growth forests. Canopy cover on the sites ranged between 2 - 100%, with a mean of 81%. The overstory was western hemlock, Douglas-fir, Sitka spruce, western redcedar and occasionally Pacific silver fir. A number of the sites included red alder, bigleaf maple or vine maple microsites, however, hardwoods do not appear to be a limiting factor in *H. glandulosa* habitat.

Plant associations and understory species were variable, with sites from both the west and east sides of the Olympic Mountains. Sites were in the Pacific silver fir vegetation zone, the Sitka spruce zone, and in the western hemlock zone. Plant associations in the western hemlock zone included drier sites with salal (*Gaultheria shallon*), and moister sites with sword fern or Devil's club (*Oplopanax horridus*), plus many other plant species, including Oregon grape (*Berberis nervosa*), salmonberry (*Rubus spectabilis*), Alaska huckleberry (*Vaccinium alaskaense*), and red huckleberry (*Vaccinium parvifolium*). Moss was a key habitat component at many sites, along with down wood in various sizes, generally in decay classes 3-5.

The largest numbers of *Hemphillia glandulosa* sites were found in the Oregon Coast Range on the Hebo District of the Siuslaw National Forest.

These sites were in relatively dense stands of 28 to 85 year old conifers, with a large component of Douglas-fir. Slope aspects were generally between 135 degrees (SSE) and 320 degrees (NNW), with the mean at 270 degrees (W). Canopy cover on the majority of the sites was generally between 60 to 90%, while the average was 84%. The conifer overstory was primarily Douglas-fir. Western hemlock was mixed with Douglas-fir, and red alder occurred in some locations. Understory species included salmonberry, red huckleberry, fool's huckleberry (Menziesia ferruginea) and vine maple. Sword fern, moss and salal were common on many of the sites.

Data from the BLM's Tillamook Resource Area were similar to the Siuslaw's. However, two of the BLM *H. glandulosa* sites were in an 11 year old previously burned plantation; the former stand may have been mixed conifer and bigleaf maple. Two warty jumping slugs were found in a 12 year old plantation on the Gifford Pinchot National Forest. Surveys have been very limited in such young forests, and more work is needed in this area. *H. glandulosa* locations in the Mt. St. Helens Ranger District of the Gifford Pinchot National Forest are stands from 40 - 200 years old. Slopes ranged from 0 - 30%, aspect from 2 - 360 degrees and canopy cover from 40 - 100%. Fifty-three percent of the sites were in the Pacific silver fir zone, with an overstory of silver fir, western hemlock, western redcedar and occasionally Douglas-fir. The remaining sites were in the western hemlock zone and included 13 hardwood sites (vine maple, bigleaf maple and red alder).

2. Species Abundance

Records for the warty jumping-slug were scarce prior to implementation of the Northwest Forest Plan in 1994. Branson did not record it in any of his surveys of the Washington Cascades (1980), the Olympic Peninsula (1977), or the Oregon Cascades and Coast Range (Branson and Branson 1984). Frest and Johannes (1993) said, "We have not seen this species at our sites." Pilsbry (1948) lists 8 locations from Washington and Oregon and 2 from British Columbia.

It has since been found to be quite common in the northern part of its range in Oregon and Washington, with a total of 1348 sites recorded in the Interagency species database. *H. glandulosa* locations in many of the survey areas are abundant and well distributed throughout the project area, with similar habitat often surrounding the project. Most records document one or a few individuals at each site.

II. CURRENT SPECIES SITUATION

A. Status History

This species was listed under 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: Standards and Guidelines C-6 and C-59). "The rating for the species is based on the possible reduction from its historic distribution, the lack of knowledge of its current status, and the lack of specific protection in the Olympic AMA" (USDA, Forest Service, and USDI, Bureau of Land Management, 1994: J2-347).

It was originally considered to be a rare species throughout its range, under Survey and Manage Category A, based on the low number of occurrences, its low detection rate in suitable habitat and its small range. After the Annual Species Review in 2002 the populations in the Oregon Coast Range and the Olympic Penninsula were considered to be stable and were removed from the Survey and Manage Standards and Guides, while the Washington Cascades populations remained in Category A. In 2004, Region 6 of the Forest Service classified this species as a Sensitive Species in Washington. It is listed by the Oregon Natural Heritage Information Center as G3 S2, and on List 2. The Washington Heritage Information center ranks it as S2S3 in Washington (at risk globally and critically imperiled within both states because of extreme rarity or because it is somehow especially vulnerable to extinction or extirpation).

B. Major Habitat and Viability Considerations

Undisturbed moist forest situations in which this species is found have been reduced by logging, agriculture, and urban development. "Many of the old sites were in the Willapa Hills and are probably extirpated, as this area has been almost completely lumbered. Most other localities were from areas now strongly urbanized" (Frest and Johannes 1993).

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. Genetic diversity in small or low density populations should be of concern.

C. Threats to the Species

Threats to *H. glandulosa* include population isolation from loss or fragmentation of habitat; and modification of habitat conditions, so that the species is no longer able to occupy a site, or so that population density is so reduced that individuals have difficulty interacting. Predation and competition from exotic and introduced mollusks are also a consideration.

D. Distribution Relative to Land Allocations

The largest number of *Hemphillia glandulosa* locations are in the Olympics and Oregon Coast Range. The majority of the Olympic Peninsula sites are in

Adaptive Management areas, as are the sites in the Oregon Coast Range. The majority of sites in the Washington Cascades on the Gifford-Pinchot NF are in the Matrix land allocation.

The Olympic Peninsula sites include several in Olympic National Park. Within the Olympic National Forest, 81% of the *H. glandulosa* locations are in the Adaptive Management Area, and 19% are in Late Successional Reserves.

On the Siuslaw National Forest, 84% of the sites are in AMA-Late Successional Reserves, and 16% in AMA outside of LSR. The Tillamook Resource Area of the BLM also has most of its sites in Late Successional Reserves (85%).

Species: *Hemphillia malonei* (Malone Jumping-slug)

I. NATURAL HISTORY

A. Taxonomic/Nomenclatural History

Family: Arionidae
Subfamily: Binneyinae
Hemphillia malonei Pilsbry (1917)

Pilsbry (1948) considered this a "doubtful" species, most likely *H. camelus*. However, Kozloff and Vance (1958) showed it to be a distinct species.

B. Species Description

1. Morphology

Pilsbry (1948) says, "The general color is dusky drab, becoming blackish-brown on the tail. There are a few small black spots along the sides of the mantle, which has a very large opening exposing the shell. Pneumostome is about midway of the mantle. Behind the mantle there is a short median impressed line flanked by obliquely decurrent lines; followed posteriorly by irregular, coarse granulation, the end of the tail then becoming carinate. The pedal furrows rise behind, as in *H. camelus*, and there is no horn above their junction, and no specialized caudal mucous pore . . . . The mantle is smooth. Total length preserved in formaldehyde 33 mm.; length of the mantle about 16 mm . . . length of the shell about 10.5 mm."

Individuals of *H. malonei* reach lengths of up to 7 cm. The ground color is usually light tan to buff, becoming darker on the tentacles and the tail. There are a few scattered, black spots on the anterior half and the sides of the mantle. The sides below the mantle are typically light colored with dark gray mottling beginning under the posterior mantle and increasing in density posteriorly. A light mid-dorsal line, somewhat tapering posteriorly, runs along the tail behind the mantle and is often bordered by

darker lines on each side. Impressed grooves run obliquely down the sides of the tail. The pneumostome is located about midway on the right side of the mantle.

Many color variations have been found, including yellow, orange, or reddish ground colors and rich brown or dark gray varieties. The spots on the mantle are occasionally indistinct or larger to form lines, squares, or more regular mottling, and in dark specimens the mantle may appear almost uniformly dark. The light dorsal line on the tail appears in all but a very few specimens. Some color variations may be geographically restricted, although different color variations are sometimes found in the same population. Variation among populations is found within portions of the species' range, e.g. within the Washington Cascades. Since different color variations have even been observed within a single brood (William Leonard, personal communication), they likely represent genetic variation rather than maternal or environmental effects.

Kozloff & Vance (1958) described the anatomical differences with the externally similar species *H. camelus*: "The fact that the sperm duct opens into the penis at one side of the base of the attachment of the verge appears to be a significant difference. The insertion of the retractor muscle of the penis jointly upon the penis and the epiphallus is characteristic of our specimens, but apparently not of *H. camelus*… The presence of a small diverticulum in the intestine, posterior to the entrance of the ducts from the digestive gland, has not been reported in the published descriptions of any species of *Hemphillia*."

2. Reproductive Biology

Like all pulmonate gastropods, individuals of *Hemphillia malonei* are hermaphrodites, possessing both male and female genitalia simultaneously. Although self-fertilization has been observed in a few species, outcrossing is most likely the norm. Individuals reach full adult size and sexual maturity within a year in the laboratory. It is believed that this species has a lifespan of one or possibly two years, typically hatching in early spring and reproducing in the following fall or winter. In mild climates, a range of size classes of individuals is commonly found. This may be a result of individuals which survive for two reproductive seasons, laying eggs both in fall and in spring, or it may be the result of asynchronous, annual populations, one group depositing eggs in fall and one in spring.

Leonard & Ovaska (2002) observed mating behavior and egg development in this species in the laboratory. Mating behavior was observed in the fall and could be separated into four phases: recognition (30 s to 3 min), involving direct physical contact; trailing (45 min to 3.5 hrs), during which roles were established and courtship was sometimes abandoned; copulation (3.5 to 12 hrs), during which spermatophores were exchanged;

and separation (1 to 2.5 hrs). Ten of the 12 observed matings were reciprocal, so that each individual both donated and received sperm. Eggs were laid 1 to 6 days after copulation in clutches of 19 to 61 eggs, each individual producing up to 4 clutches. Development time at 14°C ranged from 47 to 63 days from oviposition to hatching. The authors note that eggs of other gastropod species are known to slow or arrest development at low temperatures, such as during the winter months, and then hatch soon after temperatures rise. Most eggs developed successfully while completely submerged in water; egg mortality from dessication was also observed.

3. Ecology

Habitat of *H. malonei* is summarized by Frest and Johannes (1995):

"Generally in partly open, but uncut forest, at low to high elevations . . . , typically in rather moist Douglas-fir forest with diverse forbs and well-developed litter. Moist valley, ravine, gorge, or talus sites are preferred, i.e., low on a slope and near permanent or persistent water, but not normally subject to regular or catastrophic flooding. Persistent moisture is a *desideratum*."

These slugs assist in decomposition of forest floor debris, thereby contributing to organic matter in the soil. The species probably has a digestive efficiency rate in the high forties for assimilation of food materials, a low rate which allows viable spores and fragments of fungal hyphae to be excreted with the feces. Thus, snails and slugs represent an important dispersal mechanism for fungal species throughout the year when these mollusks are active. Specific enemies of the jumping-slugs have not been documented but, as with other mollusks, they are preyed upon by a variety of predators. Their unique "jumping" habit is assumed to be an adaptation for defense against some type or types of predators, the specifics of which were not found documented.

C. Range, Known Sites

Branson and Branson (1984) found *Hemphillia malonei* in the Columbia Gorge and Mount Hood regions of Oregon, and reported previous records from Clackamas, Multnomah, and Hood River Counties, Oregon. The type specimen is from "Tawney's Hotel, on the Salmon River, 12 miles from Mt. Hood, elevation 1600 feet (J. G. Malone...)" (Pilsbry 1948).

Malone's jumping slug is endemic to the Western Washington and Oregon Cascades and the Columbia Gorge. It is found in Clackamas, Multnomah, Hood River and Benton counties, Oregon. The majority of the documented sites in Washington are in Skamania County. This may be partly due to the numerous pre-project surveys conducted on the Gifford Pinchot National Forest (GPNF). There are other scattered documented sites for *H. malonei* in Lewis, Pacific,

Thurston, Grays Harbor, Mason, and Pierce Counties (William Leonard pers. com.). Pre-project surveys on the Olympic National Forest since 1997, however, have detected numerous *Hemphillia glandulosa* sites, but there have been no new *H. malonei* sites documented. In the GPNF, there have been many more *H. malonei* sites found than *H. glandulosa*. This suggests that *H. glandulosa* may begin to replace *H. malonei* to the west of the Cascades.

D. Habitat Characteristics and Species Abundance

1. Habitat Characteristics

"Generally in partly open, but uncut forest, at low to high elevations, typically in rather moist Douglas-fir forest with diverse forbs and well-developed litter. Moist valley, ravine, gorge, or talus sites are preferred, i.e., low on a slope and near permanent or persistent water, but not normally subject to regular or catastrophic flooding…This species may co-occur with the Larch Mountain salamander." (Frest and Johannes 1995). USDA, Forest Service, and USDI, Bureau of Land Management (1994: J2-349) under "Natural History" said, "Habitat is moist forest, not necessarily riparian areas." It is found under rotting logs, from approximately 60-1200 meters (200-4000 feet) elevation (Kozloff and Vance 1958). Branson and Branson (1984) found it at 180-1372 meters (590-4500 ft.) elevation, in Douglas-fir to subalpine fir forests, among decaying wood, wood sorrel, ferns, and mosses. It is also found on skunk cabbage and on the underside of bigleaf maple bark lying on the ground.

Since surveys began on federal land in 1997, this species has been found in a variety of forested habitat types from sea level up to 1500 meters (4800 feet). Observations indicate that it may indeed prefer wet areas, such as seeps, springs, and riparian habitat, but it also has been found in moist upland forests. It is most often (86% of known sites) found in forest stands over 70 yrs of age and tree canopy cover of more than 70%, but it has also frequently been found in forest stands that have a history of natural or human-caused disturbances. It is commonly found in 120 to 150 year old conifer stands that contain Douglas fir, Pacific silver fir (*Abies amabilis*) and western hemlock (*Tsuga heterophylla*) in the overstory. These stands are beginning to exhibit the features of old growth stands, including multi-story canopy, large snags, and large down wood.

On the Gifford Pinchot National Forest, 3% of records are in 50-year old conifer plantations where the previous stands had been clear-cut and the slash burned. These stands currently contain a diversity of shrubs and forbs, and remnant down wood. It has been found in riparian stands dominated by red alder (*Alnus rubra*), and big-leaf maple (*Acer macrophyllum*) in the overstory, and that support a diverse understory of shrubs and forbs. It has also been found in high numbers in a watershed that was burned over in the Yacolt burn and several subsequent fires

between 1902 and 1927. The stands in the watershed currently consist of a dense single story Douglas-fir (*Pseudotsuga menziesii*) overstory, and a relatively dense understory of shrubs, including vine maple (*Acer circinatum*), swordfern (*Polystichum munitum*), and huckleberry (*Vaccinium spp*.).

It appears that the presence of large wood, including well-decayed logs, is important for this species. In the absence of abundant large wood, stands that support a well developed understory of forbs and shrubs that help moderate the temperature and moisture levels at the ground can also support *Hemphillia malonei.*

On the Gifford Pinchot National Forest 95 percent of the known sites are in stands that are at least 50 years old. Since only 58 percent of the stands surveyed were over 50 years old, indications are that *Hemphillia malonei* selects for habitat at least this age. In fact, most known sites were located in stands greater than 70 years of age. In addition, 96 percent of the sites on the GPNF are in stands that have over 50 percent overstory canopy cover. Twenty-four known sites were visited during Known Site Surveys in the summer of 2002. Of these plots, 87 percent had overstory cover of greater than 50 percent. The average overstory cover at these known sites is 72 percent, and the average understory cover is 59 percent.

2. Species Abundance

Prior to 1997, total of 43 specimens of *H. malonei* had been reported from 6 locations. Malone originally collected 3 specimens from the type locality (Pilsbry 1948). Kozloff and Vance (1958) worked with 28 specimens from 2 locations, and Branson and Branson (1984) reported 12 specimens from 3 sites. Frest and Johannes (1995) said it was recollected in 1990, but gave no details.

Approximately 1,519 surveys had been conducted for this species in six administrative units, including Mt. Hood NF, Salem BLM, Gifford-Pinchot NF, Olympic NF, Wenatchee NF and Mt. Baker-Snoqualmie NF. Approximately 50% of surveys were conducted in WA and 50% in OR. Several hundred additional sites have been found for *H. malonei* as a result of these surveys. As of Oct 2005, 1472 known sites have been documented in the Interagency species database. The majority of these sites are in Oregon, where it has been found in the Clackamas River, Hood River, and Zigzag Ranger Districts on the Mount Hood National Forest, and in the Cascades Resource Area on the Salem BLM District. The species appears to be less abundant in Washington, with the majority of the known sites are on the Gifford Pinchot National Forest where 620 known sites on federal lands have been located on the St. Helens, Mt. Adams and Cowlitz Valley Ranger Districts. Three historic locations have been documented in the Olympic National Forest, and several recent locations have also been found in the Black Hills area west of Olympia,

and farther west near the town of Brooklyn in Pacific County and north near the Wishkah River in Grays Harbor County. In addition, it has been found on private land in the Columbia Gorge, Skamania County, Washington.

II. CURRENT SPECIES SITUATION

A. Status History

This species was listed under 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: Standards and Guidelines C-6 and C-59). "The rating for the species is based on the possible reduction from its historic distribution, the lack of knowledge of its current status, and the lack of specific protection in the Olympic AMA" (USDA, Forest Service, and USDI, Bureau of Land Management, 1994: J2-347).

It was originally considered to be a rare species under Survey and Manage, listed as Category A, based on the low number of occurrences, its low detection rate in suitable habitat and its small range. The Annual Species review of 2001 determined that, in the Oregon portion of its range, the provisions of the NWFP Standards and Guidelines, including the reserve system, provided for a reasonable assurance of persistence for the species without the need for additional protection under the Survey and Manage program. The species was therefore removed from the Survey and Manage program in this portion of its range. In the remainder of the range of the species, namely the Western Washington Cascades and the Olympic peninsula, the species was not as abundant, the species was more closely associated with late seral forests and the contribution of the reserve system to the persistence of the species was not as well known. In this portion of its range, the species remained in Category C. In 2004, Region 6 of the Forest Service classified this species as a Sensitive species in Washington . The Oregon Natural Heritage Information Center lists this species as G3, S2S3, and places it on List 1, and the Washington Heritage Information Center ranks its as S1S2 in Washington (at risk globally and critically imperiled within both states because of extreme rarity or because it is somehow especially vulnerable to extinction or extirpation) .

B. Major Habitat and Viability Considerations

Forests on federal lands in which this species is found today are managed for multiple-use objectives, including logging, recreation, and road development. These management activities have resulted in a reduced amount or altered distribution of suitable habitat and viable populations as compared to historic times. Current land use plans are predicted to result in an increase in suitable habitat amount and connectivity within reserved land use allocations due to ingrowth in mid-seral forests. Much of the current suitable habitat on federal lands is in late successional reserves or other withdrawn areas (61%), but specific consideration may still be needed in the matrix in some watersheds, if the current

amount of habitat in the reserve system in that watershed does not provide a reasonable assurance that the species will remain well-distributed, or if proposed management in reserves alters the habitat enough to be unsuitable for this species.

C. Threats to the Species

Genetic diversity in isolated populations of small size or low density is of concern. The species range is currently divided into three, large physically isolated regions (OR, WA cascades, and the Black Hills area west of Olympia). Urban development may permanently isolate populations in the two Washington regions. Local clusters of sites within each region may be isolated from one another in some watersheds where habitat distribution becomes spotty. Efforts should be made to increase the interconnectedness of habitat between local populations by managing the timing and silvicultural prescriptions of harvests to provide a constant, landscape-scale matrix of inter-connected habitat over time. Consideration of future landscape conditions should also be made in order to plan for younger stands to develop into suitable habitat where needed.

This species is threatened to a lesser extent by wildfire. The historic fire return interval where this species is found in western Washington is relatively long (200 years or more). However, when these fires occur, they tend to be stand replacement events and burn over large areas. Many square miles of suitable habitat could be lost if such fires are not controlled. There are indications that, given the right circumstances, *Hemphillia malonei* populations can survive the effects of large fires, or at least are able to repopulate sites as habitat conditions become favorable. Factors that may be important for this to occur are abundant remnant large wood and unburned islands of suitable habitat. These factors, in combination with diverse regenerating vegetation creating moist, humid conditions, provide habitat that becomes increasingly favorable to the species over time. Salvage operations after burn events should consider the importance of such habitat elements for recolonization and rehabilitation of burned areas.

D. Distribution Relative to Land Allocations

Approximately 11 percent of the known sites on federal land are in LSR reserves. In addition, 86 percent of the known sites within Matrix LUA are in Riparian Reserves. Remaining sites are outside of riparian reserves in the Matrix LUA.

Species: *Hemphillia pantherina* (Panther Jumping-slug)

I. NATURAL HISTORY

A. Taxonomic/Nomenclatural History

Family: Arionidae
Subfamily: Binneyinae
Hemphillia pantherina Branson (1975)

B. Species Description

1. Morphology

The body is depressed under the pouch, raising behind it to form a high compressed keel; mantle not covering posterior one-third of visceral pouch; tail with a large, distinct "horn" above meeting of pedal grooves (Branson 1975). Branson's preserved specimen measured 14.2 mm long.

The above characteristics should be sufficient to identify this slug, but its color, described by Branson and partially quoted here, is also unique. The head and tentacles are white dorsally, pale gray ventrally. The heavily granulose mantle is off-white and unmarked along the lower margins, but marbled on the dorsal two-thirds with dark stellate markings. The sides are white anteriorly, but the posterior half is marked by "26 large, cell-like granules outlined by black." Posteriorly it is "dusky" near the midline, "but the high keel is bold white."

2. Reproductive Biology

See discussion under *H. burringtoni*, above.

3. Ecology

The species was found beneath deep forest litter near a creek crossing on the Gifford Pinchot National Forest (Branson 1975). The type specimen was found in mature upland conifer forest near a riparian area containing a variety of deciduous trees and shrubs.

Particular foods and cover types are not documented, but most *Hemphillia* are usually found within or under rotting logs, or in forest floor litter, apparently feeding on decaying wood or vegetation or organisms associated with that decaying matter. Thus these slugs assist in decomposition of forest floor debris, thereby contributing to organic matter in the soil. The species probably has a digestive efficiency rate in the high forties for assimilation of food materials, a low rate which allows

viable spores and fragments of fungal hyphae to be excreted with the feces. Thus, snails and slugs represent an important dispersal mechanism for fungal species throughout the year when these mollusks are active. Specific enemies of the jumping-slugs have not been documented but, as with other mollusks, they are preyed upon by a variety of predators. Their unique "jumping" habit is assumed to be an adaptation for defense against some type or types of predators, the specifics of which were not found documented.

C. Range, Known Sites

H. pantherina is known from a single location in the Lewis River Drainage, Gifford Pinchot National Forest, Skamania County, Washington (Branson 1975). This species should be considered a potential find during surveys throughout the Cascade Range of western Washington. Type locality is given as Miller Creek crossing, Gifford Pinchot National Forest.

D. Habitat Characteristics and Species Abundance

1. Habitat Characteristics

The type specimen was found under deep forest litter near a creek crossing (Branson 1975). Potential habitats include those typical for other *Hemphillia* species, under and inside of logs and other forest floor litter, and in talus, in moist forests and riparian areas.

2. Species Abundance

H. pantherina is likely the rarest of described gastropods in the Western United States. Branson (1975) described the species from a single specimen found in 1973. It has not been found at any other location.

II. CURRENT SPECIES SITUATION

A. Status History

This species was listed under 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: Standards and Guidelines C-6 and C-59). "The rating for the species is based on the lack of specific information about the species range or locations" (USDA, Forest Service, and USDI, Bureau of Land Management, 1994: J2-351).

It was originally considered to be a rare species, under Survey and Manage Category A, based on the low number of occurrences, its low detection rate in suitable habitat and its small range. After the signing of the ROD for Amendments to the Survey and Manage in 2001 this species was placed into Category B (rare, pre-disturbance surveys not practical), due to difficulty in

identifying the species based on one location record. In 2004, Region 6 of the Forest Service classified this species as a Sensitive Species in Washington. The Washington Heritage Information center ranks it as G1S1 (critically imperiled globally and within the state because of extreme rarity or because it is somehow especially vulnerable to extinction or extirpation).

B. Major Habitat and Viability Considerations

The population appears to be very small (only one specimen documented) and limited in distribution, being known from only one small area. Several revisits to the documented site have failed to detect additional specimens, however there was considerable vagueness in the original location description, so these visits may not have surveyed the correct area. It is unknown whether this species is a valid taxa or if it has become extinct.

As with all small and/or scattered populations, genetic viability is of concern. *H. pantherina* may be a newly evolved species. Not having been found in other localities, we do not know whether or not it exists other than in the one vicinity. If a single population is the case, degradation of that habitat or other causes detrimental to the population may lead to extinction of the species.

The number and distribution 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 interacting populations. The very limited current distribution of this taxon may reflect a similar historical condition or a trend toward isolation, and risks to the single known site could eventually result in loss of genetic or ecological diversity, loss of ecological function and extinction of the local population.

C. Threats to the Species

Any site disturbance that alters the habitat characteristics within the vicinity of this population locality might be detrimental to the species persistence. A major concern would be degradation of occupied habitat from activities that alter the normal moisture regime, especially shade and water inputs.

D. Distribution Relative to Land Allocations

The type locality (only know site) is on the Gifford Pinchot National Forest and is within a LSR.

III. MANAGEMENT GOALS AND OBJECTIVES for all FOUR SPECIES

Management for these species follows Forest Service Region 6 Sensitive Species (SS) policy (2670). 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.

IV. HABITAT MANAGEMENT for all FOUR SPECIES

A. Lessons from History

Once extirpated from a site, populations of most gastropods are slow to recover. Fire is a natural disturbance factor, which has occurred over many centuries. Even as a natural process, its effects can be harmful to existing populations. The effects of fire depend on several variables, including intensity, season and relationship to the life cycle of the species. Fire can be very destructive to snails and slugs, not only killing them outright, but in its destruction of logs and other woody debris that hold moisture and create microsites necessary for survival of these animals (Applegarth 1995). 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 *Vepericola*. 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, we have an ecosystem that is lacking the components and functions provided by the mollusk fauna.

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 upon examination of the site. Logs were not measured, but are estimated to be well over 1000 linear feet per acre, and greater than 20 inches average diameter. Whether these 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 (Burke, unpublished report). Therefore, it is apparent that an intense burn leaves the biotic community under moist conifer stands with only a small fraction of its molluscan fauna for many years (possibly a century or more). Fire is generally not acceptable management for the habitat of these species.

B. 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 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. Based on the small size and limited dispersal ability of these species, the size required to sustain a population of interacting individuals may range from a few acres to 25 or more, depending on the extent of contiguous habitat and the condition of surrounding habitat needed to maintain suitable moisture conditions. Consideration should be given to daily and yearly activity cycles of the slugs as this data is collected. At the smallest scale, within each habitat area, habitat elements such as large down wood and rock features, should be protected 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 managed to provide foraging and dispersal habitat during the active seasons.

C. Management Within 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. Consider the following management considerations:

- In general, *Hemphillia* are quite vulnerable to heat and desiccation and use logs and other large woody debris, forest floor litter, and spaces under or between rocks as refugia - areas that maintain low temperature and moderate to high humidity. Management considerations could focus on maintaining the temperature and moisture regime of these microsites. Consider retaining sufficient overstory crown cover and understory vegetation to shade the ground, provide humidity through evapotranspiration, condense fog and dew, intercept underground water and hold it on the site, and impede air movement that would tend to displace the cool moist air. Available crown cover information for these habitats is meager, but observations recorded in some western hemlock/Douglas-fir stands indicated summer crown cover of 70-90% plus.

- Consider maintaining or enhancing the naturally occurring diversity of plant species in Species Habitat Areas. 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 we know too little

about the needs of these 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 hardwood and conifer species would provide a more diverse and complete set of conditions for multiple species and a more fully functioning ecosystem.

- Maintenance and future recruitment of large and small woody debris is important, as is a thick layer of litter and duff on the forest floor. These components provide cool moist places in which these animals spend the days, hide from predators, deposit their eggs, and find food. These animals use a wide variety of sizes of large woody debris. Logs appear to provide dispersal corridors as well as the above mentioned essential habitat elements. Habitat quality probably improves in direct proportion to the amount of large woody debris to a point where the debris interferes with the shade and humidity regulating function of the forest canopy cover. Specific types of cover, debris, litter, etc. will be determined by the species for which management is to be emphasized.

- As possible, protect Species Habitat Areas from fire events that cause direct mortality and loss of habitat. Prescribed fire treatments could be used to reduce fuel loading outside of Habitat Areas to protect those areas from catastrophic wildfire events.

- Activities that cause soil compaction or disturbance to forest floor litter should be avoided within Species Habitat Areas.

- Manage occupied rockslides and talus areas to prevent adverse effects from road construction, quarrying, and other major site disturbing activities that may cause temperature and/or humidity changes within the interspaces. These sites should be considered potential habitat when they lie within or near to suitable moist forest habitat areas, or at the edges of moist or wet mountain meadows.

- Consider increasing the width of occupied Riparian Reserves as needed, as part of management for these mollusk species.

- Mollusk species are known to have limited dispersal abilities and the current species diversity is the result of generations of isolated populations developing unique characteristics. Care should be taken not to further isolate individual populations. Therefore, in addition to managing this species group within Species Habitat Areas, attempts should be made to connect these habitat areas to each other or to other reserves, such as Riparian Reserves and LSRs. This could be done either directly by locating them adjacent to occupied habitat within reserves, or indirectly by retaining suitable quantities of key habitat elements in harvest or project areas to provide a potential bridge or temporary "bank account" to accelerate future habitat development.

D. Other Management Issues and Considerations

At the time of the FEMAT Analysis most of these species were known from few sites, and few had even been seen by living malacologists. Much of the habitat from which they had previously been known had been developed into urban or agricultural areas, or extensively managed. It was not even known whether or not some of these species still survived.

Hemphillia pantherina is a species needing much more careful study. Because it is known from only one site, studies of it and its habitat need to be strictly regulated to prevent its inadvertent extirpation by researchers and other curious people.

While other methods of fuel reduction are preferred, prescribed fire may be considered as a tool to be used to reduce the risk of catastrophic natural fire. Prescribed burning or other treatments should be designed to avoid significant impacts to the habitat conditions within species habitat areas as outlined in Section IV-C, while reducing the risk of wildfire in surrounding areas. If burning is conducted during seasons when animals area 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.

Implementation of the Aquatic Conservation Strategy in Riparian Reserves requires an analysis of habitat conditions and occurrences through watershed analysis to determine if actions within riparian reserves are consistent with the Aquatic Conservation Strategy objectives and should document the effectiveness of these riparian land allocations for conservation of this species habitat.

V. RESEARCH, INVENTORY, AND MONITORING NEEDS

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

Report documented sites of species through Natural Heritage Program contracts. Changes to field unit determination of documented or suspected status need to be reported quickly to the Special Status/Sensitive Species Specialist in the Regional/State Office**.** Specific areas in which there is a lack of or insufficient data include:

- complete description of the species (especially *H. pantherina*, and a reliable method to distinguish or classify specimens of the *H. glandulosa*/ *H. burringtoni* complex);

- specific habitat conditions required (i.e., temperature and moisture tolerances, and how these are maintained within the natural habitat);
- biology - breeding season, egg depositories, life span, seasonal habits (e.g., aestivation, hibernation);
- ecology--food, ecosystem functions;
- predators, diseases, and other natural threats.
- relocate and map historical *H. pantherina* location

B. Research Questions

What is the specific geographic range of each of these species?

What is the range of habitat conditions tolerated by each species? What is the range of conditions required for populations to remain secure and viable?

Biological attributes:
- 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.)?

Physical attributes:
- Elevation;
- Soil types, geology, trace elements;
- Temperature, humidity.

What are the stand characteristics (canopy cover, age, large woody debris, litter and duff, etc.) required to support the conditions required?

How do the required stand characteristics vary under different circumstances (elevation, slope, aspect, etc.)?

What stand size is required to provide sufficient area of suitable habitat?

How much time is required for recolonization of a site by species from adjacent populations?

What are the effects on mollusk populations of herbicides and other chemicals used in forest management?

C. Monitoring Opportunities

Monitoring of known sites is recommended to track trends in populations (numbers, size, and density), reproduction, quantity and quality of habitats.

Monitoring is also recommended to determine impacts on habitats and populations from management activities, natural disturbances, and vegetative succession.

- Conduct surveys in spring and fall after the first heavy rainfall or frost.
- Record all environmental conditions where these species are found to better understand their habitats and management needs.
- Through surveys and studies, determine the extent of the species' range, and the habitats and ecology of the species.
- Monitor known populations following land management activities to determine whether or not recommendations applied for this species protection are effective and sufficient.

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