Management Recommendations for Terrestrial Mollusk Species

Cryptomastix devia, the Puget Oregonian

V. 2.0

by

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EXECUTIVE SUMMARY

Species: *Cryptomastix devia* (Gould 1846)
Common Name: Puget Oregonian

Taxonomic Group: Mollusks (Phylum Mollusca: Class Gastropoda)

ROD Components: Survey and Manage Strategies 1 and 2.

Other Management Status: *Cryptomastix devia* is on the Oregon Natural Heritage Program (ONHP) list 3, the Washington State Monitoring list, and the BLM Tracking list for Oregon and Washington.

Range: *Cryptomastix devia* inhabits areas of the western Cascade Range and Puget Trough at low to moderate elevations from southern Vancouver Island, B.C., Canada through western Washington into northwestern Oregon, between The Dalles and Portland, with the potential to extend southward in the Willamette Valley and Coast Range. There are 69 observations from about 29 locations in the ISMS Known Site Database, and additional new sites have been discovered.

Specific Habitat: *Cryptomastix devia* inhabits moist, conifer forest habitats. Although often occurring within riparian areas and possibly confined to the riparian zone in some dry landscapes or less densely forested areas, it is not generally a riparian obligate. It is usually found associated with bigleaf maples growing among the conifers. This species is often found on or under hardwood logs or leaf litter, or in the litter under sword ferns that are growing near or under the crown of an old bigleaf maple tree. Rocks may also be used. Young *C. devia* may be found among or under mosses.

Threats: Primary threats to this species are loss of habitat due to forest management practices, conversion for agricultural, urbanization and other uses, and fire. Natural threats may include vertebrate and invertebrate predators (i.e., predatory snails, and beetles), but in adequate habitat natural predators are rarely a threat to a population. Harvest of special forest products (i.e., raking for mushrooms, firewood gathering) are potential threats in limited habitats. Exotic mollusks are rapidly increasing within the range of *Cryptomastix devia*, but the effects on this native snail has not been documented.

Management Recommendations:
Three management strategies are recommended for *Cryptomastix devia*, 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 shade and limiting intense 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 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 which occupy a portion of the project area. The Habitat Area is an area or polygon around several 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 occurs 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 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:

- What is the range of habitat conditions tolerated by the 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?

I. NATURAL HISTORY

A. Taxonomic/Nomenclatural History

Family: Polygyridae
Species: *Cryptomastix devia* (Gould, 1846)

Triodopsis (Cryptomastix) devia (Gould) in Pilsbry, 1940.
Polygyra devius Hanna and Rixford, 1923.
Polygyra devia Gld., Dall, 1905.
Mesodon devius Binney, 1883.
Mesodon devia Gld., Tryon, 1867; W.G. Binney, 1878.
Odotropis devia Gld., J.G. Cooper, 1868.
Helix baskervillei Pfeiffer, 1852.
Helix devia Gould, 1846.

(From Henderson, 1929, 1936; and Pilsbry, 1940)

B. Species Description

1. Morphology

The largest *Cryptomastix*, the shell of *C. devia*, has a greater diameter (outer edge of aperture to opposite side of shell) of 18-25 mm. Color of the shell is yellowish horn to brown. Mature shells have a broadly reflected lip margin; immature shells lack the reflected lip margin and have short, moderately spaced, microscopic bristles on the shell (difficult to see with a 10x lens and readily lost from collected shells). The basal lip margin supports a long, low tooth-like lamella (fold), and there is a distinct parietal tooth in the aperture.

Other Pacific Northwest shells of similar size do not have the apertural teeth. Two other *Cryptomastix* are found within the same range: *C. germana* is the smallest species of the genus (8 mm. diameter), and usually retains long, curved bristles on its shell as an adult. *C. hendersoni* is somewhat smaller than *C. devia* (to 18 mm. diameter), and usually lacks apertural teeth, although it sometimes has a very small parietal tooth.

Other species with which *C. devia* may be confused are:

(1) *Allogona townsendiana*, which is larger, and *A. ptycophora*, may be about the same size as *C. devia*. *Allogona* lack the parietal tooth, and shells of the immature are without the short hooked bristles of immature *C. devia*.

(2) Immature *Monadenia fidelis* can be confused with immature *C. devia*. Immature *M. fidelis* is more angular at the periphery, lacks the short bristles of fresh immature *C. devia* shells, and the peripheral bands of *M. fidelis* are usually apparent, though not always obvious in small living snails (Henderson 1929; Pilsbry 1940; and personal observations). The young *M. fidelis* also have rather straight edged maleations on the dorsal surface of the whorls.

2. Reproductive Biology

Cryptomastix devia hatch from eggs and live for more than one year. However, specific details on life span and reproduction for this species were not found.

Like most Terrestrial gastropods, *Cryptomastix* are hermaphroditic, having both male and female organs. Although not confirmed specifically for *C. devia*, self-fertilization has been demonstrated in some species of gastropods, but cross-fertilization is the norm. Bayne (1973) discussed the complexities of the Pulmonate reproductive system, and studied mechanisms by which allosperms (sperm from another) exert dominance over autosperms (sperm from oneself) during fertilization. Thus, ". . . self-fertilization is normally avoided, but remains a possible alternative to cross-fertilization." The advantage is in normally avoiding potentially deleterious inbreeding, yet retaining the option to reproduce if a mate is not available.

3. Ecology

Nothing was found in literature sources on the ecology of *Cryptomastix devia*, but Pilsbry (1940) states of the Family Polygyridae, "Their food is chiefly the mycelia of fungi." He also says, "The young snails wander abroad more freely than adults, and are often found on plants where the adults are under cover." Although the natural foods of *C. devia* have not been specifically documented, one immature specimen was observed to eat lettuce, reluctantly, in captivity (personal observation). While it is suspected that mycophagy is the primary life style of this species, it appears that at least the young may be partially herbivorous on green plants during certain seasons. The species probably has a digestive efficiency rate in the high forties for assimilation of food materials, a low rate that allows viable spores and fragments of fungal hyphae to be excreted with the feces. Thus, they represent an important dispersal mechanism for fungal species throughout the year when this mollusk is active.

Cryptomastix devia is a low to mid-elevation, old-growth forest associate. It appears to have an affinity to old-growth western hemlock/sword fern plant associations with bigleaf maple and/or possibly other hardwood components

well represented. It is found among deciduous leaf litter, under ferns, on the underside of hardwood logs, or among rocks within the above or similar plant associations.

C. Range, Known Sites

The known range of *C. devia* is in the western Cascade Range and Puget Trough at low to moderate elevations (from near sea level upwards through the Western Hemlock Series) from southern Vancouver Island, B.C., Canada through western Washington to between The Dalles and Portland, in Oregon.

There are currently 69 observations for *C. devia* from about 29 localities in the Known Site Database. Considering grouped localities, they are actually from about 10 areas, the largest (10 records) being the metropolitan Seattle area. Known sites from National Forest lands occur on the Olympic and Gifford Pinchot National Forests and within the Columbia Gorge National Scenic Area. It is also known from the vicinity of the Mount Baker-Snoqualmie, and Mount Hood National Forests and the Salem BLM District. It is expected to occur on the Wenatchee National Forest since other western Cascades species are found in valleys on the east slopes of the Cascades, and one immature specimen collected there, in Chelan County in 1998, appears to be this species (Burke, personal observation; specimen of G. Roberts).

Pilsbry (1940) gave locations at Vancouver Island, B.C., "Puget Sound, type locality", Seattle, King County; Carson, Skamania County; Freeport, Cowlitz County (Henderson 1929); and Nisqualie flats, Thurston/Pierce counties, Washington, and Hayden Island, Oregon, opposite Vancouver, Washington. Frest and Johannes (1993) reported locations from King, Clark, Skamania, and Thurston counties, Washington, and Multnomah County, Oregon. Branson (1980) reported it from Lake Chelan State Park, Chelan County, a record that needs to be confirmed. Other unidentified *Cryptomastix* have been found in that vicinity, but it is an unlikely habitat for *C. devia*. It has also been found on the Gifford Pinchot NF, Lewis County, Washington. (Burke, 1996 unpublished report; Kogut, personal communication).

Henderson (1936) says there are *Polygyra devia* (Gould) in the Hemphill-Hannibal collections at Stanford University from Kalama, Clark County, Clearwater, (Jefferson County, apparently), Freeport, Cowlitz County, and Seattle, King County, Washington; Portland, and Hayden Island, Multnomah County, Oregon. He also cites but questions the validity of a record from Yakima, Washington. Frest (Known Site Data Base) questions the validity of the Clearwater record as being an Idaho species and more likely from Clearwater, Idaho. If the Chelan County record is verified, it will be a range extension and confirmation of the species in the eastern Cascades of Washington.

D. Habitat Characteristics and Species Abundance

1. Habitat Characteristics

Records for *C. devia* indicate its habitat to be in mature to old growth, moist forest and riparian habitats, under logs, in leaf litter, around seeps and springs, and often associated with hardwood debris and leaf litter and/or talus. It often occurs under or near bigleaf maple trees and may be found under sword ferns growing under those trees, or on the underside of bigleaf maple logs. Canopy cover over natural occupied habitats was usually greater than 70%, with rare exceptions on wetter sites. Juveniles of this snail may also be found under or among mosses such as grow on the trunks of old bigleaf maples.

Frest and Johannes (1993) said the habitat is low to middle elevations; old growth and riparian associate; habitat includes leaf litter along streams, under logs, seeps, and springy areas. Dr. Baker found them at bases of east-facing slopes along the lake north of Seattle, near damp places with maples and sword ferns (Pilsbry 1940).

North of the Cispus River, Lewis County, Washington, they were found in mature and old growth forest, seldom in riparian habitat (Burke, personal observations). Some sites were quite rocky, one overlaying a talus scree slope, while other sites contained almost no surface rock. The plant association was old-growth western hemlock/sword fern, but *C. devia*, *Monadenia fidelis*, and *Prophysaon dubium* appeared associated with bigleaf maple logs or leaf litter within that association. Most of the *C. devia* were found on the underside of bigleaf maple logs that were sound but with the bark loose and falling away. They were most often found on logs greater than 12 inches in diameter, but which were broken into smaller chunks. The larger logs in the area were too heavy to move for examination. Pieces as small as 3 feet long by 5-6 inches in cross-section were found with this snail on them. Other *C. devia* were found in forest floor litter often under sword ferns growing among or near the base of living mature big-leaf maples. Canopy cover in occupied forest sites was usually greater than 80% mixed conifer and hardwoods. Wetter sites with a greater component of bigleaf maple sometimes had more open canopies. Possibly additional water compensates for the reduced shading by moderating temperature fluctuations as well as maintaining humidity.

Records in the Mollusk Known Site Database show habitat under logs and bark in rainforests of fir, alder, cottonwood, and willows.

2. Species Abundance

Current knowledge of this species indicates that it is widespread across its range, but of quite spotty distribution. As of August 1998, ISMS shows 69 observations in 29 localities but, if grouped further, there would be only about 12 nonurban areas, 14 of the observations being from the metropolitan Seattle and Portland areas.

The greatest known populations are in the Lower Cispus River watershed on the Cowlitz Valley Ranger District, Gifford Pinchot National Forest. Based on recent findings, it still occurs in that watershed in fair numbers in Late-Successional Reserves (LSRs) and a few other areas. Four weeks of field work on the Randle Ranger District (now part of the Cowlitz Valley RD), during spring, summer, and fall, 1995, located this species in 5 of 40 sites surveyed. All of the *C. devia* sites were within 6 miles of each other. The greatest number of *C. devia* found at any one site at one time was 6. Many other sites have also been located on the Cowlitz Valley RD since the 1995 surveys, but there is little information about this species' current status or abundance elsewhere.

Much of its former range is now urban or has been developed for agriculture. Ten of 42 records from prior to 1994 are from the metropolitan Seattle area, and it apparently still occurs there in a few protected forested parks, but most of those sites can be expected to have been developed for housing, business, industry, streets, and highways. It generally appears to be lacking from areas that were burned under timber management.

II. CURRENT SPECIES SITUATION

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

The FEMAT analysis for *C. devia* determined that under the preferred management option insufficient habitat would remain to allow the species to stabilize well distributed across Federal lands; there would be 7% probability that it might remain viable but with gaps in its distribution; there is about 50% probability that populations will remain viable in refugia; and 43% probability that it will be extirpated from federal lands. These ratings were based on "past actions" that have caused the species to decline due to forest management and urban area development (USDA, Forest Service, and USDI, Bureau of Land Management, 1974: J2-307).

Smith (1970) considered *Triodopsis devia* (=*C. devia*) endangered, "because of industrial expansion in the Seattle area. May not be in danger elsewhere in its range." Since 1994, additional populations of *C. devia* have been discovered, but new data is insufficient to indicate that survival of the species is secure.

B. Major Habitat and Viability Considerations

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

Cryptomastix devia occurs in moist forest habitats, such as old-growth hemlock/sword fern associations, and it appears to be associated with hardwoods within these stands. Such stands have been reduced by timber harvest, and conversion of forest land for agricultural and urban development.

Current distribution of this species is sparse and patchy; it is not generally abundant in known habitats relative to populations of other associated gastropods.
For species with patchy distribution, concerns for viability increase as habitat areas decrease in number and size toward a critical threshold. 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.

Where more than one "survey and manage" species occurs in the same stand, their habitats, while similar, will not be exactly the same and multiple species' management may be problematic. For example in the Cispus River Watershed, *Cryptomastix devia, Prophysaon dubium*, and *Prophysaon coeruleum* were all found in the same small area of an old growth western hemlock/sword fern stand. However, *P. coeruleum* was more closely associated with conifer logs, while *P. dubium* and *C. devia* were associated with hardwoods within the stand. *P. dubium* and *C. devia* were found in what appeared to be identical microhabitats in some situations, but more often they were in somewhat different microhabitats. For example, both species were found on maple logs; when not on logs, *P. dubium* was more often found among dead maple leaves in the upper litter layer, while *C. devia* was usually in older, more decayed forest floor liter, most often under sword ferns.

C. Threats to the Species

Further loss of habitat to support the species across the landscape - Much of the formerly known range of *C. devia* has been developed for urbanization or agriculture. At the time of the FEMAT Analysis, *Cryptomastix devia* was known from only about 42 records from 24 localities, 6 in Oregon and 18 in Washington. Ten of the records were from what is now the metropolitan Seattle area. Currently, habitat disturbances and modifications such as timber harvest, fire, and development appear to be the greatest threats to this species.

Reduction in quality of existing habitat - Quality habitat is important to this snail for maintaining a balanced biotic community to support them and for escaping predators. It appears to be closely associated with moist conifer forest plant associations supporting a hardwood component, such as bigleaf maple. There appears to be a need for hardwood leaf litter, mycorhiza, or other associated fungi or microbes.

Predation - Concern about predators increases as habitat quality or quantity decreases. Up to three species of *Haplotrema* and *Ancotrema* (predatory snails that feed on snails, slugs, and other invertebrates) occur in the same habitats in greater numbers than *C. devia*. Ground beetles (*Scaphinotus* sp.), specifically adapted for preying on snails, are common in northwest forests (White 1983; Kozloff 1976), and other insects as well as reptiles, amphibians, birds, and mammals also prey on them. Hiding and escape cover is provided by forest floor litter, including fine and large woody debris. However, in good habitat predators are rarely a threat to a population.

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

High intensity fire - High intensity fire is particularly damaging to gastropod populations as it destroys both the snails 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 hardwood logs for firewood could be particularly damaging.

D. Distribution Relative to Land Allocations

Some of the locations where *C. devia* remain are on the Olympic and Gifford Pinchot National Forests, and may fall within the Adaptive Management Areas (AMAs) of

those forests (USDA, Forest Service, and USDI, Bureau of Land Management, 1974: J2-307). It occurs within Late-Successional Reserve (LSR) in the Lower Cispus Watershed, Cowlitz Valley Ranger District of the Gifford Pinchot N.F., and at least within the edge of the Cispus AMA (Burke, 1996 unpublished report). Many of the historic sites are in the area of Seattle and its suburbs. It apparently still occurs in a few parks where natural forest stands exist, but it is expected that most of those historic sites have been developed.

III. MANAGEMENT GOALS AND OBJECTIVES

A. Management Goals for the Taxon

Management goals for this 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).

This species is relatively abundant in some parts of its range 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 its 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 indicates 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.

There are few records for this species and many of the older records provide little if any information on habitat or the microsite in which the specimens were found. There is little habitat information available from historic records.

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 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). In one of the prime habitat areas in the Lower Cispus Watershed, after the bigleaf maple logs were removed from along the road, *C. devia* became very difficult to find in the area where it was previously most abundant.

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. 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 this 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.

Cryptomastix devia occupies scattered localities within parts of the western Washington Cascades, Olympic Peninsula, southwestern Washington, eastern Washington Cascades, Willamette, and Deschutes Province Planning Analysis Areas. *C. devia* has been found in localized but fairly common populations in one area of its range, the Cowlitz Valley Ranger District, primarily in the Lower Cispus Watershed. From this population, we have added significantly to our understanding of its habitat requirements and relationships within the biotic community that it occupies.

There is adequate information about the habitat associations used by *Cryptomastix devia* to conclude that management measures can be prescribed to maintain, conserve or improve its habitat. Although there are geographic differences in habitat that are not well understood, there are sufficient observations to define habitat associations, and there are situations that evidence how this species should respond to management measures.

Since the 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 otherwise 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. For purposes of managing locally common known sites, the Habitat Area is the site.

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

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.

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 this species is 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 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 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 *Cryptomastix devia* and other survey and manage species will occur within the same area, an ecosystem management approach in which a mix of all habitat elements are maintained would be the most reasonable. In Habitat Areas co-inhabited by *Cryptomastix devia* and possibly other species of concern (e.g., *Prophysaon coeruleum, Prophysaon dubium, 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 this 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 this species spends 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 *Cryptomastix devia*.

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 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 this 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 this snail occurs. 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 report a need for management or research if exotic species are discovered.
- 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, 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 this 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. Most natural stands in which *C. devia* has been found have had canopy cover greater than 70%. The few exceptions have been area with high water tables. Therefore, minimum canopy cover in Habitat Areas should generally be maintained at an average of 70%. This level of canopy closure recognizes and allows a +/- 10% fluctuation 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 this species and its habitats are minimized.

Prescribed burning within Habitat Areas is strongly discouraged due to the limited area where the species is locally common. 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 and piling should be done outside of the Habitat Area as much as feasible. 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 outside of the Habitat Area and leaving scattered logs is suggested whenever possible to provide additional habitat.

Strategy 3 is suggested where this species is 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 through the Habitat Area to maintain occupation by this 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 this 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 is 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 known sites. 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 project area (Habitat Area) should retain suitable habitat components and diversity required. 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. 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 the year. 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 50 to 60% canopy closure should be sufficient to maintain favorable habitat for *C. devia* in the Habitat Areas outside of the hot spots it other habitat components are maintained (i.e., logs, litter and duff, sword ferns and other ground vegetation). This level of average shading may be attained by averaging small openings with more dense canopy, as long as the distribution maintains the desired level of connectivity across the Habitat Area. This canopy closure level recognizes and allows +/- 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 this species and the entire stand should partially meet habitat requirements. The habitat elements in the entire 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 use the means which has the least impact on mollusk populations and habitat while meeting the objectives of the burn (e.g., hand piling and burning for slash disposal). 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 this 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

At the time that the Northwest Forest Plan was developed, this species was 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 range and habitat of this 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 this 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.

Exotic species are entering habitats occupied by this 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 *Cryotomastix* 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 this snail prior to the Northwest Forest Plan (NFP) was from few, generally poorly documented observations. Literature sources (Pilsbry 1940; Branson 1977, 1980; Branson and Branson 1984) give general site information at best, but detailed records of specific plants or other microhabitat elements are primarily from personal knowledge from surveys done mostly since the NFP (Frest, Applegarth, Weasma and Duncan, personal communications; Burke, personal observations).

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 this species?
-What is the range of habitat conditions tolerated the 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

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 this species are found to better understand its habitats and management needs.

Monitor natural sites for conditions and trends of populations.

Monitor managed sites for implementation and effectiveness of prescriptions.

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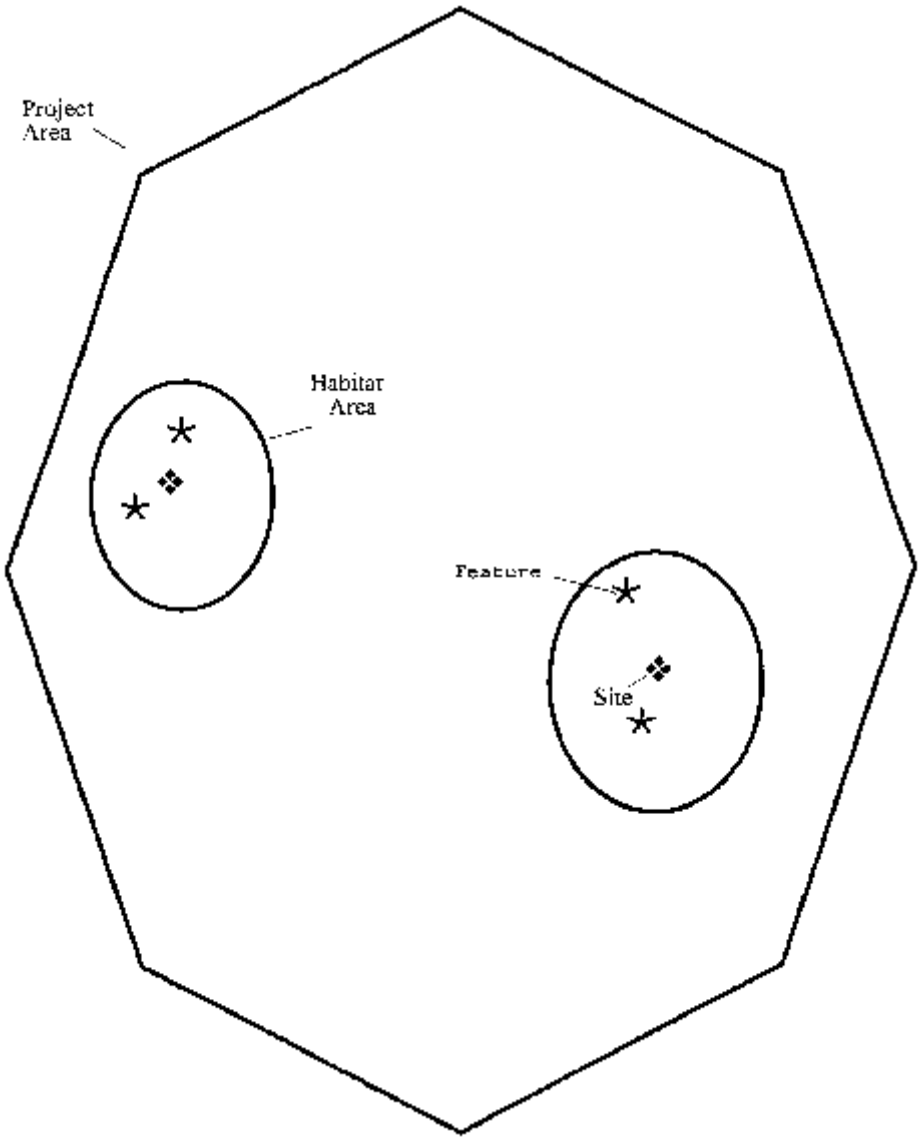
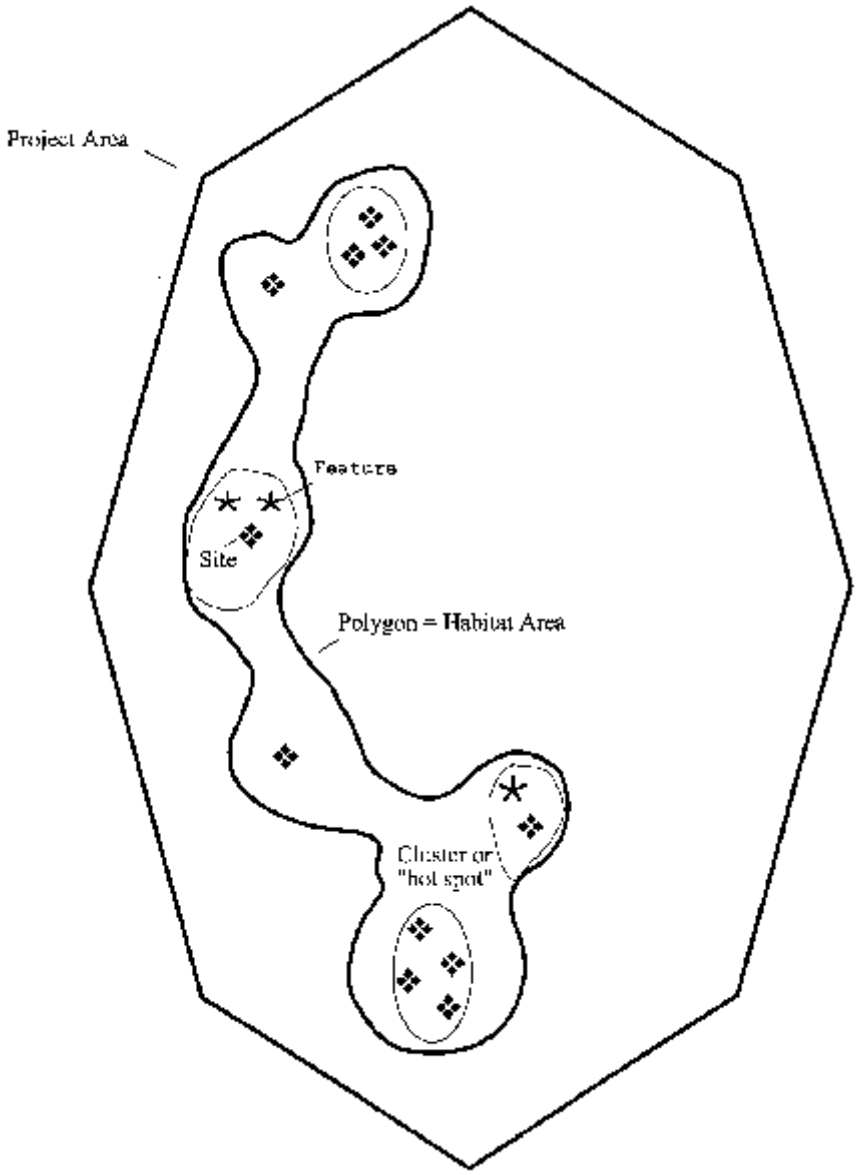
APPENDIX - FIGURES

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.



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.



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.