

**CONSERVATION ASSESSMENT for**  
*Corydalis aquae-gelidae* Peck & Wilson

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Management Recommendations  
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USDI Bureau of Land Management, Oregon and Washington**

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## **Preface**

### *Management Recommendations*

Much of the content in this document was included in a previously transmitted Management Recommendation (MR) developed for management of the species under the previous Survey and Manage Standards and Guidelines (USDA and USDI 1994a,b). With the removal of those Standards and Guidelines, the previously transmitted MR has been reconfigured into a Conservation Assessment (CA) to fit the BLM Oregon/Washington and Region 6 Forest Service Special Status/Sensitive Species Programs (SSSSP) objectives and language.

Since the transmittal of the MR in January 1998, new information has been gathered regarding habitat, number of sites, and distribution relative to land allocation. New information added into this CA reflects the finding of new populations on the Willamette National Forest (NF) extending the southern portion of the range of the species, some related information on pollinators, and Kaye's (2001) morphometric analysis of the species. However most of the information still reflects information up to and including the year 1998.

### *Assumptions on site management*

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

### *Management Considerations*

Under the "Managing in Species Habitat Areas" section in this Conservation Assessment, there is a discussion on "Management Considerations". "Management Considerations" are actions or mitigations that the deciding official can utilize as a means of providing for the continued persistence of the species' site. These considerations are not required and are intended as general information that field level personnel could utilize and apply to site-specific situations.

Management of this species follows Forest Service 2670 Manual policy and BLM 6840 Manual direction. (Additional information, including species-specific maps, is available on the Interagency Special Status Species website.)

## SUMMARY

**Species** *Corydalis aquae-gelidae* Peck & Wilson (Cold Water Corydalis)

**Taxonomic Group** Vascular Plants

**Other Management Status** NatureServe ranks *Corydalis aquae-gelidae* with a Global Heritage Rank of G3, representing a global condition of vulnerable and at moderate risk of extinction due to very restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors (Oregon Natural Heritage Information Center 2004). The Oregon Natural Heritage Information Center also ranks the species S3 and Heritage List 1, which they consider critically imperiled, and the Washington Natural Heritage Program (WNHP) ranks the species S2S3. *C. aquae-gelidae* is Bureau of Land Management (BLM) Bureau Sensitive in Oregon, and BLM Bureau Assessment in Washington. The species is Forest Service (FS) Region 6 Sensitive in Oregon and Washington.

**Range and Habitat** The entire global range of *Corydalis aquae-gelidae*, a regional endemic, is known from ninety-three sites within Clackamas, Multnomah, Linn, and Marion, Counties in Oregon and Skamania and Clark Counties in Washington. All sites, except four, are on federal lands managed by the Gifford Pinchot and Mt. Hood National Forests (NFs) and the BLM Salem District. The species is found primarily along the crest of the Cascade Range (Washington Natural Heritage Program 1994, Oregon Natural Heritage Program 1995). The range has been extended with the identification of a population at Traverse Creek on the Willamette NF (Kaye 2001).

Habitat requirements include a close proximity to seeps, springs or streams with relatively cold water, a substrate of gravely sand, upper level canopy closure of 70 to 90 percent, and little herbaceous competition. Sites are between 370 m (1200 ft) and 1310 m (4260 ft) in elevation.

**Threats** Activities that change hydrologic function, reduce inputs of gravel substrate, increase stream temperature, change canopy structure, result in soil disturbance or mechanical damage may impact *C. aquae-gelidae* populations or individual plants.

### Management Considerations

- Maintain species habitat areas that currently meet parameters for hydrologic function, canopy closure, stream temperature and substrate.
- Cultural activities, such as thinning of trees and shrubs, may be useful in cases where excessive shading is resulting in reduced population vigor. Planting of fast-growing conifer or deciduous species appropriate to the site may be used to provide shade where deficient.
- Where stream temperatures are greater than acceptable levels, maintain existing cover and augment shading by planting trees and shrubs appropriate to the site.
- Sites that appear to be outside of prescribed hydrologic parameters need further investigation to determine the exact cause. Changes in hydrology are most often the result of culvert placement and can be remedied by either removing or replacing the culvert. Changes may also occur as the result of road placement or water diversion.
- Projects designed to trap gravels and sand to enhance fish spawning habitat may also serve to provide required substrates for *Corydalis* establishment. Efforts should be made to incorporate the needs of *C. aquae-gelidae* into project design.
- Avoid trampling, digging or any other activity that will result in mechanical damage to plants, including habitat restoration projects.

### **Data and Information Gaps**

- Most known *Corydalis aquae-gelidae* sites have been located through project-level surveys. For watersheds which have had a relatively low level of management activity, and few surveys for *Corydalis*, an inventory of potential habitat in determining the full extent of the species' range and numbers.
- Determine the effectiveness of *C. aquae-gelidae* habitat restoration or manipulation.
- Understand the genetics of *C. aquae-gelidae*. Knowing the genetic variability of the species within and between populations will help managers determine population boundaries and assess the contribution of individual populations toward viability of the species range-wide.

## I. NATURAL HISTORY

### A. Taxonomy and Nomenclature

Warren C. Wilson first noted *Corydalis aquae-gelidae* in 1942 along the Tanner Creek Trail in Multnomah County, Oregon. Morton Peck and Wilson described the species in 1956, based on collections made from a population at the confluence of the Clackamas and Collawash Rivers in Clackamas County, Oregon (Hitchcock et al, 1964). Lidén recognizes the species as a subspecies of *C. caseana* (1996) and the plant profile of National Plants Database lists *C. caseana* Gray ssp. *aquae-gelidae* (M.E. Peck & Wilson) Zetterlund & Lidén. Kaye (2001) noted that his morphometric analysis of the *C. aquae-gelidae* and *C. caseana* species including the Traverse Creek population tends to support Lidén's interpretation of *C. aquae-gelidae* as a subspecies of *C. caseana*. The species is called coldwater fumewort or Clackamas corydalis.

### B. Species Description

#### 1. Morphology and Chemistry

*Corydalis aquae-gelidae* is an herbaceous perennial with hollow stems arising from deep-seated, fleshy, tuberous roots. Plants are typically from 0.3 to 1.1 m (1.0 to 3.5 ft) tall. The leaves are 4 to 6 times divided with numerous elliptic terminal leaflets 5 to 12 mm (0.2 to 0.5 in) long and 2 to 5 mm (0.1 to 0.2 in) broad. The showy rose-lavender flowers are 12 to 20 mm (0.5 to 0.8 in) long, bilabiate, with a prominent spur. Arrangement is in a 30 to 60 flowered, simple to compound raceme (Figure 1). Flowering occurs from May through August. The fruit is an elliptic capsule 10 to 15 mm (0.4 to 0.6 in) long with 2 mm (0.1 in) long seeds (Hitchcock et al. 1964).

*Corydalis aquae-gelidae* is most similar in morphology to *Corydalis caseana* (Case's corydalis), which ranges from northeast Oregon and Idaho to California. Within the range of *C. aquae-gelidae*, *Corydalis scouleri* (Scouler's corydalis) is relatively common but differs by having less dissected leaves with larger leaflets and flowers.



**Figure 1.** *Corydalis aquae-gelidae* line drawing (Hitchcock et al. 1964).

## 2. Reproductive Biology

A number of the tuberous rooted species of the genus *Corydalis* are known to reproduce vegetatively from offsets, although it appears that *Corydalis aquae-gelidae* reproduces by seed only (Goldenberg 1990). No information could be found on pollinators, although bumblebees have been observed on *Corydalis aquae-gelidae* flowers. It is not documented what pollinators visit the flowers of this species or whether it is self-fertile. However a closely related species (*Corydalis caseana* ssp. *brandegei*) in the genus has been found to receive visits from long-tongued bumblebees (*Bombus appositus*) and from short-tongued nectar-robbing bumblebees (*Bombus occidentalis*). Hummingbirds were also seen visiting the flowers but they did not pollinate them. The species produces nectar found in the spur and has a mixed-mating system (Maloof 2000).

*Corydalis aquae-gelidae* typically produces 100 to 1500 seeds per plant with occasional plants producing up to an estimated 3000 seeds per plant (Goldenberg 1992). When the seed capsules are mature they dehisce explosively, dispersing the seed up to several meters. Dispersion may also be facilitated by a fleshy food body (elaiosome) attached to the seed, which may be attractive to ants

(Goldenberg 1992). Goldenberg (1992) determined that germination occurs when seed is stratified at 3° C. (37° F.) for a six to seven month period. Germination also occurred at temperatures of 17° C. to 27° C. (63° F to 81° F.), much greater than those expected under natural conditions, if substrates are kept saturated. Conversely, poor germination results when seed is allowed to dry (Goldenberg 1992, Guerrant 1995 personal communication). Seedlings appear to establish readily if a moist substrate of gravely sand is available but establishment and recruitment is poor in organic substrates or substrates that are not well watered.

Demographic studies in Oregon (Goldenberg 1990) found *C. aquae-gelidae* populations to be comprised of 38 percent seedlings, 48 percent juveniles, three percent non-reproductive adults and 11 percent reproductive adults. From this data and observation on seedling growth rates, it appears that juveniles are two to five years old, adult plants remain in a non-reproductive stage for a relatively short period, reaching reproductive maturity in six to nine years, and adult plants are long-lived, perhaps 25 years or more (Goldenberg and Zobel 1997).

### **3. Ecological Roles**

*Corydalis aquae-gelidae* has a relatively high percentage of its biomass stored in the below ground portion of the plant as starch in the tuberous root (root/shoot ration of 2.4 to 3.8) and a low percentage (eight percent) allocated to reproductive structures. In addition, the species is long-lived (Goldenberg and Zobel 1997). These qualities are characteristic of “stress tolerators”, slow-growing plants of relatively unproductive environments which allocate a large proportion of their resources to storage and long-term survival.

### **C. Range and Sites**

*Corydalis aquae-gelidae* is a regional endemic known from 93 sites in Clackamas, Multnomah, Linn, and Marion Counties in Oregon and Skamania and Clark Counties in Washington (Figure 2), a range of approximately 90 air miles north-south and 35 miles east-west (USDA and USDI Appendix J2 1994b, Washington Natural Heritage 1994, Oregon Natural Heritage 1995). Oregon sites are concentrated along the Upper Clackamas River, Oak Grove Fork Clackamas River, and South Fork Eagle Creek. The distribution in Washington is more sporadic with most sites occurring in the headwaters and tributaries (stream order 0 to 2) of Canyon Creek, Wind River and East Fork Lewis River). The range has been extended with the identification of a population at Traverse Creek on the Willamette NF (Kaye 2001). All sites, with the exception of four, are located on federal lands. This may be due, in part, to a lack of survey work on non-federal lands, but it is also a likely reflective of the distribution of suitable habitat.



Figure 2. Distribution of *Corydalis aquae-gelidae*

#### D. Habitat Characteristics and Species Abundance

All sites of *Corydalis aquae-gelidae* are located within the Western Hemlock Zone (Halverson et al. 1986, Topik et al. 1986) and Pacific Silver Fir Zone (Hemstrom et al. 1982, Brockway et al. 1983).

*Corydalis aquae-gelidae* is associated with perennial streams, seeps and springs with relatively cold water and a substrate of gravely sand. Goldenberg (1990), found the horizontal distance of individual plants to water ranged from -20 to 290 cm (-0.7 to 9.6 ft), with a mean of 37 cm (1.2ft) for Oregon populations. Vertical distance to water ranged from -12 cm to 95 cm (-0.3 ft to 3.1 ft) with a mean of 7 cm (0.2 ft), where negative values are below the waterline. The mean water temperature at these sites was 9.6° C (49° F) during the growing season with a range from 5.9° C to 14° C (43° F to 57° F). Plants are absent from organic substrates such as marshes and bogs.

Light levels appear to be an important determinant of suitable habitat. Gamon (1983) reports that where canopy level approaches 100 percent closure, the number of individual plants decrease as does the incidence of flowering. Goldenberg (1992) observed plants growing within clear cuts to have yellowed foliage, poor growth and no seedling recruitment. This may not only be a factor of intense solarization but also an inability to compete with aggressive pioneer species. Densimeter readings within Oregon populations found the percent canopy closure to range from 0 to 100 percent with a median of 84 percent (Goldenberg 1992). Both Goldenberg and Gamon came to a similar conclusion, that the species seems best suited to habitats in which a high, partial canopy allows sufficient light for growth and reproduction, but hinders the establishment of competing vegetation. A general distinction can be made between Oregon and Washington populations in terms of the stream order they are associated with. Oregon populations are most numerous in headwater areas (stream order 0) and 3rd, 4th, and 5th order streams, but largely absent from 1st and 2nd order streams. In Washington, most populations are associated with headwaters and 1st and 2nd order streams. This difference may simply be due to the greater number of 3rd, 4th and 5th order streams that occur within the range of *C. aquae-gelidae* in Oregon.

Sites vary in slope from 90 percent to flat and most often have an aspect of northwest to northeast, although all aspects have been recorded. Precipitation within the species' range varies from 1500 mm to 2500 mm (60 to 100 in) annually.

Diaz and Mellen (1996) have described the *Corydalis aquae-gelidae* Plant Community from three plots located on the Mt. Hood NF. The Community represents sites with gravel and sand deposition, very close to the high water line, where *Corydalis* is dominant. Associates included *Senecio triangularis* (arrow-leaved groundsel), *Senecio pseud aureus* (beach groundsel), *Delphinium trollifolium* (trollius-leaved larkspur), *Aconitum columbianum* (Columbian monkshood), *Aster modestus* (great northern aster), *Alnus incana* (gray alder), *Physocarpus capitatus* (Pacific ninebark) and a well-developed moss layer. The Community had an average 10.7 vascular plant species per plot, the lowest value among riparian plant communities recorded for the Mt. Hood and Gifford Pinchot NFs. This reflects the strong dominance of *C. aquae-gelidae* at these sites. It should be noted that *C. aquae-gelidae* is likely to occur as a less dominant associate of other plant communities and is not restricted to one described community. Sensitive plant site information from the Salem District BLM, Gifford Pinchot and Mt Hood NFs list associated species as *Saxifraga arguta* (stream saxifrage), *Mimulus guttatus* (yellow monkey flower), *Tolmiea menziesii* (piggy-back plant), *Tiarella unifoliata* (foamflower), *Oxalis oregana* (Redwood sorrel), *Isopyron hallii* (Hall's isopyrum), *Polysticum munitum* (sword fern), *Veronica Americana* (American brooklime), *Montia siberica* (miner's lettuce), *Alnus rubra* (red alder), *Oplopanax horridum* (devil's club), *Acer circinatum* (vine maple), *Ribes lacustre* (black gooseberry), *Thuja plicata* (Western redcedar), *Taxus brevifolia* (Western yew), *Tsuga heterophylla* (Western hemlock), *Abies procera* (Noble fir), *Abies amabilis* (Pacific silver fir) and *Pseudotsuga menziesii* (Douglas fir).

The *Corydalis aquae-gelidae* Plant Community is found within Rosgen B and C channel types in Oregon (Diaz, et al. 1996). C channel types are described as having a low gradient, meandering, with a broad, well defined floodplain (Rosgen 1994). B channel types have a higher gradient, more defined channel and are less meandering (Rosgen 1994).

## II. CURRENT SPECIES SITUATION

### A. Status History

NatureServe ranks *Corydalis aquae-gelidae* with a Global Heritage Rank of G3, representing a global condition of vulnerable and at moderate risk of extinction due to very restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors (Oregon Natural Heritage Information Center 2004). The Oregon Natural Heritage Information Center also ranks the species S3 and Heritage List 1, which they consider critically imperiled, and the Washington Natural Heritage Program ranks the species S2S3. In Oregon, *C. aquae-gelidae* is BLM Bureau Sensitive and in Washington, is BLM Bureau Assessment. The species is FS Region 6 Sensitive in Oregon and Washington.

### B. Major Habitat and Viability Considerations

*Corydalis aquae-gelidae* was rated 10-48-40-2 for Outcomes A, B, C and D respectively under Option 9 (USDA and USDI 1994a). Outcome B (48 percent), where the species would be expected to stabilize with significant gaps in the historic distribution on federal lands was given the greatest probability, followed by Outcome C (40 percent), where the species is restricted to refugia with strong limitations on interactions among local populations. Other factors contributing to the species' designation include; approximately 67 percent of known populations occur within the Matrix, and individuals and habitat have been lost as the result of past actions including hydroelectric projects, timber harvest, road construction, and fish habitat improvement projects (USDA and USDI 1994b). The species has limited potential to establish outside of known population areas due to its specific habitat requirements.

Major considerations for *Corydalis aquae-gelidae* habitat and viability in Oregon and Washington include light levels, hydrologic function, water temperature, substrate, and vegetative competition. Hydrologic function and water temperature should be considered at the watershed level since activities upstream or downstream could affect hydrologic function and water temperature.

Based on a median value of 84 percent canopy closure for populations in Oregon (Goldenberg 1992), canopy closures of 70 to 90 percent should provide an optimal range for shade. At this level, vegetative competition will also be held to acceptable levels.

Hydrologic function is best described as the maintenance of perennial water within acceptable vertical and horizontal distances from plants. Goldenberg (1990) found the horizontal distance of individual plants to water was -20 to 290 cm (-0.7 to 9.6 ft), with a vertical distance ranging from -12 to 95 cm (-0.3 ft to 3.1 ft). The extreme values within these ranges may represent outliers or relict plants and not necessarily optimal habitat. To determine the optimal range, one standard deviation of the mean is used. This equates to a horizontal distance of -18 to 86 cm (-0.6 to 2.8 ft) and a vertical distance of -7 to 21 cm (-0.2 to 0.7 ft) to water. Water temperature is also an important habitat consideration. Stream temperature ranged from 5.9° C to 14° C (43° F to 57° F) for Oregon populations (Goldenberg 1990). The upper temperature limit of 14° C is viewed as the critical threshold.

Substrates vary from cobble to sand. Plants occurring on silt-textured substrates or soils high in organic matter occur only rarely and are totally absent from bogs and marshes. A typical substrate in Oregon is greater than 50 percent gravel with coarse sand filling the interstices (Goldenberg 1990). This substrate suggests that this species requires a substrate that is moist but also well drained in which water is cool and well oxygenated.

### **C. Threats to the Species**

Threats to populations in Oregon and Washington can occur at different scales. Regional climatic fluctuations such as drought could affect local watersheds by altering hydrologic function. Forest management activities upstream could cause an increase in stream temperatures beyond the identified upper threshold during the growing season, decreases in shade below lower threshold levels, increases in vegetative competition and mechanical damage to plants.

Changes in hydrology, which result in dewatering or inundation of *Corydalis aquae-gelidae* sites, can adversely affect populations by reducing seed germination and recruitment and plant growth. Distances to water outside of the horizontal and vertical ranges of -18 to 86 cm (-0.6 to 2.8 ft) and -7 to 21 cm (-0.2 to 0.7 ft) respectively are assessed to be adverse to habitat. A stream temperature of 14° C (57° F) during the growing season is the upper threshold for those *C. aquae-gelidae* habitats measured in Oregon; temperatures greater than this will result in unsuitable habitat. Increases in stream temperature are most often caused by a decrease in shade or stream flow. The resulting higher temperatures will affect areas downstream; therefore, *Corydalis* may be threatened by actions that occur some distance upstream of the actual habitat.

Canopy cover, which falls outside of the 70 to 90 percent range, can affect site viability. Plants under canopy closure less than 25 percent were found to be chlorotic and stunted (Goldenberg 1990) while plants with 100 percent canopy closure had a lower incidence of flowering (Gamon 1983). An increase in the availability of light will result in increased vegetative competition from early seral species. Maintaining a high partial canopy of 70 to 90 percent closure will maintain unsuitable habitat for these

competitive species.

The stems of *C. aquae-gelidae* are hollow, fragile and are easily damaged. Mechanical damage could result from equipment or trampling. The resulting loss of leaves, flowers or fruit can affect long-term site viability.

Trampling from recreational activity is a concern but is judged to be minor at this time.

#### **D. Distribution Relative to Land Allocations**

All sites are within the Northwest Forest Plan (NWFP) area and, with the exception of four, are located on federal lands. In Washington there are populations on the Gifford Pinchot NF, and in Oregon on the Mt. Hood NF, Willamette NF, and Salem BLM.

Approximately 67 percent of known *Corydalis aquae-gelidae* sites occur within the Matrix land allocation (USDA and USDI 1994b). Because of the close proximity of sites to perennial water, it is most likely all are located within Riparian Reserve land allocations. The width of interim Reserves have been established for different water bodies based on ecologic and geomorphic factors. Since *C. aquae-gelidae* is associated with seeps, springs, non fish-bearing streams and fish-bearing streams, the width of the interim Reserve at each site will vary. Sites located on or near the Clackamas River in the Wild and Scenic River corridor are also within a Congressionally withdrawn land allocation. The majority of the remaining sites occur within Late Successional Reserves.

### **III. MANAGEMENT GOALS AND OBJECTIVES**

Management for this species follows FS Region 6 Sensitive Species (SS) policy (FS Manual 2670), and/or BLM Oregon and Washington Special Status Species (SSS) policy (6840).

For Oregon and Washington BLM administered lands, SSS policy details the need to manage for species conservation. Conservation is defined as the use of all methods and procedures that are necessary to improve the condition of SSS and their habitats to a point where their Special Status recognitions no longer warranted. Policy objectives also state that actions authorized or approved by the BLM do not contribute to the need to list species under the Endangered Species Act.

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

### **IV. HABITAT MANAGEMENT**

#### **A. Lessons from History**

Management activities that have affected *Corydalis aquae-gelidae* sites include timber harvest, road construction, hydroelectric development and fish habitat improvement projects (USDA and USDI 1994b).

Conclusions can be made as to the response of *Corydalis aquae-gelidae* to timber harvest activities

based on formal data collection and casual observation. Gamon (1991) revisited twenty-six of thirty-nine sites on the Gifford Pinchot NF in 1990. Sites that occur in relatively undisturbed habitat were found to be doing well. Sites located within or adjacent to timber harvest areas were found to be in decline as demonstrated by a decrease in the number of plants at these sites. This decline was attributed to increased vegetative competition on the ground, a decrease in light penetration resulting from an increase in dense deciduous tree and shrub cover following timber harvest, and altered hydrology. Plants growing in clear-cut units with little or no over story canopy on the Mt Hood NF exhibited small, curled, and discolored leaves as well as reduced seed production and a higher incidence of downy mildew damage (Goldenberg 1990). The Stone Creek Hydroelectric Project, implemented in 1992, resulted in the loss of some plants during the construction phase. To determine how *C. aquae-gelidae* will be affected by lower water levels within the diversion reach, monitoring plots were established at the site. Data were scheduled to be collected annually from 1994 through 1998 and every five years thereafter. Three years of collected data have not yet been analyzed.

### **B. Identifying Species Habitat Areas**

All known sites of *Corydalis aquae-gelidae* on federal lands administered by the FS and/or BLM in Washington and Oregon, (specifically, the Gifford Pinchot, Mt. Hood, and Willamette NFs, and the BLM Salem District) are identified as areas where the information presented in this Conservation Assessment could be applied. A species habitat area is defined as the suitable habitat occupied by a known population, plus the surrounding habitat needed to support the site.

### **C. Managing in Species Habitat Areas**

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

Specific management considerations include the maintenance or restoration of hydrologic function, cold-water temperatures, and gravelly-sand substrate, the maintenance of a high, partial over story and the avoidance of ground disturbance. The following identifies in further detail the management considerations for this species:

- Maintain conditions that meet habitat parameters for hydrologic function, canopy closure, stream temperature and substrate over time.
- Cultural activities, such as thinning of the tree and shrub component, may be useful in cases where excessive shading is resulting in reduced population vigor. The threshold for excessive shading is considered to be 90 percent and above. Planting of fast-growing conifer or deciduous species appropriate to the site may be used to provide shade on sites that have less than 70 percent canopy closure.
- Stream temperatures greater than acceptable levels will most likely be the result of a deficiency in streamside vegetative cover. The source of the high temperatures may not be at the *Corydalis* site itself, but upstream some distance. The remedy can be to maintain existing cover and augment shading by planting trees and shrubs appropriate to the site.
- Proper hydrologic function can be determined by measuring the horizontal and vertical distance of *Corydalis* populations to perennial water during the growing season. Sites that appear to be outside the prescribed parameters need further investigation to determine the exact cause (refer to specific distances cited under “**C. Threats to Species**”). Changes in hydrology are most often the result of culvert placement and can be remedied by either removing or replacing the culvert. Changes may also occur as the result of road placement or water diversion.

- Deposition of fine textured sediment at a *Corydalis* site is not conducive to maintenance of the population. The cause has its origin in the hydrology of the site and can be addressed as above. Projects designed to trap gravels and sand to enhance fish spawning habitat may also serve to provide required substrates for *Corydalis* establishment. Try to incorporate the needs of *C. aquae-gelidae* into project design.
- Avoid trampling, digging or any other activity that will result in mechanical damage to plants, including habitat restoration projects.

## V. RESEARCH, INVENTORY, AND MONITORING OPPORTUNITIES

The objective of this section is to identify opportunities to acquire additional information which 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. The inventory, research, and monitoring identified below are not required. These recommendations should be addressed by a regional coordinating body.

### A. Data and Information Gaps

- Most known *Corydalis aquae-gelidae* sites have been located through project-level surveys. For watersheds which have had a relatively low level of management activity, and few surveys for *Corydalis*, an inventory of potential habitat in determining the full extent of the species' range and numbers.
- Determine the effectiveness of *C. aquae-gelidae* habitat restoration or manipulation.
- Understand the genetics of *C. aquae-gelidae*. Knowing the genetic variability of the species within and between populations will help managers determine population boundaries and assess the contribution of individual populations toward viability of the species range-wide.

### B. Research Questions

- What is the genetic variability of *Corydalis aquae-gelidae* within and between populations?
- What are the dispersal mechanisms for *C. aquae-gelidae*?
- How does *C. aquae-gelidae* respond to habitat enhancement?
- Will *C. aquae-gelidae* colonize newly created habitat and at what rate?

### C. Monitoring Opportunities and Recommendations

- Continue to support monitoring of the *Corydalis aquae-gelidae* population at the Stone Creek Hydroelectric Project to determine the effects of water diversion.
- Where management actions are done within *C. aquae-gelidae* populations, including habitat enhancement, monitor for abundance and reproduction of plants as well as habitat parameters (hydrology, shade, stream temperature, substrate).
- Report documented sites of species through Natural Heritage Program contracts, and enter data into agency regional databases.
- Report sitings and survey work in the appropriate agency database: Geo-spatial Biological observation (GeoBOB) database or Natural Resource Information System (NRIS).
- Changes to field units' determination of documented or suspected status need to be reported quickly to the Special Status/Sensitive Species Specialist in the Regional Office/State Office.

## **GLOSSARY**

### **Buffer**

An area which is managed to protect a site that can be undisturbed or managed. The buffer is meant to maintain and/or improve the habitat conditions of the site and provide life requisites for the species.

### **Connectivity**

The linkage of similar but separated suitable habitat patches, by corridors or “stepping stones” of like habitat that permits interaction between individuals or populations over time. Connectivity must consider time in the context of its potential effects to genetic drift or isolation.

### **Fragmentation**

The loss, division or isolation of patches of similar habitat at a scale relevant for the species being addressed.

### **Monitoring**

The collection of information used to determine if management actions are meeting objectives of standards and guidelines and if they comply with laws and management policy. Monitoring is used to determine if standards and guidelines are being followed (implementation monitoring), if they are achieving the desired results (effectiveness monitoring), and if underlying assumptions are sound (validation monitoring). Monitoring usually collects information on a sampling basis, provides standardized data, and occurs at multiple levels and scales.

### **Site (Occupied)**

The location where an individual or population of the target species (taxonomic entity) was located, observed, or presumed to exist and represents individual detections, reproductive sites or local populations. Specific definitions and dimensions may differ depending on the species in question and may be the area (polygon) described by connecting nearby or functionally contiguous detections in the same geographic location. This term also refers to those located in the future. (USDA, USDI 1994a)

### **Persistence**

The likelihood that a species will continue to exist, or occur, within a geographic area of interest over a defined period of time. Includes the concept that the species is a functioning member of the ecological community of the area.

### **Range**

The limits of the geographic distribution of a species.

### **Species Habitat Area**

The geographic area managed to provide for the continued persistence of the species at the site; may include occupied and unoccupied habitats.

### **Suitable Habitat**

Abiotic and biotic environmental conditions within which an organism is known to carry out all

aspects of its' life history.

**Viability**

Ability of a wildlife or plant population to maintain sufficient size to persist over time in spite of normal fluctuation in numbers, usually expressed as a probability of maintaining a specified population for a specified period (USDA and USDI 1994a).

**Viable populations**

A wildlife or plant population that contains an adequate number of reproductive individuals appropriately distributed on the planning area to ensure the long-term existence of the species (USDA, USDI 1994a). For invertebrate, non-vascular plant and fungi species “appropriately distributed” may include; the species is well-distributed, the species is distributed with gaps or the species is restricted to refugia. Refer to page 123 in Chapter 3 and 4 of the FSEIS for the Northwest Forest Plan for further clarification.

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