# MANAGEMENT RECOMMENDATIONS
# FOR
# TERRESTRIAL MOLLUSK SPECIES

## *Prophysaon coeruleum*, Blue-Gray Taildropper

**&**

## *Prophysaon dubium*, Papillose Taildropper

**V. 2.0**

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## EXECUTIVE SUMMARY

**Species:** ***Prophysaon coeruleum*** Cockerell, 1890 **(Blue-gray Taildropper)**
***Prophysaon dubium*** Cockerell, 1890 **(Papillose Taildropper)**

**Taxonomic Group:** Mollusks (Phylum Mollusca: Class Gastropoda)

**ROD Components:** Survey and Manage Strategies 1 and 2.

**Other Management Status:**
*Prophysaon coeruleum* is on the Oregon Natural Heritage Program List 2 and Washington State Monitoring List.
*Prophysaon dubium* is on the Oregon Natural Heritage Program List 2, Washington State Monitoring List, BLM Assessment species for Oregon, and BLM Tracking species for Washington.

**Range:**
*Prophysaon coeruleum* - Western Cascades and Puget Trough of Washington, western Oregon, south to northern California. It occurs on both sides of the Cascades in southern Oregon and is suspected on the east slopes of the Cascades in Washington.
*Prophysaon dubium* - Washington Cascades (east and west) and Olympic Mountains south through the western Oregon Cascades and Coast Range, into the Siskiyou and Trinity mountains of northern California.

**Specific Habitat:**
*Prophysaon coeruleum* is more closely associated with conifer forests and *Prophysaon dubium* is more closely associated with hardwood stands. Both species are found in some mixed conifer stands. Some specific microsite characteristics for the individual species include:
*Prophysaon coeruleum* - Typical *P. coeruleum* is often found in late-successional forests where it is associated with conifer logs, ground litter, fungi and mosses.
*Prophysaon dubium* - It is a generally found in late successional forest or riparian areas more closely associated with hardwood logs, leaf litter and fungi.

**Threats:**
Primary threats to these species are

- -Isolating or losing additional populations
- -Further loss of habitat to support the species across the landscape
- -Predation
- -Competition from exotic mollusks
- -High intensity fire

**Management Recommendations:**

Three management strategies are recommended for *Prophysaon coeruleum* and *P. dubium*, depending on local distribution within the area under consideration. A primary concern in all strategies is to moderate fluctuations in temperature and humidity by maintaining favorable shade and limiting adverse impacts of fire.

- **Strategy 1** is the recommended option where the species is not locally common. The general prescription is to maintain or restore microsite conditions and best habitat features at the site. The Habitat Area is the area needed to generally maintain favorable microsite conditions at the single site. Habitat disturbance should be only to benefit the species.
- **Strategy 2** can be used when the species is locally common, and occurs in locally clustered sites that occupy a portion of the project area. The Habitat Area is an area or polygon around all sites. This approach allows limited disturbance, including thinning and other activities.
- **Strategy 3** can be used where the species is locally common and when it seems to occur throughout a proposed project area. The Habitat Area is the same as the survey or project area. This approach allows a higher level of disturbance, including openings, thinning and other activities, but connectivity within the Habitat Area remains.

All known sites should be within a Habitat Area. In Strategy 1, known sites will be managed individually within Habitat Areas. In Strategies 2 and 3, known sites will be managed collectively as a population within Habitat Areas. In areas where these species are locally common, local managers have the option of using Strategies 1, 2, or 3. There can be a combination of Habitat Area types within a single project.

Strategies 2 and 3 are intended to provide additional flexibility while successfully maintaining and/or improving habitat for populations and providing for continued occupation of the area by the species. Strategies 2 and 3 allow some of the individual sites to be temporarily degraded, while maintaining the population as a whole. They maintain contiguity throughout the occupied habitat and stipulate that any degradation should recover within twenty years.

**Information Needs:**

Some of the primary information needs are:

- Are the recognized variants of *P. coeruleum* separate species or subspecies?
- What is the range of habitat conditions tolerated by each species? What is the range of conditions (biological and physical attributes) required for populations to remain secure and viable?
- What stand characteristics (canopy cover, age, large woody debris, litter and duff, etc.) are required to support the required conditions?
- 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?

## MANAGEMENT RECOMMENDATIONS

**SPECIES** ***Prophysaon coeruleum*** Cockerell, 1890 **(Blue-gray Taildropper)**
***Prophysaon dubium*** Cockerell, 1890 **(Papillose Taildropper)**

### INTRODUCTION

The descriptive parts of sections I and II are arranged by species in the order listed above. However, the Management Recommendations for them, sections III through VI, are combined. In general, management for these species should be implemented as an ecosystem management approach, since these two species, other survey and manage species, as well as other species of concern are likely to be found in the same areas.

These management recommendations are primarily based on information available from all sources in August 1998. Additional data and analysis collected since that time may lead to differing management recommendations in the future.

### Common Characteristics of *Prophysaon* (Taildropper Slugs)

The taildroppers are a genus of arionid slugs. Turgeon et al. (1998) listed 9 species of *Prophysaon*. The mature slugs of this genus range in size from less than 20 mm long to over 100 mm. They are of various colors, including shades of red, orange, blue, brown, and yellow, and often are marked with distinct patterns. The pneumostome (breathing pore) is in the right side of the mantle in all slugs; however, the position of this pore relative to the length of the mantle is distinct by genus. In *Prophysaon* it is forward of the midpoint of the right mantle margin. There is no caudal mucous pit. A distinction of the genus is an impressed line that can be seen in most species as an oblique indentation on the tail marking the point at which auto-amputation occurs. In species where this line is not distinct laterally, it can sometimes be seen as a fine white line across the sole of the foot.

The two survey and manage species discussed below are relatively small and are distinctive in appearance. They are distinguished from each other externally by color and surface pattern and texture. The distinguishing characteristics are evident on these two species even when they are very small, so they are usually easily identified once the surveyor becomes familiar with them.

## *Prophysaon coeruleum* (Blue-gray Taildropper)

# I. NATURAL HISTORY

## A. Taxonomic/Nomenclatural History

This species is in the family Arionidae. It was originally named *Prophysaon coeruleum* by Cockerell (1890). No changes have subsequently been proposed for this name. The type locality is in Olympia, Washington.

## B. Species Description

### 1. Morphology

*P. coeruleum* is nearly uniform blue-gray with scattered white flecks in the integument. Adults are 20-40 mm long, although mostly smaller, young animals are usually found in the field. Prominent grooves and ridges on the tail are horizontal and generally parallel, although occasionally interconnecting, and they become obliquely angled on the sides with increasing slope nearer and below the mantle. Low rounded bumps may be seen on the mantle, but these are not nearly as prominent as the papillae on *P. dubium*.

The following is quoted in Pilsbry (1948). Type description, "Length (in alcohol) 22 ½ mill., in motion, 43 mill. Body and mantle clear blue-gray, paler at sides, sole white. Mantle finely granulated, broad, without markings. Length of mantle 7 mm, breadth 5 mm Respiratory orifice 2 ½ mm from anterior border. Body subcylindrical, tapering, pointed. Distance from posterior end of mantle to end of body, 10 3/4 mm The reticulations take the form of longitudinal equidistant lines, occasionally joined by transverse lines, or coalescing. Sole not differentiated into tracts . . . . The neck is long and white, or very pale. (Cockerell)". Pilsbry adds, ". . . about 25 mm. long. The general color is clear payne's gray, the head and neck paler. Back with close, deep longitudinal grooves, which, on the sides, become oblique and more spaced, and more anteriorly they radiate vertically below the mantle."

"*Prophysaon coeruleum* is an exceedingly distinct species, distinguished . . . by its color and the character of its reticulations." (P. B. Randolph quoted in Pilsbry, 1948, page 693). "The very narrow foot-margin, with an unusually distinct border above, is another distinguishing feature." (Pilsbry, 1948, page 693).

A variant of the blue-gray taildropper occurs in southern Oregon in Jackson and Klamath counties. This variant has been called the Klamath taildropper by T. Frest and E. Johannes, who originally discovered it. Apparent external

differences from typical *P. coeruleum* are in the color and habitat. Its color is more blue-brown than blue-gray, and the sole color is grey rather than white. It occurs in drier habitats in the Southern Oregon Cascades, extending down the east slopes. Other than that, it appears the same, exteriorly, as typical *P. coeruleum*, but a description of its internal morphology has not yet been published.

Another blue variant, possibly a separate species of *Prophysaon*, is found in Douglas and Jackson counties of southern Oregon. This slug varies externally from *P. coeruleum* by a lighter, more translucent blue color caused by a greater abundance of the white pigments in the integument, but more distinctly by a different pattern of tubercles on the tail. This variant has low, not deeply delineated rectangular tubercles opposed to the well defined ridges and grooves of typical *P. coeruleum*.

In Washington, an undescribed blue-gray slug occurs, the Ryan Lake or Blue-keeled slug, discovered by Burke in 1995. This one is obviously not a taildropper. It is easily distinguished by its pneumostome being well back in the right side of the mantle, its smooth integument, and its keeled tail.

## 2. Reproductive Biology

Like most terrestrial gastropods, *Prophysaon* are hermaphroditic, having both male and female organs. Although not confirmed specifically for *P. coeruleum*, 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.

Slugs are generally oviparous (egg laying). Eggs of *Prophysaon* slugs can be found in groups of several to many in cool damp spots such as under logs or pieces of wood on the shaded forest floor.

## 3. Ecology

*Prophysaon coeruleum* normally occurs in late-successional forests of moist plant associations, or at least in stands with an abundance of late-successional attributes (i.e., cool moist sites with large and small woody debris, and relatively thick layers of litter and duff). It is known to be mycophagous (feeding on

fungi) at least in part, and through its foraging, it disseminates spores and hyphal fragments of mycorhizal and other fungi on which it feeds. Within stands in which it occurs with other "survey and manage" species (*P. dubium, Cryptomastix devia*, or *Megomphix hemphilli*), *P. coeruleum* appears to be generally more closely associated with conifers and conifer debris, than these other three "survey and manage" species, which appear to prefer hardwoods.

This slug is preyed upon by a variety of vertebrates and other invertebrates. Tail-dropping is an effective means to escape predators such as the haplotreme snails.

Nearly all gastropods are alternate hosts for a variety of parasites (e.g., lung worms), but specific symbiotic relationships of this species have not been documented, probably because it has been seen rarely in the past.

## C. Range, Known Sites

As of August 1998, *Prophysaon coeruleum* has been found at 1665 known sites from Medford, Oregon, to Seattle, Washington, in the Coast Range and western Cascades to the Puget Trough. Frest and Johannes (1996) add that the range of this species may extend as far east as Upper Klamath Lake and potentially along the eastern flank of the Cascades in Washington and Oregon. Three examples have been found at one location in Siskiyou County, California (Applegarth, personal communication).

The type locality is Olympia, Washington. Pilsbry (1948) reported records of it from: Olympia, Thurston County, and Seattle, King County, Washington; and Portland, Multnomah County; Oswego, Clackamas County; and Corvallis, Benton County, Oregon. Branson and Branson (1984) collected one from each of 6 sites in Oregon (2 sites from each of Clackamas and Lane counties, and 1 from each of Marion and Jackson counties).

There were few records of it prior to the Northwest Forest Plan (NFP) Record of Decision in 1994, and most of those records were from the northern part of its range. However, surveys done in response to the NFP have discovered this species to be much more common in the southern part of its range in southwestern Oregon, especially in Douglas and Lane counties. The blue-brown variant, or Klamath taildropper of Frest and Johannes, may be found in the drier parts of Klamath and Jackson counties. The Klamath and the blue-white variant (apparently a different species) have not been recorded separately from the typical blue-gray taildroppers during the recent surveys by Federal land management agencies. We have no records as to the relative abundance and exact range of each of these variants. Typical *P. coeruleum* is found in Washington and northern Oregon. There are few more records from Washington now than there were before the NFP was implemented.

Since surveys began, these slugs have been found in localized populations in specific areas of their ranges. *P. coeruleum* is fairly abundant in southwestern Oregon, and is found in locally abundant, though scattered distribution over other parts of its range in Oregon. However, in northwestern Oregon and in Washington, it is only known from a few sites, and appears to be quite rare.

## D. Habitat Characteristics and Species Abundance

### 1. Habitat

This species appears to be confined primarily to old-growth forests in the northern part of its range, but it is apparently more abundant and may occur in moist second-growth stands in western Oregon, as long as late-successional attributes remain in sufficient quantity. In Washington, Burke and Hanson (personal observations) found it in a western hemlock/sword fern plant association, under bark and among mosses under conifer logs and under bits of small, usually conifer debris. According to P. B. Randolph, "it occurs solitary in dark fir woods under damp logs" (Pilsbry 1948). In southern Oregon, it may be found among forest floor litter and debris usually in stands where the ground is moist and well shaded.

The blue-gray taildropper is apparently primarily mycophagous, that is, a fungus eater (N. Duncan and E. Cazares, unpublished observation). Slugs of this species have been observed consuming above-ground fungal fruiting bodies and using the hollowed stipes of several species as protected sites for mating and temporary refugia. Fecal analysis revealed spores from numerous underground truffle species, especially during the fall season (N. Duncan, personal communication). mycorhizal fungi species require a variety of different plant species as hosts. Therefore, the naturally occurring diversity of plant species in management areas is important for maintaining a broad range of hosts to support a variety of species of mycorhizal and other fungi, and to make other food substrates available throughout the seasons. This diversity will also ensure that specific plant species, which may be found to be critical in the life cycle of these mollusks, are not inadvertently lost.

Habitats in which the typical variety of this slug is found are moist forest, normally late-successional or, if second growth, with late- successional attributes. For *P. coeruleum*, these forests are usually dominated by conifers, but there is often a strong hardwood component. They are usually in moist plant associations, the forest floor being moist but not wet or saturated. The ground is shaded, and covered by moist, fairly deep layers of litter and duff. The species has been found in a range of forest canopy closure levels. In an analysis of data from Coos Bay and Roseburg BLM Districts (N. Duncan and R. McGraw, unpublished report), approximately 10% of known locations

occurred in areas where canopy closure averaged less than 50%. In this study, the majority of sites were in areas with canopy closure greater than 70%. Sites located in the Klamath/Siskiyou province occurred in less dense canopy than those in more northern provinces. There is an abundance of large and small woody debris (conifer and hardwood) scattered over the ground, large logs (greater than 20 inches average diameter) in better habitats, covering 1000 or more linear feet per acre. Logs of decomposition class 2-4 appear to be used most often. Low vegetation may be patchy.

Vegetation at the sites as listed include: Douglas-fir, western hemlock, western red cedar, white pine, sugar pine, maples, alders, ferns, scouring rushes, and mosses. It is associated with decaying wood, logs or rocks. Elevations are 300-1370 meters (1000-4500 feet) (Branson and Branson 1984).

In the eastern part of its range in southern Oregon, it is replaced by an apparent ecotype, or similar species, the Klamath taildropper of Frest and Johannes, which occurs in drier environs, extending even into the edges of grasslands. It would appear that this Klamath variety may have been what Branson and Branson (1984), ". . . encountered in dry, volcanic areas . . . ." These sites include drier forested areas than noted by other authorities. However, they also mention that at the higher sites, snows remained until into July, the month that they surveyed these areas.

Specific circumstances other than those described above may also provide suitable habitat. Many snails and slugs use talus and/or riparian habitats where, under certain conditions, suitable microsites may occur as a result of other combinations of environmental features.

**2. Abundance**

Records of the blue-gray taildropper were scarce prior to implementation of the Northwest Forest Plan, Branson and Branson (1984) providing the only published sightings since Pilsbry (1948). It has since been found to be quite common in parts of southwestern Oregon, especially Lane and Douglas counties. As of August 1998, the ISMS database included 1665 records for this species. (This number includes variants. Because all similar slugs are being entered as the blue-gray taildropper, the number of variants is unknown.) Where found, individuals are usually widely separated from each other and appear to be solitary in habit.

In the northern part of its range (Washington, which includes the type locality, and northern Oregon), the blue-gray taildropper appears to be rare. We know of only two sites in Washington, 5 miles apart, where it has been found in recent years (1995 through 1998). Previous records from Washington were

prior to Pilsbry's 1948 work. There is only one location in California, documented by photos of examples from Siskiyou County (J. Applegarth, Eugene BLM).

Branson and Branson (1984) found one *P. coeruleum* from each of 6 sites of 82 areas surveyed in the Oregon Cascades and Coast Range. Branson (1977, 1980) did not find this species at 353 locations surveyed in the Washington Cascades and the Olympic Peninsula. Branson (1977) wrote, "Although reported from Olympia (type locality) by Henderson (1929a) and Dall (1910), I did not secure slugs with the characters of this species." Frest and Johannes (1993) reported it not found recently by them prior to 1993. Burke (1996) found 3 specimens at a single site in the Randle Ranger District, Washington Cascades. Other specimens have since been found at that same site.

## II. CURRENT SPECIES SITUATION

### A. Why Species is Listed Under Survey and Manage Standard and Guideline

The FEMAT analysis rating for *Prophysaon coeruleum* was based on failure to relocate historic sites, conversion of much of the historic range to urban area, and uncertainty about effects of the proposed action (USDA Forest Service, and USDI Bureau of Land Management, 1974: J2-351).

Although now known to be fairly common in parts of southwestern Oregon, the blue-gray taildropper is rare in Washington and California, and of spotty distribution in northern Oregon. It was one of the rarest gastropods found by Burke (1996) during 4 weeks of searching in the Lower Cispus Watershed on the Randle Ranger District, Gifford Pinchot National Forest, in 1995. Only three individuals were observed, all within about 5 acres in a large old growth western hemlock stand. Frest and Johannes (1993) reported it not found recently by them. Branson (1977, 1980) and Branson and Branson (1984) reported one specimen from each of 6 sites out of 82 locations surveyed in Oregon, but none from 353 locations surveyed in Washington.

*Prophysaon coeruleum* is on the Oregon Natural Heritage Program list 2 and Washington State Monitoring List. Oregon Natural Heritage Program list 2 species are imperiled because of rarity or because other factors make them very vulnerable to extinction or extirpation (typically with 6-20 known occurrences).

### B. Major Habitat and Viability Considerations

Analysis is needed on the morphology and ecology of the variants that could be similar species or subspecies. Before anything can be concluded about the security of this (or these) species, their relationship needs to be determined, and differences distinguished between their habitats and ecology.

Primary habitat of *P. coeruleum* is in moist conifer forests. But, this species may be more closely associated with the conifer debris in these stands while *P. dubium* and some of the other survey and manage mollusks are more closely associated with the hardwood component.

The blue-gray taildropper is apparently a rare species in Washington and northwestern Oregon. Further south in Oregon, it is more common and may occupy a broader range of environments. However, within the southern part of its range other variants or species occur that may be responsible for the broader ecological amplitude in that area. The relationships between the Klamath variant and typical *P. coeruleum* needs to be resolved, and their ecology better understood, before viability concerns can be laid to rest.

For species of patchy distribution, concerns for viability increase as habitat areas decrease in number and size toward a critical threshold. As population size decreases there is a greater possibility of catastrophic loss of local or limited populations. The quality of remaining habitats becomes more critical. With a smaller population, there is a greater potential for isolation of populations which could lead to the potential for the deleterious effects of inbreeding. There is also increased chance of population loss from predation, pathogens or other causes.

Loss of suitable conditions for mycorhizal fungal populations in managed forests is a concern for the continued viability of this species. It is known that severe burning and exposure to hot, dry conditions results in the loss of these critical elements of forest ecosystems. It is expected that forest practices that result in the loss of the fungal community, reduced plant diversity and less than suitable conditions for slug species, which aid in fungal dispersal, could ultimately result in less productive and unhealthy forests.

## C. Threats to the Species

**Further loss of habitat to support the species across the landscape** - Much of the formerly known range of *P. coeruleum* has been developed for urbanization or agriculture. Currently, habitat disturbances and modifications such as timber harvest, fire, and development appear to be the greatest threats to this species. The species may be more secure in the southern half of its range than in the northern half, but that issue will remain unresolved until the species or varieties are sorted out, and surveyors distinguish between them when recording site locations and habitat data.

**Reduction in quality of existing habitat** - Quality habitat is important to these slugs for maintaining a balanced biotic community to support them, and for escaping predators. While they are known to be mycophagous, at least in part, the lack of detail on their ecology points out the importance of a diversity of vegetation needed within

their habitats to provide a variety of fungi and other potentially required but as yet unknown elements.

**Predation** - In adequate habitat, natural predators rarely threaten a population. Concern about predators increases as habitat quality decreases. Up to three species of *Haplotrema* and *Ancotrema* (predatory snails that feed on snails, slugs and other invertebrates) occur in the same habitats in greater numbers than all Prophysaons. 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 fine and large woody debris.

**Competition from exotic mollusks** - Exotic slugs are increasing within the range of *P. coeruleum*. 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.

**High intensity fire** - High intensity fire is particularly damaging to gastropod populations, as it destroys both the animals and their habitats.

**Isolating or losing population variations and potentially undescribed species** - Because there appears to be a number of variants of the blue grey taildropper in Oregon and possibly northern California, the isolation of, or extirpation of population segments in those areas may result in the inadvertent extirpation of other species before they are described.

**Inadvertent losses because of other management activity** - For example, harvest of special forest products can be a threat in limited habitat areas. Raking the forest floor for mushrooms, or removal of logs for firewood could be particularly damaging.

## D. Distribution Relative to Land Allocations

The two sites on the Cowlitz Valley (Randle) Ranger District are in Late-Successional Reserves. Two of Branson and Branson's (1984) Oregon sites are on the Mount Hood National Forest, 3 are in the Willamette National Forest, and 1 is in the Rogue River National Forest. One of the Willamette National Forest sites is in the Diamond Peak Wilderness, but land allocations of the other sites need to be determined.

As of August 1998, there were over 1,600 sites in the ISMS database, most of which are newly discovered. Many of the new sites in Oregon are on the Roseburg, Eugene, Salem, and Medford BLM districts. These new sites are presumed to be in matrix and Adaptive Management Areas, since this is where most surveys have been conducted.

## *Prophysaon dubium* (Papillose Taildropper)

# I. NATURAL HISTORY

## A. Taxonomic/Nomenclatural History

This species is in the family Arionidae. It was originally described as *Prophysaon coeruleum* var. *dubium* by Cockerell (1890). Pilsbry (1948, p. 694) recognized it as a distinct species. The type locality is Olympia, Washington.

## B. Species Description

### 1. Morphology

*Prophysaon dubium* is a small slug, 15 to 30 mm long. Most specimens found in the field are smaller, seldom exceeding 20 mm. They are usually light brown in color with dark brown or black markings. Seldom is a dark specimen seen (purplish gray, as described by Pilsbry 1948; or blue-gray by Branson and Branson 1984), although the light-scattering of the dense papillae may give them the appearance of being darker than they are, especially in very small specimens. The mantle is mottled with 2 or 3 irregular longitudinal bands. The most distinctive characteristics are the papillae and the distinctive lines on the tail. The papillae are distinct, dense, and conical, and cover the body except for the head, neck, and tentacles. The tail is marked by dark brown or black, thread-width, indented lines. The dorsal-most two run irregularly parallel from the back of the mantle, then branch off about one-third to one-half the way back to the posterior end. Laterally, these lines run obliquely down the sides toward the posterior, becoming progressively steeper anteriorly, to vertical below the mantle.

Pilsbry (1948) describes it as follows: Preserved specimens are 8 to 14 mm long. "The essential features of *P. dubium* are its conspicuously papillose integument and the great length of the epiphallus, over twice the length of the preserved animal...." It may be found with *P. coeruleum*, from which it differs, "... not only by its dark color but by the much greater length of the epiphallus...." "Externally there is no light dorsal line, such as *P. andersoni* usually shows." "The color is some shade of purplish gray (or it might be described as violet-slate . . .), with various darker or blackish clouds, irregular or in two main bands on the mantle, and more or less pigmentation along the impressed grooves of back and flanks, the neck of a light tint with some spotting."

Cockerell's type description (1890, quoted in Pilsbry 1948) says, "Length (in alcohol) 8 mill. Length of mantle 4 mill. Distance from posterior end of mantle

to end of body 3½ mill. Mantle broad, with four bands composed of coalesced black marbling, very irregular in shape, and running together anteriorly. Body dark, tapering. Sole pale, its edges gray . . . ."

One specimen from Lane County, Oregon was seen that appeared purplish-gray. However, other *P. dubium* from the same site were as described in the first paragraph under "morphology", above. Specimens found in Humboldt County, California are occasionally lighter brown in color, but have consistent darker markings and papillose texture typical of this species.

## 2. Reproductive Biology

Like most Terrestrial gastropods, *Prophysaon* are hermaphroditic, having both male and female organs. Although not confirmed specifically for *P. dubium*, 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.

Slugs are generally oviparous (egg laying). Eggs of *Prophysaon* slugs can be found in groups of several to many in cool damp spots such as under logs or pieces of wood on the shaded forest floor.

## 3. Ecology

The *Prophysaon* appear to be herbivorous and mycophagous, at least in part, having been observed on mushrooms and among decaying deciduous plant litter. See Habitat Characteristics, below.

*Prophysaon dubium* normally occurs in late-successional forests of moist plant associations, or at least in stands with an abundance of late-successional attributes (i.e., cool moist sites with large and small woody debris and relatively thick layers of litter and duff). It is known to be mycophagous (feeding on fungi) at least in part and, through its foraging, it disseminates spores and hyphal fragments of the mycorhizal and other fungi species on which it feeds.

Within stands in which it occurs with other "survey and manage" species (*P. coeruleum*, *Cryptomastix devia*, or *Megomphix hemphilli*), *P. dubium* appears to be generally more closely associated with hardwood litter and debris, as are *C. devia* and *M. hemphilli*. However, *P. dubium* is more often

found in the surface layer of hardwood leaf litter, while the micro habitat of these two snails varies some and *P. coeruleum* is more likely to be associated with conifer debris.

These slugs are preyed upon by a variety of vertebrates and other invertebrates. Tail-dropping is an effective means by which to escape invertebrate predators, such as the haplotreme snails. Forest floor cover in the form of logs and litter appears important to these slugs for hiding cover and escape from the abundant predators that occur in their habitats, as well as for protection from desiccation and temperature fluctuations.

Nearly all gastropods are alternate hosts for a variety of parasites (e.g., lung worms, etc.), but specific symbiotic relationships of this species have not been documented, probably because it has been seen rarely in the past and has been studied very little.

## C. Range, Known Sites

As of August 1998, there are 332 observations of *Prophysaon dubium* in the Washington Cascades (east and west sides) and Olympic Mountains, south through the Oregon Cascades and Coast Range, and the Siskiyou and Trinity mountains of northern California. County records include: Pierce, Thurston, Lewis, Skamania, Kittitas, and Chelan counties, Washington; Hood River, Clackamas, Jackson, Douglas and Lane counties, Oregon; and Siskiyou and Trinity counties, California.

Frest and Johannes (1993) reported that it has been found in Pierce and Thurston counties, Washington; Hood River County, Oregon; and Trinity County, California, with one site on the Trinity National Forest. Type locality is Olympia, Thurston County, Washington. Burke (personal observations) has records of it from the Gifford Pinchot National Forest, Lewis and Skamania counties, Washington in 1994 and 1995, and on the Wenatchee National Forest, Kittitas County, Washington in 1994, and Chelan County, Washington in 1998.
From Pilsbry (1948) - "Washington: Olympia, Home, Pierce Co.; Oregon: Oswego, Clackamas Co.; mushroom growth at the edge of a mountain meadow within a few feet of a stream, the first creek east of Cascade Locks . . . ."

Published reports of this species include; Macnab (1958) for Lincoln County, Oregon, Roth and Pressley (1983) for Trinity County, California, and Webb (1959) for Lane County, Oregon. Branson and Branson (1984) collected 1 specimen from Jackson County, Oregon. They reported previous locations from the literature as Portland, Oswego, and Corvallis.

## D. Habitat Characteristics and Species Abundance

### 1. Habitat

The papillose taildropper is most often found in moist late-successional conifer forest stands with a hardwood component. It appears to be associated with hardwood debris and leaf litter within those stands. They are sometimes found in second growth stands that were not burned for slash disposal or site prep if sufficient habitat elements remain. In the eastern Washington Cascades, it has been found mostly in riparian areas. The degree to which the species is dependent on riparian habitat probably depends on the general forest conditions in the area. In the eastern Cascades of central Washington in Douglas-fir and grand fir plant associations during a dry year, they were confined to the riparian zone. On the west slopes of the Washington Cascades, they were found more often in nonriparian moist hemlock forests (Burke, personal observations). It has also been found in a rock slide in northern California.

The papillose taildropper is known to be primarily mycophagous, that is a fungus eater. They have been observed consuming above-ground fungal fruiting bodies and using the hollowed stipes of several species as protected sites for mating and temporary refugia. Fecal analysis revealed spores of numerous underground truffle species, especially during the fall season (N. Duncan, personal communication). Therefore, the naturally occurring diversity of plant species in management areas is important for maintaining a broad range of hosts to support a variety of species of mycorhizal and other fungi, and to make other food substrates available throughout the seasons. This diversity will also ensure that specific plant species, which may be found to be critical in the life cycle of these mollusk species, are not inadvertently lost.

Habitats in which this slug is found are moist forest, normally late- successional or, if second growth, with late-successional attributes. For *P. dubium*, these forests are usually of moist conifer plant associations, but there is always a strong hardwood component also. The forest floor is moist but not wet or saturated. The ground is shaded and covered by moist layers of litter and duff. The species has been found in a range of forest canopy closure levels. Within an analysis done in southwest Oregon (N. Duncan and R. McGraw, unpublished), approximately 10% of known locations occurred in areas where canopy closure averaged less than 50%. In this study, the majority of sites were in areas with canopy closure greater than 70%. There is an abundance of large and small woody debris (conifer and hardwood) scattered over the ground. Large logs in better habitats cover 1000 or more linear feet per acre. Logs of decomposition class 2-4 are probably most often used. Low

vegetation may be patchy but tall shrubs (i.e., vine maple) may enhance the habitat.
Hardwood components vary by area. Bigleaf maple (*Acer macrophyllum*) and vine maple *(A. circinatum*) are highly used, and are commonly, but not always, present where *P. dubium* occurs. In one eastern Washington Cascades site it was found in a riparian area between grand fir and Douglas-fir stands. This site was recorded as having scattered western red cedar seedlings and saplings in the riparian area, and as containing alder, black cottonwood, and redosier dogwood, with snowberry, black prickly currant, and black twinberry also present. If any maple were present on this site, it was a minor component and not recorded. Another eastern Washington Cascades site was in a riparian zone within a grand fir forest with abundant bigleaf maple.

USDA Forest Service, and USDI Bureau of Land Management (1974: J2-352), and Frest and Johannes (1993, quoting Roth 1993) say that the species is at least a partial riparian associate, but has also been found in rock slides and at the edge of a mountain meadow near a stream in the southern part of its range. Two locations on the Wenatchee National Forest (Burke 1994, 1996) were all in riparian and associated with hardwood debris. On the Gifford Pinchot National Forest, one was in a riparian zone in late-successional western hemlock forest, and three in late-successional western hemlock/sword fern forest, but associated with leaf litter of bigleaf and vine maples, and the logs of bigleaf maple. Another one was found among salal in a Douglas-fir stand, and one in a moist young western hemlock stand with numerous large old logs, at the edge of a riparian zone above a creek, among Oregon grape under a vine maple. Three more were found within the edge of a mature, second growth western hemlock/sword fern stand with a heavy bigleaf maple component but in areas where conifer cover was dominant.

Macnab (1958) found the species in undisturbed 250-year-old Douglas-fir forest at 425-460 meters (1400-1500 feet) elevation on the north side of a mountain; and Roth and Pressley (1983) found them at 370 meters (1215 feet) elevation in a rockslide on the north side of the Trinity River; and Webb (1959) found this species in mature conifer forest on the east bank of the Long Tom River at about 183 meters (600 feet) elevation.

Pilsbry (1948) cited H. W. Harry's report from "mushroom growth at the edge of a mountain meadow within a few feet of a stream . . . ." Branson and Branson (1984) may have found it at one site in Oregon, "571 m elevation (1873 feet); soil, marginal oak forest."

## 2. Abundance

While the species range is large, known sites from within that range are widely scattered. There were only 5 records in early versions of the Known Site Database. However, since the Northwest Forest Plan was implemented, many new sites have been added, and the known range has been extended to include a few sites in the eastern Cascades of Washington.

*P. dubium* has now been found at additional sites in southern Oregon. However, because the known sites are so widely scattered, and there are relatively few specimens from each site, the abundance and security of this species is difficult to assess at this time. The current ISMS Database contains 332 observations from 298 locations in Oregon. However, these data show a spotty distribution, 252 of these reports being from two administrative units, the Eugene BLM and the Willamette National Forest. It appears that there may be areas in which this species is quite common, but its populations may be widely scattered throughout most of its range. Future surveys will provide additional data needed to assess the species overall status.

Historic occurrences in the following discussion indicate a general scarcity of this species across its range. Branson (1977 and 1980) did not find *P. dubium* in Washington. Branson and Branson (1984) reported only one from their surveys in Oregon. Frest and Johannes (1993) reported that it had not been collected recently in Washington or Oregon, but had been collected in California by Roth and Pressley (1983). Burke (personal observations) has observed it from three drainages in the eastern Cascades of Washington and from seven sites in the Cispus River Watershed in the western Washington Cascades. Although found at five sites during the Lower Cispus Watershed Analysis surveys in 1995, this species was poorly represented in the fauna of the areas surveyed, compared to other gastropods (Burke, 1996).

## II. CURRENT SPECIES SITUATION

### A. Why Species is Listed Under Survey and Manage Standard and Guideline

"The FEMAT rating reflects significant uncertainty about the specific distribution of the species, rarity of the species, and resulting uncertainty about how it will be affected by Alternative 9. Over time the species could be restricted to refugia within LSRs if a large portion of sites outside LSRs are disturbed" (USDA Forest Service, and USDI Bureau of Land Management (1974: J2-352).

*Prophysaon dubium* is on the Oregon Natural Heritage Program list 2, Washington State Monitoring List, BLM Assessment species for Oregon, and BLM Tracking species for Washington.

## B. Major Habitat and Viability Considerations

*Prophysaon dubium* is most often found in late-successional stands of moist conifer forest plant associations with a hardwood component. Some second growth stands that were not burned and had a liberal amount of large woody debris and other late-successional attributes, appear to also support this species. In drier areas, riparian habitats appear to provide conditions suitable to support this slug, and it may also be found in rockslides where conditions are suitable.

The scattered distribution of this slug, throughout the relatively broad range in which it occurs, indicates that it requires a set of conditions not found in all stands that appear suitable. The proper balance of overstory and understory to maintain proper site temperature, humidity, foods, and other specific requirements is not normally considered in environmental assessments.

For species of patchy distribution, concerns for viability increase as habitat areas decrease in number and size toward a critical threshold. Probability of catastrophic loss of local or limited habitats increases, 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 as population size decreases.

Isolated areas of habitat need to be of sufficient quantity and quality to provide all of the needs for viable populations of the species of concern as well as the other organisms that inhabit the same biotic community so that excessive competition does not reduce the habitat capability. Populations need to be able to withstand predation, parasitism, disease, and other natural interactions. Cover in the environment should be sufficient to protect the animals from extreme fluctuations in temperature and humidity, and to provide suitable and safe places for incubating eggs, aestivation, and hibernation, as well as for regular diurnal or nocturnal activities.

Loss of suitable conditions for mycorhizal fungal populations in managed forests is a concern for the continued viability of this species. It is known that severe burning and exposure to hot, dry conditions results in the loss of these critical elements of forest ecosystems. Forest practices that result in the loss of the fungal community, reduced plant diversity, and less than suitable conditions for slug species, which aid in fungal dispersal, will ultimately result in less productive and unhealthy forests.

## C. Threats to the Species

**Further loss of habitat to support the species across the landscape** - Much of the formerly known range of *P. dubium* has been developed for urbanization or agriculture. Currently, habitat disturbances and modification, such as timber harvest, fire, and development appear to be the greatest threats to this species. Under timber

management, slash disposal and site preparation by burning or ground scarification have direct impacts on the animals. Stand modification would have indirect impacts, altering temperature and humidity on and within the forest floor. Both the direct and indirect impacts would affect populations and species viability within areas of habitat.

**Reduction in quality of existing habitat** - Quality habitat is important to these slugs for maintaining a balanced biotic community to support them, and for escaping predators. It is found closely associated with hardwood trees in conifer forest stands; thus there may be a need for hardwood leaf litter, mycorhizal or other associated fungi or microbes. The overall lack of detail on their ecology points out the importance of a diversity of vegetation needed within their habitats to provide a variety of fungi and other potentially required but as yet unknown elements.

**Predation** - Concern about predators increases as habitat quality decreases. Up to three species of *Haplotrema* and *Ancotrema* (predatory snails that feed on snails, slugs and other invertebrates) occur in the same habitats in greater numbers than all Prophysaons. 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 fine and large woody debris. In good habitat predators are rarely a threat to a population.

**Competition from exotic mollusks** - Exotic slugs are increasing within the range of *P. dubium*. To what extent these introduced species might compete with the native gastropods or buffer them from predation has not been demonstrated, but experience from other lands is not encouraging. 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.

**High intensity fire** - High intensity fire is particularly damaging to gastropod populations, as it destroys both the animals and their habitats.

**Inadvertent losses because of other management activity** - For example, harvest of special forest products can be a threat in limited habitat areas. Raking the forest floor for mushrooms, or removal of logs for firewood could be particularly damaging.

## D. Distribution Relative to Land Allocations

Across its range, the species does not have a strong riparian association. There is a stronger riparian relationship on the east slope of the Cascades Range in Washington and in other forests with dry plant associations. There are over 300 sites in the ISMS database, most of which are newly discovered. Many of the new sites in Oregon are on the Eugene BLM District and in the Willamette National Forest. These new sites

are presumed to be mostly in matrix and Adaptive Management Areas, since this is where most surveys have been conducted.

## The following sections, III through VI, apply to both *Prophysaon coeruleum* and *Prophysaon dubium*.

## III. MANAGEMENT GOALS AND OBJECTIVES for both *Prophysaon coeruleum* and *Prophysaon dubium*.

### A. Management Goals for the Taxon

Management goals for these species are to assist in maintaining the species viability.

### B. Specific Objectives

1. Maintain and/or restore environmental components to provide for sufficient quantity and quality of habitat which should sustain populations in their existing distribution across the natural range of the species. Habitat components include: stands of mixed conifer and hardwood trees, bigleaf maple and sword ferns where available; uncompacted moist, cool, soils; relatively deep litter and duff; fungi; and large and small woody debris (both conifer and hardwood).

These species are relatively abundant in some parts of their ranges while being quite rare in other parts. The following two objectives address the difference in density of sites across the landscape.

2. Manage isolated populations by maintaining or improving existing habitat conditions. When a species is not found to be locally common, the specific objective for management is to maintain or improve microsite characteristics at each known site by maintaining an area large enough to moderate fluctuations in humidity and temperature, and to sustain other environmental characteristics. When habitat is in relatively good condition, decisions to restore or enhance it should not be made prematurely. Restoration of suitable habitat is appropriate if it is deteriorating through natural processes, or has been degraded by human activities.

3. Where the species is locally common, maintain persistence of populations and a relatively high level of suitable habitat conditions and features that will allow for the continued occupation of the area by the species. In these situations, management activities within their habitats may be done with little long-term impact on the species if certain precautions are observed. Habitat manipulation may be used to improve habitat conditions and/or maintain local populations of the species while allowing other management to occur. Restoration of suitable habitat is appropriate if it is deteriorating through natural processes, or has been degraded by human activities. Data gathered from surveys over the past two to three years indicate that the habitat requirements of species with extensive ranges may vary in different ecoregions. Therefore, management prescriptions may also vary by site, area or ecoregion.

## IV. HABITAT MANAGEMENT

### A. Lessons from History

If we have learned anything from history, it should be that management with a single or primary objective creates more problems than it resolves. Therefore, when managing habitat for a survey and manage species, other species, other resource objectives, and the ecosystem as a whole, including natural succession, potential natural disturbances within the site, and influences from adjacent lands, should all be considered.

Prior to the NFP there were few records for most of these species. Many of the older records provide little if any information on habitat or the microsite in which the specimens were found.

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 depends on several variables, including intensity, season and relationship to the life cycle of the species. Fire, especially intense fire events, can be very destructive to snails and slugs. Fire can kill the mollusks (if they are unprotected), and it can destroy logs and other woody debris that hold moisture and create microsites necessary for survival of these animals (Applegarth 1995; Burke, personal observations). 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* (Burke, personal observations). 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.

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 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).

## B. Identification of Habitat Areas for Management

In the first few years of implementing the Northwest Forest Plan, some Survey and Manage species were found to be more abundant in some areas than was envisioned when the Survey and Manage approach was being developed. This has led to questions about whether it is necessary to protect each and every site where the species has been found. If the distribution of a species is widespread, and discovery sites are locally common, it is possible to manage multiple sites within a given area collectively as a local population.

Individual mollusks are mobile and may move from the location where they were discovered. Additional individuals may also be present in nearby areas and remain undetected and unprotected by single site management. Thus management of the entire area occupied by the population would be more effective for population survival than management of smaller areas around individual sites. While this approach may cause possible loss of some individuals, all individuals may not be critical to the persistence of that population. Managing larger areas of occupied habitat rather than small areas around individual sites may result in a smaller but persistent population in the local area without risk to the regional species distribution.

Since our knowledge of habitat requirements and distribution for these species has increased, we can move from simply protecting site conditions as they are to using management prescriptions that allow habitat manipulation while maintaining persistence of the local population. These prescriptions could be applied to a range of different sizes of management areas, from small islands of habitat around individual discovery sites to multiple site polygons or designated management areas incorporating entire project areas.

Certain criteria need to be considered in order to take the more flexible approach of managing for populations rather than individual sites.

1. The species should be well distributed in all or a significant portion of its range,
2. There should be adequate information about its habitat associations to allow biologists to prescribe management to maintain, conserve or improve its habitat, and

3. The species should be locally common within and adjacent to the project area.

Both *Prophysaon coeruleum* and *Prophysaon dubium* are well-distributed in all or a significant portion of their ranges. *Prophysaon coeruleum* is widespread, but common only in southwestern Oregon. It is less common and more spottily distributed north of Corvallis, Oregon. In Washington it is rare, and in northern California it is rare. *Prophysaon dubium* is also widespread throughout most of its range, but is not known to be particularly abundant in any specific geographic province.

There is adequate information about the habitat associations of both *Prophysaon coeruleum* and *Prophysaon dubium* to conclude that management measures can be prescribed to maintain, conserve or improve their habitats. Although there are geographic differences in habitat that are not well understood, there is an abundance of observations to define habitat associations, and there are numerous situations that evidence how these species should respond to management measures.

Since conditions for distribution and habitat have been met, the only remaining criterion to meet in order to manage for populations rather than individual sites is whether or not the species is considered "locally common" in the Survey Area. The determination of "locally common" should be based on the results of protocol survey visits to individual project areas, any surveys beyond protocol requirements, incidental discovery of sites, and on historic data. A species may be considered as "locally common" if it meets all the following criteria:

1. There is a minimum of at least two sites in the survey or project area. The survey area may be increased beyond the project area to meet this criterion. This would be especially appropriate for small projects. The intent of this criterion is to establish a minimum number of sites in a local area.

2. There should be a ratio of at least one site per 10 acres or 4 hectares averaged for the Survey or project area. (In cases where sites are common in a portion of the Survey or project area, but not present in another portion of the area being considered, then these areas can be subdivided and managed differently. The minimum size after a subdivision of a Survey Area should be 20 acres or 8 hectares.) The intent of this criterion is to display evidence that the species occupies several sites within the area being considered.

3. The species is known to occur in adjacent or nearby forest stands. Known sites occurring within adjacent Riparian Reserves or outside of project boundaries, but within contiguous or nearby forest habitat, can be considered as documentation of occupancy in adjacent stands. The intent of this criterion is to display evidence that there are opportunities for repopulation of the Habitat Area.

4. The species is known to occur in adjacent or nearby watersheds. For purposes of this evaluation, known sites should be documented within at least one adjacent or nearby 6th field watershed. (Sixth field watersheds are expected to be approximately 20,000 acres or 8,100 hectares in size.) The intent of this criterion is to display evidence that the species is distributed across a broader landscape.

These criteria should all be addressed when determining if the species is locally common. Local biologists should document their consideration of these criteria and the intent of the criteria when determining if the species is locally common. These criteria are not intended to be absolute and inflexible. Other factors, such as the type of activity being proposed and the location of this area relative to other known sites can also be considered. It is very important to document the rationale used for developing site specific management proposals.

In reading this section, it is important to keep in mind the distinction between sites, occupied habitats, and Habitat Areas. The detailed discussion describing different strategies for managing known sites should be considered in conjunction with these definitions.

- **Site** -- The "site" is defined as that point at which the species was found, or a small area where two or more specimens were found within 10 meters (33 feet) of each other. A point location can be the marked feature in a Sample Area (or plot) where one or more examples were found, or the isolated site of a point search, or the center of a group of sightings within 10 meters (33 feet) of each other (and defined by UTM coordinates that are at least 10 meters from the next site).
- **Occupied Habitat** -- For this discussion, the "occupied habitat" is an area of closely similar habitat surrounding the sites, which is known or presumed to be occupied by the species.
- **Habitat Area** -- The "Habitat Area" is the area to be managed for the species in the immediate vicinity of known sites. It is that area around known sites including the habitat features that contribute to the environmental conditions important to the species at the known site.

There are three types of Habitat Areas and management strategies that can be used to manage for these species.

1. Habitat Areas for single site locations. Management is to maintain, benefit and enhance the species at the single site.
2. Habitat Areas that are polygons of several site locations. These polygons are subsets of a potential project area. Management should achieve continued occupation by the species within the Habitat Area by maintaining a relatively

high level of suitable habitat conditions and features and limiting disturbance. For purposes of managing locally common known sites, the Habitat Area is the site.

3. Habitat Areas covering a disturbance area, the entire project or larger area. The objective of this strategy is to maintain favorable habitat conditions within the Habitat Area to maintain occupation by the species while allowing some management to occur. For purposes of managing locally common known sites, the Habitat Area is the site.

These three types of Habitat Areas and management strategies are illustrated in the Appendix.

All known sites should be within a Habitat Area. In Strategy 1, known sites will be managed individually within Habitat Areas. In Strategies 2 and 3, known sites will be managed collectively as a population within Habitat Areas.

In areas where these species are locally common, local managers have the option of using Strategies 1, 2, or 3. There can be a combination of Habitat Area types within a single project.

Management activities which manipulate the habitat are allowed in Strategy 1 only to benefit the species. Strategies 2 and 3 allow habitat manipulation for a broader range of benefits. Strategies 2 and 3 are intended to provide additional flexibility while successfully maintaining and/or improving some habitat for populations and providing for continued occupation of the area by the species.

The following chart summarizes a few of the distinguishing characteristics of the three Habitat Areas and Management Strategies. A more complete description and explanation of recommended management in these Habitat Areas is in the following section.

**COMPARISON OF THREE HABITAT AREAS AND MANAGEMENT STRATEGIES**

| Attribute | Strategy 1 | Strategy 2 | Strategy 3 |
|---|---|---|---|
| Local population | Not locally common | Locally common | Locally common |
| Distribution of sites | Isolated, single sites | Clusters of multiple sites | Sites scattered across a landscape |
| Distribution of suitable habitat | Isolated areas | Irregular, mosaic distribution | Relatively uniform |
| Description of Habitat Area | Area around known site. Portion of typical project area. | Polygon around cluster of several known sites & habitat features. Portion of typical project area. Becomes the known site. | Entire survey area or project area or disturbed area. Becomes the known site. |
| Recommended Management within Habitat Area | Generally no disturbance. Disturbance only to benefit species. Maintain favorable microsite conditions and best features at site. | Limited disturbance. Some thinning and other activities allowed. Favorable habitat conditions & features at most individual sites maintained. | Limited disturbance. Greater thinning than allowed under strategy 2. Selected favorable habitat conditions and features at some individual sites maintained. |
| Fire management in Habitat Areas. | Protect from fire. | Protect from fire in low fire frequency areas. Avoid broadcast burning. Cool, patchy under burns allowed. | Protect from fire in low fire frequency areas. Avoid broadcast burning. Cool, patchy under burns allowed. |

## C. Management Within Habitat Areas

Management considerations will normally include maintaining 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). This requires that a sufficient amount of overstory crown cover and understory vegetation be retained to shade the ground, provide humidity through evapotranspiration, and impede air movement that would tend to displace the cool moist air. It also requires maintenance of large and small woody debris, and a layer of litter and duff on the forest floor. These components provide cool moist places in which the animals spend the days, hide from predators, deposit their eggs, and find food.

Since there is a strong likelihood that both *Prophysaon coeruleum* and *P. dubium* will occur within the same Habitat Areas, and other survey and manage species as well, an ecosystem management approach in which a mix of all habitat elements are maintained would be the most reasonable. For example, too much emphasis should not be placed on hardwoods when *Prophysaon coeruleum* is more closely associated with conifers, and too much emphasis on conifers would overlook the needs of *P. dubium* that might occur in the same Habitat Areas. In Habitat Areas co-inhabited by these two, and possibly other species of concern (e.g., *Cryptomastix devia*, *Hemphillia glandulosa*, or *Megomphix hemphilli*), management should be for a mix of environmental components required by all of the species of concern.

Where possible, integrate protection with other allocations, especially riparian reserves. When found within Riparian Reserves, consider increasing the width of occupied riparian reserves as potential management for habitat requirements for these mollusk species.

Attempt to maintain habitat contiguity by extending boundaries of Habitat Areas to meet other reserve areas such as Riparian Reserves, other Habitat Areas etc., to minimize fragmentation of populations.

Since these species spend different portions of the year at different locations on or within the forest floor, it is appropriate to consider how impacts would be different based on the time of year the activity occurs. Consider whether they are active on the surface or in litter, are dormant in large woody debris or in the ground estivating.

Three management strategies are available for *Prophysaon coeruleum* and *P. dubium*.

**Strategy 1** is the option where the species is not locally common. This is the cautious approach where individual known sites are managed within designated Habitat Areas. No or very minimal disturbance is generally expected within the Habitat Area. Management within a Habitat Area should be to maintain, benefit and/or enhance the species.

The size and quality of each Habitat Area should be sufficient to maintain favorable environmental conditions at the site location, conserve (or restore) the identified associated habitat features and important ancillary features, and provide conditions that allow this species to survive at this site. The size and shape of the Habitat Area depends on site specific conditions. While the Northwest Forest Plan identifies management for the species on the order of tens of acres (USDA, Forest Service, and USDI, Bureau of Land Management, 1974: J2-353), it is recognized that smaller Habitat Areas can be used. 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 determination of the size and shape of the unit needed. Of central concern is protecting the site from mechanical damage and conserving favorable temperature and humidity regimes at the site. Dryer, more open stands, southerly or westerly aspects, upper slopes, etc., generally indicate the need for larger Habitat Areas. 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 (Chen, 1993 and others). These are listed in the Reference Section.

Within Strategy 1, management of Habitat Areas should;

- Minimize disturbance of the forest floor litter, duff, and woody debris.
- Maintain existing canopy closure of trees within a large enough area to moderate fluctuations of temperature and humidity on the site.
- Maintain a component of hardwood trees and shrubs, including bigleaf maple trees (oldest preferred) and other hardwoods, to provide a constant supply of logs, leaves, and leaf mold. Site specific conditions will normally determine the optimum mix of tree species, but it appears that mixed stands of conifer and hardwoods provide the best habitat. In the interest of ecosystem management a diversity of tree species should be maintained on the site, but emphasis should be placed on the species that the mollusk species is observed to be using in the local area. The desired mix of hardwoods and conifers should be guided by mixes found at the sites supporting the major populations of the mollusk species for which management is being emphasized.
- Maintain or enhance the naturally occurring diversity of plant species in 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. Maintaining a mix, such as occurs in natural late-successional stands, would provide a more diverse and complete set of conditions for multiple species and a more fully functioning ecosystem.
- Maintain important cover and microhabitats by preserving dead and downed woody debris (especially Class 2 - 4). It is recommended that large and small

woody debris be maintained in its natural abundance in stands where these slugs occur. Falling trees to provide logs in stands where insufficient numbers occur may be done, but is not recommended unless the resulting canopy cover will provide sufficient shade to maintain cool, moist conditions.

- Avoid prescribed burning within these Habitat Areas, and protect them from wildfire by fuels management in adjacent areas and other means.
- As feasible, protect Habitat Areas from exotic snails and slugs, and control exotic species where they occur.
- Protect occupied rockslides and talus areas from road construction, quarrying, and other major site disturbing activities that may cause temperature and/or humidity changes within the interspaces or instability within the slope.

Outside of the Habitat Areas, management would be done to Forest Plan management objectives and guidelines.

**Strategy 2** is suggested where the species is locally common and the multiple known sites occur in locally clustered areas within a project area, or there is an identifiable concentration of favorable habitat features and conditions that occurs together with those sites. These multiple sites are managed as a collective population. The Habitat Area encompasses the population, but it is less than the entire project or survey area. All known sites should be within a Habitat Area. For purposes of managing known sites in Strategy 2, the Habitat Area is the site. Management should achieve continued occupation by the species within the Habitat Area by maintaining a relatively high level of suitable habitat conditions and features.

The advantage of the Strategy 2 approach is that while it achieves the basic objective of managing for the benefit of the species, it also allows some harvest and other activities within the Habitat Area (including tree removal, yarding corridors and skid roads), and gives more flexibility for management of other species within the area. This approach involves some level of risk and implies that the manager knows what habitat features are important to the species in question. With this approach, the management prescription used is sufficient to maintain some connectivity within the polygon and between hot spots, while allowing some degradation of conditions to occur. It is expected that some microsite conditions of the Habitat Area may be affected. However, by following these guidelines, the mollusk population will continue to occupy the Habitat Area after management activities occur.

Use of this strategy would normally begin with identifying and selecting concentrations of known sites or habitat features, such as old bigleaf maples and down logs. These areas would generally be designated as "hot spots". A polygon drawn around selected hot spots, additional sites and habitat features would be the Habitat Area. Hot spots normally include known sites and desired habitat features. Hot spots do not have to include known sites. Not all sites need to be included within a hot spot. (See illustrations in Appendix.) There can be one or several multi-site Habitat Areas within a

survey area, and there may also be one or more single-site Habitat Areas for outlying sites within the same Survey Area.

The Habitat Area should be large enough to generally maintain favorable habitat conditions at selected concentrations of habitat features at and near occupied sites. There should be enough distance between the sites and the Habitat Area boundary that most of the original shading of most of the sites would be conserved. The polygon normally includes the areas that would have been protected if these sites were managed individually plus intervening areas and possibly some adjacent areas of habitat features.

Habitat conditions within hot spots should be managed with a minimum of disturbance. Management should emphasize habitat protection, maintenance or enhancement for the benefit of the species. The guidelines for Strategy 1 (other than size of the Habitat Area) would also apply to hot spots. The number and distribution of these hot spots should reflect (but not necessarily match) the existing distribution of habitat elements and known sites. The size of each hot spot area will depend on the type of potential adverse environmental effects from adjacent areas. In other words, if the cluster or hot spot is surrounded by relatively undisturbed habitat, the need for additional protection is reduced. It is recommended that at least one hot spot be identified per 10 acres or 4 hectares in the Habitat Area. The hot spots can be relatively small (1 - 2 acres in size) and should make up 10-20% (or more) of the total Habitat Area.

Outside of these hot spots, but still within the Habitat Area, management may be allowed for other purposes. However, while these activities may occur, management of the Habitat Area should maintain a relatively high level of suitable habitat conditions that will allow for continued occupation by the species. While activities may occur, there should be a focus on moderating the fluctuations in temperature and humidity. Examples of some of these types of activities include skid trails, yarding corridors and falling and removal of trees. Management could also be intended to improve the habitat for the species (e.g., thin to promote propagation or growth of hardwoods for *P. dubium*, or to enhance conifer growth in young thickets; fall an occasional tree to improve distribution of large woody debris).

Many activities and conditions affect the suitability of sites for these species. However, one of the major influencing factors is shade. Shade helps to moderate fluctuations in temperature and humidity. Management activities in the Habitat Area should result in crown cover sufficient to provide shade over most of the Habitat Area at the completion of the project. The emphasis is to maintain some connectivity within the polygon and between hot spots. This level of average shading is most important during the hottest and driest time of the year. On the average, the stand should maintain favorable temperature and humidity regimes by retaining more shaded areas than open areas. This level of average shading could be achieved by combining open areas with denser areas. Both species have shown a greater tolerance for less shade in the southern portion of their ranges. There is a greater need to maintain shade in the northern portion of their ranges.

Previous data on stand conditions where these species have been found show that suitable conditions may be achieved with canopy closure from 50% to 70%, depending on the province. The lower ranges of expected suitable canopy closure for different provinces are shown below;

| | |
|---|---|
| Klamath/Siskiyou provinces | 50% |
| All Oregon provinces other than Klamath/Siskiyou | 60% |
| All Washington provinces | 70% |

These levels recognize and allow +/- 10% fluctuations for site specific conditions.

Mature trees provide shade and also radiate heat at a higher level above the ground. For this reason, the level of canopy closure should come from the larger or more mature trees available in the stand. Local specialists have the option of identifying and using other means of measuring stand conditions which will result in the targeted levels of shade. Their rationale for how other measurement systems are used should be documented.

As a general rule, the effects of habitat disturbance from broadcast burning for site preparation or slash disposal should be avoided within Habitat Areas. Generally, keep fire out of Habitat Areas in regions with a longer fire return interval (greater than 50 years). Areas with relatively short fire return intervals (less than 50 years) have a greater need for and opportunity to use prescribed burns to manage fire risk in and around Habitat Areas. Because fire is a more frequent active component of these ecosystems, it is appropriate to use it as a management tool as long as adverse impacts to these species and their habitats are minimized.

Prescribed burning within Habitat Areas is discouraged (including broadcast burning, burning naturally created slash piles and slash piles caused by management activities). However, it may be acceptable if ground disturbance is limited to a relatively small portion of the Habitat Area and if the intensity of the burn can be minimized. Fire prescriptions should target cool, patchy under burns that leave a portion of the Habitat Area (approximately 30% minimum) unburned. The timing of the prescribed fire should take into consideration the species life cycles and behaviors. Populations should be protected from prescribed fires while they are active on the ground surface. While keeping in mind the possible adverse effects of fire protection measures, use all possible measures to keep fire out of areas designated as ‘hot spots’ for the species.

During site preparation or slash disposal, efforts should be made to reduce ground disturbance and retain large woody debris to the degree possible. Burning piles is generally preferable to broadcast burning. Hand piling is much preferred to machine piling. Piles should be covered and burned in the same season or left unburned to prevent mollusks from being attracted to the piles and killed.

Outside of the Habitat Areas, management would be done to Forest Plan management objectives and guidelines. Prescribed burning to manage the risk of wildfire is encouraged. Mitigations should be designed to reduce the effects of broadcast burning and ground disturbance within the Habitat Area. For example, retaining unburned piles and down wood and leaving scattered logs outside of the Habitat Area is suggested whenever possible to provide additional habitat.

**Strategy 3** is suggested where one or both of these species are locally common and if the distribution and numbers of sites and habitat features suggest that they are likely to occur more or less throughout the survey area. This strategy defines an entire project or survey area as a single multi-site Habitat Area. All known sites should be within the Habitat Area. This area and these sites are managed as a collective population. For purposes of managing known sites in Strategy 3, the Habitat Area is the site.

The objective of this strategy is to maintain primary habitat conditions within the Habitat Area to maintain occupation by these species while allowing some management to occur. This strategy could also be considered if there are multiple, small Survey Areas that are close together in a continuous area of potential habitat, and there is a possibility of managing them and the intervening land as a single multi-site Habitat Area.

By following these guidelines, it is expected that mollusks will continue to occupy the Habitat Area after management activities occur. A temporary decline in local populations of these and other mollusk species can be expected to follow a major reduction of tree canopy. But, if stand species diversity, sufficient shade and large woody debris are maintained, then in less than 20 years the habitat should regain suitability and occupancy. This strategy may result in short-term reduction of overall habitat quality, but should maintain connecting corridors within the Habitat Area (especially between hot spots) and adequate protection of hot spots to ensure continued occupation by the species.

'Hot spots' of known sites and habitat features should be identified and managed to emphasize habitat protection, maintenance or enhancement. To establish these hot spots, select and delineate polygons around clusters of the most densely occupied sites and the best concentrations of suitable habitat that are large enough to maintain environmental conditions at the selected sites or features. The number and distribution of these hot spot areas should reflect (but not necessarily match) the existing distribution of habitat elements and known sites. Hot spots normally include known sites and desired habitat features. Hot spots do not have to include a known site. Not all sites need to be included within a hot spot. It is recommended that at least one hot spot be identified per 10 acres in the Habitat Area. The hot spots can be relatively small (1 - 2 acres in size) and should make up 10-20% (or more) of the total Habitat Area. The selection of which areas to treat as hot spots may be guided by all expressed concerns, including other uses, forestry operations and conservation of other special status species.

Management over the remainder of the survey or project area (Habitat Area) should retain suitable habitat components and diversity required for each species. These components include conifer and hardwood trees, tree and shrub species used by associated fungal species, large down woody material (including a source for future recruitment). These components should be shaded. Examples of some of the types of activities which could occur within the Habitat Areas include skid trails, yarding corridors, road construction, falling and removal of trees, and site preparation.

Many activities and conditions affect the suitability of sites for these species. However, one of the major influencing factors is shade. Shade helps to moderate fluctuations in temperature and humidity. Management activities in the Habitat Area should result in crown cover sufficient to shade portions of the Habitat Area at the completion of the project. The emphasis is to maintain some level of connectivity within the Habitat Area and between hot spots. This level of average shading is most important during the hottest and driest time of year. On the average, the stand should have at least the same amount of shaded areas and open areas. This level of average shading could be achieved by combining openings in the forest canopy with denser areas. Both species have shown a greater tolerance for less shade in the southern portion of their ranges where forests are naturally more open. There is a greater need to maintain shade in the northern portion of their ranges. Under this strategy, external influences effect the internal habitats much less than they would in a situation where there is an abrupt edge where stand conditions change. It is the opinion of the authors that under these conditions, an average of 40 to 50% canopy closure would be sufficient to maintain favorable habitat for the species in these Habitat Areas outside of the hot spots if other habitat components are maintained (i. e. logs, litter and duff).

These levels recognize and allow +/- 10% fluctuations for site specific conditions.

Mature trees provide shade and also radiate heat at a higher level above the ground. For this reason, the level of canopy closure should come from the larger or more mature trees available in the stand. Local specialists have the option of identifying and using other means of measuring stand conditions which will result in the targeted levels of shade. Their rationale for how other measurement systems are used should be documented.

At the completion of the project, portions of the stand (generally the 'hot spots' and connecting corridors) should meet habitat requirements for these species and the entire stand should partially meet habitat requirements. The habitat elements in the project area should regain full suitability and occupancy in less than 20 years.

As a general rule, the effects of habitat disturbance from broadcast burning for site preparation or slash disposal should be avoided within Habitat Areas. (In this strategy, the entire project is the Habitat Area.) However, the role of fire in the ecosystem is also recognized, especially in areas with a relatively short fire return interval (less than 50

years). It is appropriate to use fire as a management tool as long as adverse impacts to the species and its habitat are minimized. Prescribed burning outside of the Habitat Area to manage the risk of wildfire is encouraged.

Prescribed burning within Habitat Areas is discouraged (including broadcast burning, burning naturally created slash piles and slash piles caused by management activities). However, it may be acceptable if ground disturbance is limited to a relatively small portion of the Habitat Area and if the intensity of the burn can be minimized. Fire prescriptions should target cool, patchy under burns which leave a portion of the Habitat Area (approximately 30% minimum) unburned. The timing of the prescribed fire should take into consideration the species life cycles and behaviors. Populations should be protected from prescribed fires while they are active on the ground surface. While keeping in mind the possible adverse effects of fire protection measures, use all possible measures to keep fire out of areas designated as 'hot spots' for these species.

During site preparation or slash disposal, efforts should be made to reduce ground disturbance and retain large woody debris to the degree possible. Burning piles is generally preferable to broadcast burning. Machine piling generally creates excessive levels of disturbance, so piles should be hand built. Piles should be covered and burned in the same season or left unburned to prevent mollusks from being attracted to the piles and killed. Retaining unburned piles and logs is suggested whenever possible to provide additional habitat.

## D. Other Management Issues and Considerations

It is apparent that, although often found in the same stands, these two species use different habitat elements. *Prophysaon coeruleum* is reportedly found on a variety of substrates in southwestern Oregon, but it may be found in conifer stands with little if any hardwood component. In Washington, it is generally found in late-successional conifer stands that normally contain hardwoods, but within these stands it may be found at sites that are nearly pure conifer, where *P. dubium* would not occur. *Prophysaon dubium* is also found within the same kinds of forests, often in the same stands as *P. coeruleum* but *P. dubium* is almost always found associated with hardwoods, either among leaf litter or on logs. In the Eastern Washington Cascades and Yakima Province Planning Areas, *P. dubium* is most often found in riparian habitats and, within those provinces, it may be confined to the riparian zone during prolonged droughty periods.

At the time that the Northwest Forest Plan was developed, these two species of *Prophysaon* were known from few sites and few living malacologists had even seen them. Much of the habitat from which they had previously been known, had been developed into urban or agricultural areas, or intensively managed. Although surveys were not required to be done until projects implemented in FY 1999, biologists from several federal land management units took the initiative to proceed, anticipating the need to prepare for the time that the surveys would be required. As a result, we have

learned more about the ranges and habitats of these species over the past three years than the total that was known prior to that time. As more units survey for them, we have the potential to fill in many of the knowledge gaps that still exist. As we gain knowledge of these species we can better evaluate the need for special management for them and, where it is needed, we can better plan for maintenance of the habitat and populations.

Variants of the blue grey taildroppers in southern Oregon, and perhaps northern California, may be separate species. There is a recognized difference in the habitats occupied by the dark variant (Klamath taildropper) which generally uses drier areas and more open habitats. Characteristics of habitats used by the Klamath variant and typical *P. coeruleum* should not be combined for analysis because that would confuse habitat descriptions. Each of the different variants and their habitat data need to be recorded separately in order to evaluate species (or subspecies) status and clarify management needs and recommendations when these differences are resolved. For management purposes, until a taxonomic examination of the *coeruleum* complex is published, all variants should be treated as one species.

Exotic species are entering habitats occupied by these species. If exotic species are found, measures to control them should be implemented as feasible. Measures to control exotic species should not be adverse to *Prophysaon* and other native species.

## 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 Northwest Forest Plan level.

### A. Data Gaps and Information Needs

What was known of the habitat and ecology of these slugs prior to the Northwest Forest Plan (NFP) was from few, generally poorly documented observations. Literature sources (Pilsbry 1948; Branson 1977, 1980; Branson and Branson 1984) give general site information at best, but detailed records of specific plants or other micro habitat elements are primarily from personal knowledge from surveys done mostly since the NFP (Frest, Applegarth, Weasma and Duncan, personal communications; Burke, personal observations).

Taxonomy of the blue-gray taildroppers needs to be clarified. The typical *Prophysaon coeruleum* is distinct and easily identified. But similar species or varieties occur within and immediately adjacent to the range of *P. coeruleum*. To date, all bluish taildroppers have been reported as *P. coeruleum*, when there may be 3 or more recognizable

separate taxa. There are also apparent habitat differences between some of these variants.

The different varieties are not difficult to distinguish. Field personnel need to be trained in the differences, as they have been for the other species, and instructed to record them as individual taxa, even though a common name may be all that is available. Until this is done, the range and habitat data on *P. coeruleum* in ISMS cannot be validated.

Only a few of the land allocations of the known sites were available at this writing. Others need to be determined and recorded.

Additional data could help resolve several questions. These include;
-What is the specific 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?
-What are the species 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.)?
- Distance moved in a lifetime?

-What are the species physical attributes?

- Elevations of habitat used;
- Soil types, geology, trace elements;
- Temperature, humidity.

## B. Research Questions

Are the recognized varieties of *P. coeruleum* separate species or subspecies? Would DNA or other genetic analysis be appropriate to resolve taxonomic questions?

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

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

What are the effects of herbicides and other chemicals used in forest management on mollusk species.

What are the land management allocations at the known sites?

## C. Monitoring Needs and Recommendations

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.

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, no more than 5% of its occupied habitat should be disturbed during surveys or monitoring.

Conduct surveys in spring after the ground has thoroughly thawed, and in fall after the first week of heavy rainfalls or frosts (if before significant rains).

Record all environmental conditions where these species are found to better understand their habitats and management needs.

Monitor natural sites for conditions and trends of populations.

Monitor managed sites for implementation and effectiveness of prescriptions.

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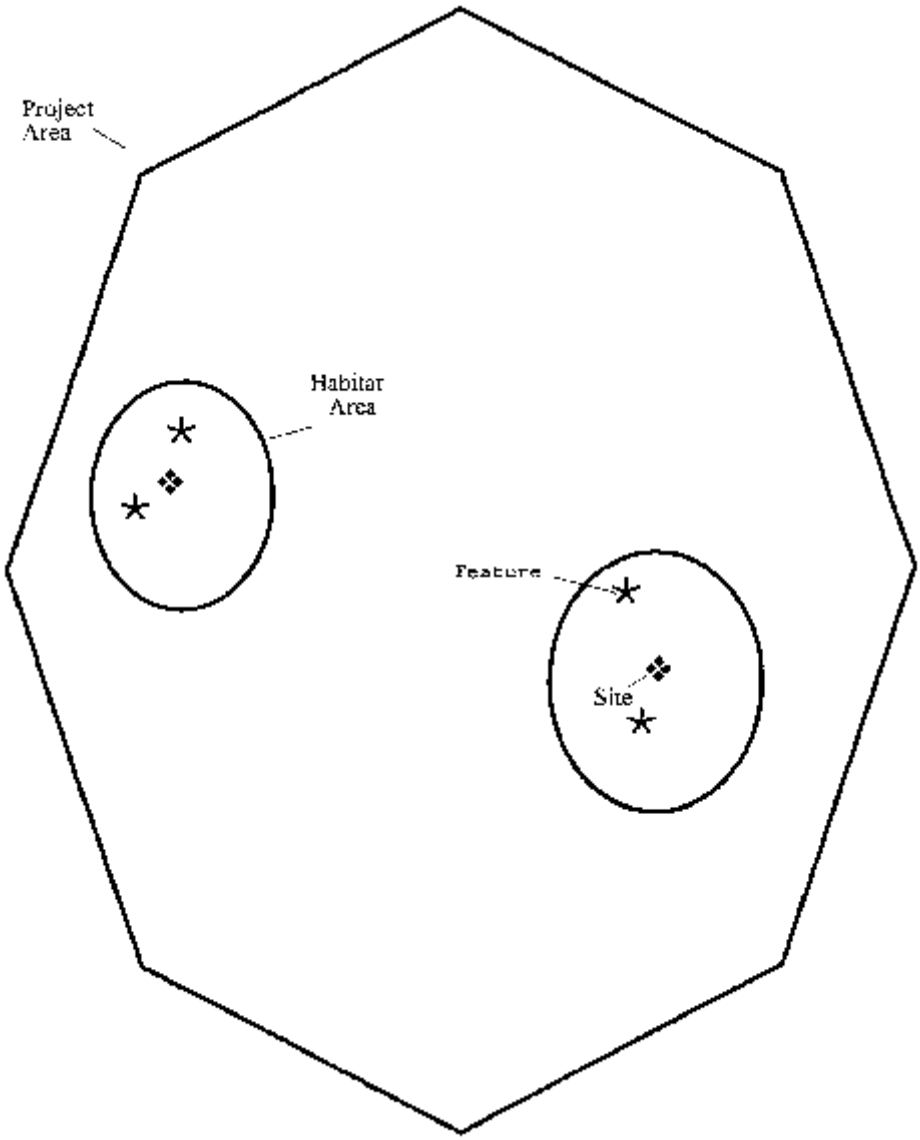
# APPENDIX - FIGURES

**Strategy 1** is the option where the species is not locally common. This is the cautious approach where individual known sites are managed within designated Habitat Areas. No or very minimal disturbance is generally expected within the Habitat Area. Management within a Habitat Area should be to maintain, benefit and/or enhance the species.



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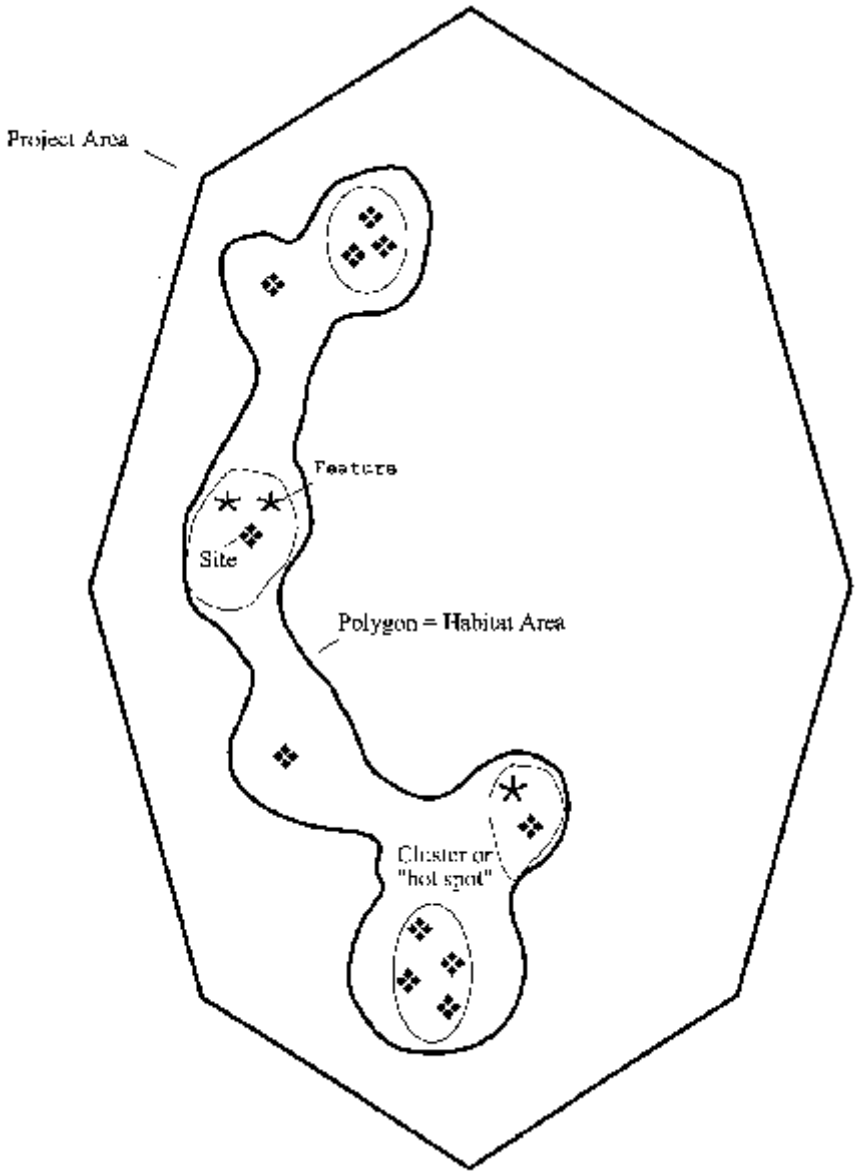

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