Amerorchis rotundifolia (Banks ex Pursh) Hultén (roundleaf orchid): A Technical Conservation Assessment

Prepared for the USDA Forest Service,
Rocky Mountain Region,
Species Conservation Project

February 25, 2005

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Peer Review Administered by
Center for Plant Conservation

Handley, J. and B. Heidel. (2005, February 25). *Amerorchis rotundifolia* (Banks ex Pursh) Hultén (roundleaf orchid): a technical conservation assessment. [Online]. USDA Forest Service, Rocky Mountain Region. Available: http://www.fs.fed.us/r2/projects/scp/assessments/amerorchisrotundifolia.pdf [date of access].

ACKNOWLEDGMENTS

Kent Houston (Shoshone National Forest) and Erwin Evert (Research Associate Morton Arboretum) provided survey and management information. Evert also provided field data from 2004. Maria Mantas (former botanist of Flathead National Forest) granted her permission to use the photograph on the cover of this assessment. Beth Burkhart (USDA Forest Service), Kathy Roche (USDA Forest Service), Erwin Evert, and two anonymous readers provided helpful reviews. The information in this report was obtained from the specimens and collection label information resources of the Rocky Mountain Herbarium as well as survey data and reports compiled and prepared by the Wyoming Natural Diversity Database (WYNDD) and the Montana Natural Heritage Program. This report was prepared under contract between the USDA Forest Service Rocky Mountain Region and WYNDD/University of Wyoming.

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COVER PHOTO CREDIT

Amerorchis rotundifolia (roundleaf orchid). Photograph by Maria Mantas. Used with permission.

SUMMARY OF KEY COMPONENTS FOR CONSERVATION OF *AMERORCHIS ROTUNDIFOLIA*

Status

In the Rocky Mountain Region (Region 2) of the USDA Forest Service (USFS), *Amerorchis rotundifolia* (roundleaf orchid) is a disjunct boreal species at the southern limits of its rangewide distribution. There are only two occurrences of this species within Region 2, which designates it as a sensitive species. Both occurrences are on the Shoshone National Forest in Wyoming. The NatureServe global rank for this species is demonstrably secure (G5), and the Wyoming Natural Diversity Database state rank for this species is critically imperiled (S1).

Primary Threats

Amerorchis rotundifolia is a wetland obligate in the Rocky Mountains, and hydrological alteration is a direct threat to its habitat. Hydrological conditions at the Swamp Lake occurrence may have been changed by: past highway reconstruction that impeded outflow of water, wildfires that removed tree cover and accelerated water run-off, salvage logging of standing dead timber that may have increased run-off, and ditching and draining of wetlands higher in the watershed. Most of the past and present threats in Wyoming are exerted from uses in adjoining lands, as in the case of wetland ditching and draining that is occurring on private lands upstream from Swamp Lake. Such disturbances also promote the invasion and spread of noxious weeds.

Primary Conservation Elements, Management Implications and Considerations

Within the Rocky Mountain Region, *Amerorchis rotundifolia* is restricted to wet spruce forests associated with peatlands, a cool, moist setting that is very stable and sheltered. It grows in the shade at the base of *Picea glauca* (white spruce) on mosses that blanket the lateral tree roots. It is known from two occurrences in the Shoshone National Forest, both of which are within a short segment of the Clarks Fork River Valley. Most of one occurrence lies within Swamp Lake Special Botanical Area and the Special Botanical Area designation provides a broad protection framework that sets the goal of maintaining water quality and quantity. The designation may require more detailed standards. Information is incomplete on this species' abundance, trends, biology, and potential threats, indicating a need for further inventory and monitoring of known sites.

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INTRODUCTION

This assessment is one of many being produced to support the Species Conservation Project of the USDA Forest Service (USFS) Rocky Mountain Region (Region 2). *Amerorchis rotundifolia* (roundleaf orchid) is the focus of an assessment because it is a sensitive species in Region 2. Within the National Forest System, a sensitive species is a plant or animal whose population viability is identified as a concern by a Regional Forester because of significant current or predicted downward trends in abundance and/or in habitat capability that would reduce its distribution. A sensitive species may require special management, so knowledge of its biology and ecology is critical.

Goal

Species conservation assessments are produced as part of the Species Conservation Project to provide forest managers, research biologists, and the public with a thorough discussion of the biology, ecology, conservation status, and management of the species. The assessment goals limit the scope of the work to critical summaries of scientific knowledge, discussion of broad implications of that knowledge, and outlines of information needs. The assessment does not seek to develop specific management recommendations. Rather, it provides the available ecological background upon which management must be based. It also cites management recommendations proposed elsewhere and presents the available information on the consequences of changes in the environment that result from management (i.e., management implications). This assessment provides a reference to promote species conservation on National Forest System lands (Blankenship et al. 2001).

Scope

This assessment examines the biology, ecology, conservation status, and management of *Amerorchis rotundifolia* throughout its range with specific reference to the geographic and ecological characteristics of Region 2. This assessment is concerned with reproductive behavior, population dynamics, and other characteristics of *A. rotundifolia* under the current set of environmental conditions. Because the species' range lies primarily outside of Region 2, this assessment incorporates information from the rest of its range in Montana, the northern Great Lakes region, the northern New England region, and, to a lesser extent, the more northerly latitudes in Canada and Alaska. This information is placed in the ecological context of the Rocky Mountain Region.

In producing the assessment, refereed literature, unpublished reports, herbarium documentation, and publications on the orchid family were compiled and interpreted. Such data represent the most complete available information for *Amerorchis rotundifolia* in the Rocky Mountain Region.

Treatment of Uncertainty

Science represents a rigorous, systematic approach to obtaining knowledge. Competing ideas regarding how the world works are measured against observations. However, because our descriptions for the world are always incomplete and observations limited, science focuses on approaches for dealing with uncertainty. A commonly accepted approach to science is based on a progression of critical experiments to develop strong inference (Platt 1964). However, strong inference, as described by Platt, suggests that experiments will produce clean results (Hillborn and Mangel 1997), as may be observed in certain physical sciences. The geologist, T.C. Chamberlain (1897) suggested an alternative approach to science where multiple competing hypotheses are confronted with observation and data. Sorting among alternatives may be accomplished using a variety of scientific tools (e.g. experiments, modeling, logical inference). Ecological science is, in some ways, more similar to geology than physics because of the difficulty in conducting critical experiments and the reliance on observation, inference, good thinking, and models to guide understanding of the world (Hillborn and Mangel 1997).

While well-executed experiments represent a sound approach to developing knowledge, alternative approaches such as modeling, critical assessment of observations, and inference are also accepted as sound approaches. These scientific tools are to be used in concert with the most complete species status data to produce a robust analysis. The data and analyses presented in this document on *Amerorchis rotundifolia* in the Rocky Mountain Region are not exhaustive but provide a robust framework for interpreting distribution and biology. The strength of evidence for particular ideas is noted and alternative explanations are described when appropriate.

Publication on the World Wide Web

To facilitate the use of species assessments in the Species Conservation Project, they are being published

on the World Wide Web site of Region 2. Placing the documents on the Web makes them available to agency biologists and the public more rapidly than publishing them as reports. More importantly, it facilitates their revision, which will be accomplished based on guidelines established by the Region.

Peer Review

Assessments developed for the Species Conservation Project have been peer reviewed prior to their release on the Web. This assessment of *Amerorchis rotundifolia* was reviewed through a process administered by the Center for Plant Conservation, employing at least two recognized experts on this or related taxa. Peer review was designed to improve the quality of communication and to increase the rigor of the assessment.

MANAGEMENT STATUS AND NATURAL HISTORY

Management Status

Federal status

Amerorchis rotundifolia is a widespread boreal species found within only one state (Wyoming) of the USFS Rocky Mountain Region, which currently lists it as a sensitive species (**Table 1**; USDA Forest Service 2003). It also occurs in Montana, where the USFS Northern Region (Region 1) lists it as a sensitive species (USDA Forest Service Washington Office 2004). In the Eastern Region (Region 9) of the USFS, this species is designated a sensitive species by the Regional Forester for the Hiawatha National Forest in Michigan and for the Chequamegon-Nicolet National Forest in Wisconsin. It is not designated sensitive for the Superior and Chippewa national forests in Minnesota (USDA Forest Service 2000) because the species is determined not to be at risk there. The U.S. Fish and Wildlife Service does not list *A. rotundifolia* as Threatened or Endangered under the Endangered Species Act.

Heritage program ranks

Amerorchis rotundifolia is ranked as globally secure (G5) by The Nature Conservancy (**Table 1**; NatureServe 2003). It is ranked as critically imperiled (S1) in Wyoming (Keinath et al. 2003), which is the only state in the USFS Rocky Mountain Region with known occurrences It is ranked as rare to imperiled (S2S3) in Montana, the only other state where it is known in the Rocky Mountains. This species is also critically imperiled (S1) in Michigan and Maine, and it is ranked imperiled (S2) in Wisconsin. There are historical records for Vermont and New Hampshire, where it is ranked as known only from historical records in both states (SH). The plant is presumed extirpated (SX) in New York (St. Hilaire 2002). NatureServe (2003) lists Idaho as harboring the species, but it is not accepted in the state's floras, so it is not ranked (SNR). Minnesota and Alaska do not track *A. rotundifolia* and do not rank it (also denoted with an SNR). In Canada it is not ranked in the Yukon Territory, Northwest Territories, Nunavut, or Labrador. Alberta, Saskatchewan, and Manitoba rank it as secure (S5), New Brunswick ranks it as critically imperiled (S1), Quebec ranks it as imperiled (S2), Newfoundland ranks it as imperiled or vulnerable (S2S3), British Columbia ranks it as vulnerable or possibly secure (S3S4), and Ontario ranks it as possibly or demonstrably secure (S4S5). It is not known from Nova Scotia or Prince Edward Island.

State protection

There is no state legislation or policy protecting rare plant species in Wyoming or in Montana. Michigan and Wisconsin list *Amerorchis rotundifolia* as Endangered and Threatened, respectively (Penskar and Higman 1999, Wisconsin Department of Natural Resources 2003).

Existing Regulatory Mechanisms, Management Plans, and Conservation Strategies

Amerorchis rotundifolia is a sensitive species in the USFS Rocky Mountain Region. Sensitive designation in the National Forest System signifies it "is a plant species identified by the Regional Forester for which population viability is a concern as evidenced by a significant current or predicted downward trend in population number or density and/or a significant current or predicted downward trend in habitat capability that would reduce a species' existing distribution" (USDA Forest Service 1995). *Amerorchis rotundifolia* has no status under the Endangered Species Act of 1973 (U.S.C. 1531-1536, 1538-1540). USFS policy requires a biological evaluation to be prepared, as part of the National Environmental Policy Act process, to determine potential effect on sensitive species. By USFS direction, sensitive species must be prevented from becoming designated as threatened or endangered by the U.S. Fish and Wildlife Service.

Within the Rocky Mountain Region, the two known occurrences of *Amerorchis rotundifolia* occur

Table 1. Conservation status and ranks of *Amerorchis rotundifolia*.

Listing	Status/Rank
USDA Forest Service Region 2 Sensitive Species List[1]	Sensitive
USDA Forest Service Region 1 Sensitive Species List	Sensitive
USDA Forest Service Region 9 Sensitive Species List	Sensitive on two forests
U.S. Fish and Wildlife Service Endangered Species Act	Not listed
NatureServe Global Ranking[2]	Secure (G5)
Wyoming Natural Diversity Database[2]	Critically imperiled (S1)
Maine, Michigan, New Brunswick	S1
Wisconsin, Quebec	S2
Montana, Newfoundland Island	S2S3
British Columbia	S3S4
Ontaria	S4S5
Alberta, Manitoba, Saskatchewan	S5
New Hampshire, Vermont	SH
New York	SX
Alaska, Idaho, Minnesota, Labrador, Northwest Territories, Nunavut, Yukon Territory	SNR
Colorado, Kansas, Nebraska, South Dakota, Nova Scotia, Prince Edward Island	Not known in state / province

[1]USDA Forest Service. 2003, Forest Service Manual, Title 2600 - Wildlife, Fish and Sensitive Plant Habitat Management; Region 2 Supplement 2900-2003-1.

[2]**Heritage Ranks:** WYNDD uses a standardized ranking system originally developed by the Nature Conservancy and its network of natural heritage programs (now called NatureServe) to assess the global and statewide abundance and the probability of extinction of each plant and animal species, subspecies, and variety. The global and state-rank codes are as follows:

G Global rank: rank refers to the rangewide status of a species.

T Trinomial rank: rank refers to the rangewide status of a subspecies or variety.

S State rank: rank refers to the status of the taxon in Wyoming. State ranks differ from state to state.

Each taxon is ranked on a scale of 1-5 from most vulnerable to extirpation to least.

1 Critically imperiled because of extreme rarity (often known from 5 or fewer extant occurrences or very few remaining individuals) or because some factor of a species' life history makes it vulnerable to extinction.

2 Imperiled because of rarity (often known from 6-20 occurrences) or because of factors demonstrably making a species ulnerable to extinction.

3 Rare or local throughout its range or found locally in a restricted range (usually known from 21-100 occurrences).

4 Apparently secure, although the species may be quite rare in parts of its range, especially at the periphery.

5 Demonstrably secure, although the species may be rare in parts of its range, especially at the periphery.

on the Clarks Fork Ranger District of the Shoshone National Forest in Wyoming. One occurrence is in the Swamp Lake Special Botanical Area. The management prescription for Special Areas in the Shoshone Management Prescription 10G (Johnston 1987) states such areas are to be "…managed for the goal of protection, and maintenance in good condition, of unique and unusual plant species and plant communities that occur in the wetlands contained within the area. Protection and maintenance of the present quantity and quality of water is necessary to achieve this goal. Public access is restricted to non-destructive, day recreational use. Vegetation manipulation, water modification, and land disturbances are not allowed within the area. Transportation on the roads marking the boundary of the area may be needed for access to areas away from the wetland complex, but the present roads and trails will not be significantly changed. Use will not be permitted that unreasonably impairs or threatens the quality or quantity of the features stated in the goal."

Amerorchis rotundifolia has not been addressed in any management plan or conservation strategy in the Rocky Mountain States, and there have been no biological evaluations conducted for this species in the Rocky Mountain Region (Kent Houston personal

communication 2003). If enforced, existing policy and regulations may be adequate to conserve the species in the Rocky Mountain Region.

Amerorchis rotundifolia occurs in six units of the National Park System, all in Alaska. *Amerorchis rotundifolia* does not occur in any units of the National Park System in the states of Wyoming, Colorado, South Dakota or Nebraska. *Amerorchis rotundifolia* also occurs in some protected areas in Canada although it does not have does not have a conservation status different from any of the rest of the flora at these sites. Occurrences within national parks and other nature reserves are likely to have a reduced level of threats. Falkner and Stohlgren (1997) provide information about the conservation contribution of National Parks even when their primary purpose is not biological conservation.

Biology and Ecology

Classification and description

Systematics and synonymy

Amerorchis is a monotypic genus in the Orchidaceae (orchid family). It is in the subtribe Orchidinae and a member of the clade within this subtribe that has the most complex biogeography (Bateman et al. 2003). *Amerorchis rotundifolia* was first described by Joseph Banks and published by Frederick Pursh (1814) as *Orchis rotundifolia*. The genus *Orchis* was established by Linnaeus (1737). The generic description was quite general, as was the norm of the time. In 1805, Carl Ludwig von Willdenow described the segregate genus *Habenaria*, and in 1823 John Richardson published the name *H. rotundifolia*. Louis Claude Marie Richard segregated the genus *Platanthera* from *Habenaria* in 1818, and in 1835 John Lindley made the combination *P. rotundifolia* owing to significant morphological similarities with members of that genus. In 1966 Károly Rezsö Soó von Bere placed it in the Eurasian genus *Ponerorchis*, a segregate genus created in 1852 by Heinrich Gustav Reichenbach. In 1968 Eric Hultén formed the monotypic genus *Amerorchis* to contain this species due to the unique set of traits that differentiate it from other orchid genera, including the solitary leaf and scapose stem being produced by a slender branching rhizome with slender fibrous roots, rather than rounded or palmately-lobed tuberoids, and the lobed lip and flower color (Hultén 1968 in Luer 1975). The synonyms for this species include the following:

Orchis rotundifolia Banks ex Pursh

Habenaria rotundifolia (Banks ex Pursh) Richardson

Platanthera rotundifolia (Banks ex Pursh) Lindl.

Ponerorchis rotundifolia (Banks ex Pursh) Soó

Amerorchis rotundifolia (Banks ex Pursh) Hultén

Several infraspecific ranks of *Amerorchis rotundifolia* are published, but they are not recognized in the PLANTS Database (USDA Natural Resource Conservation Service 2003) or NatureServe (2003). William Henry Mousley described the *forma lineata* in 1941 from specimens from Alberta with longitudinal stripes rather than spots on the lip (publishing it under the genus *Orchis*), which was proposed as a variety by Edward Groesbeck Voss in 1966. In 1957 Jacques Rousseau described the narrow-leafed *forma angustifolia.* Bernard Boivin described *forma beckettii*, characterized by all white flowers with off-white lips, from Manitoba (in the genus *Orchis*) in 1960. Warren Mazurski and Laurence P. Johnson described the white lipped *forma immaculata* in 1995. All other material, including that in USFS Region 2, represents the widespread form.

History of the species

Joseph Banks possessed the first known collection of *Amerorchis rotundifolia* in his herbarium; whether he collected it himself or not is unknown (Johnson 1987). This collection was simply labeled "On Hudson's Bay", and the species was published by Frederick Pursh (1814). The generic name *Amerorchis* is a combination of "American" and *Orchis*, referring to a Greek term used by Theophrastus to reflect the shape of the twin tubers found in the first members of that genus (Hitchcock et al. 1969). The specific epithet *rotundifolia* refers to the round leaf that is one of the diagnostic features of the species. The first Wyoming collection was made by Edward Pillsbury Pearson and Dorothy Sue Pearson, brother and sister, in 1924 on the Clarks Fork Valley in Park County. The collection label described the location as on Crandall Creek, near Simpson's Cabin (also called Pearson's Cabin). In 1982, Erwin Evert and Robert Lichvar conducted surveys near the Simpson's Cabin, but the incorrect creek (Lodgepole Creek) was put on the 1982 collection label. In 1985, two additional occurrences were discovered in the Clarks Fork Valley by Erwin Evert: one at Camp Creek, immediately south of Wyoming State Highway 296; and the other at Swamp Lake. In 2004, Erwin Evert and Bonnie Heidel resurveyed the area near the Simpson's

Cabin on Oliver Gulch, confirming the proximity of this occurrence of *A. rotundifolia* to Swamp Lake. The Oliver Gulch occurrence was reinterpreted to be a sub-occurrence of the Swamp Lake occurrence based on proximity and likelihood of gene exchange. Another outlier of a few plants was found north of State Highway 296 in the opposite direction from Swamp Lake in 2004 (**Table 2**).

Non-technical description

Amerorchis rotundifolia is a glabrous perennial forb, 10 to 36 cm (4 to 14 inches) tall with delicate rhizomes or stolons from which a few, slender, fibrous roots originate. There is a single, elliptic or round leaf, 3 to 9 (15) cm (1 to 4 [6] inches) long, at the base of the stem. The inflorescence is a more or less crowded, 2 to 15 (18)-flowered terminal raceme. The flowers are 1 to 2.5 cm (0.4 to 1 inch) across and consist of three pinkish-white, petal-like sepals, 6 to 11 mm long: two narrow, pink upper petals; and a white oblong, purple-spotted lip petal 6 to 9 mm long. The lip is deeply lobed at the sides and flared at the tip with a slightly curved spur 5 to 6 mm long at the back. The fruit is a greenish-brown, upright capsule with many tiny seeds (**Figure 1** and **Figure 2**; Hitchcock et al. 1969, Fertig et al. 1994, Fertig 2000).

The chromosome number of *Amerorchis rotundifolia* is 2N=42 (Hitchcock et al. 1969, Pridgeon et al. 1997 as cited in Bateman et al. 2003). It is a diploid that shares the same base chromosome number with other related genera (Bateman et al. 2003).

Distribution and abundance

Rocky Mountain Region distribution

There are two known occurrences of *Amerorchis rotundifolia* in Wyoming. They are the only occurrences known in USFS Region 2 (**Table 2** and **Figure 3**) and represent disjunct occurrences at the southern limits of the species' rangewide distribution. Both occurrences are on the Clarks Fork Ranger District of the Shoshone National Forest and restricted to a 7-mile (11.3-km) valley segment of the Clarks Fork of the Yellowstone River drainage in Park County (Fertig 2000, Hartman and Nelson 2003).

As originally reported, the occurrence on the shores of Swamp Lake is widely-scattered in at least seven different places that may represent sub-occurrences within this large wetland basin. They have a total occurrence size estimated at "several hundred individuals" occupying approximately 10 acres (4 ha) in a band of habitat that spans the 1.5 mile (2.4 km) long southern margin of Swamp Lake (Fertig and Jones 1992, Fertig 2000). Two small wetlands near Swamp Lake also harbor *Amerorchis rotundifolia* and are so close that gene flow is likely. They are likely to be hydrologically connected and considered to be sub-occurrences of the Swamp Lake occurrence. Until recently, one of these was treated as a separate occurrence, but more precise location information was provided by Erwin Evert in 2004, and subsequently re-surveyed by him to clarify its location and confirm its proximity to Swamp Lake. The Camp Creek occurrence is not in a discrete wetland basin and spans a much smaller area than Swamp Lake, but it is similar in net occupied area and total occurrence numbers, occupying an estimated 15 acres (6 ha) of habitat with occurrence numbers estimated between 200 and 300. The two occurrences total approximately 400 to 500+ plants over approximately 25 acres (10 ha).

Systematic survey of *Amerorchis rotundifolia* and other Wyoming species of concern has been conducted north of Swamp Lake by Walter Fertig as part of the Swamp Lake documentation. There has been unsuccessful limited survey to relocate one of the two other occurrences and limited surveys in a few suitable

Table 2. Occurrences of *Amerorchis rotundifolia* in USDA Forest Service Rocky Mountain Region. All are located on Shoshone National Forest in Wyoming. Based on Wyoming Natural Diversity Database occurrence data through 2004.

Occurrence Number	Location	Management / Ownership	Estimated abundance	Estimated occupied area (ac)
001	Corral Creek	USFS	—	—
002	Swamp Lake (main)	USFS	200+	10
002	Oliver Gulch (sub-occurrence)	USFS	15 to 20 (1982); 3 (2004)	0.1
002	North of Hwy (sub-occurrence)	USFS	2	0.1
003	Camp Creek	USFS	200 to 300	15
TOTAL			400 to 500+	Approximately 25

Figure 1. Photograph of *Amerorchis rotundifolia* by Jennifer Whipple (Swamp Lake).

sites (Kent Houston personal communication 2003), but there has not been systematic survey for this species in the valley apart from the Swamp Lake area.

A census of *Amerorchis rotundifolia* was made at Swamp Lake in 1992 and 1996 by Fertig, presumably based on a count of flowering stems, and at Camp Creek by Heidel in 2004, based on flowering stems. It is possible that stem counts do not represent population size for three reasons. First, stem counts do not represent the number of individuals if this species reproduces vegetatively. A cluster of flowering stems may all be connected underground (ramets) and represent a single individual (genet), or they could represent several individuals (genets). In 1992, Fertig noted that the species occurs in groups of "2-7 individuals", but most of the Camp Creek individuals observed by Heidel in 2004 were not clustered. It is not possible to differentiate individuals without destructive digging, and Rocky Mountain Herbarium specimens offer no examples of underground connections between flowering stems. More detailed notes on flowering stem

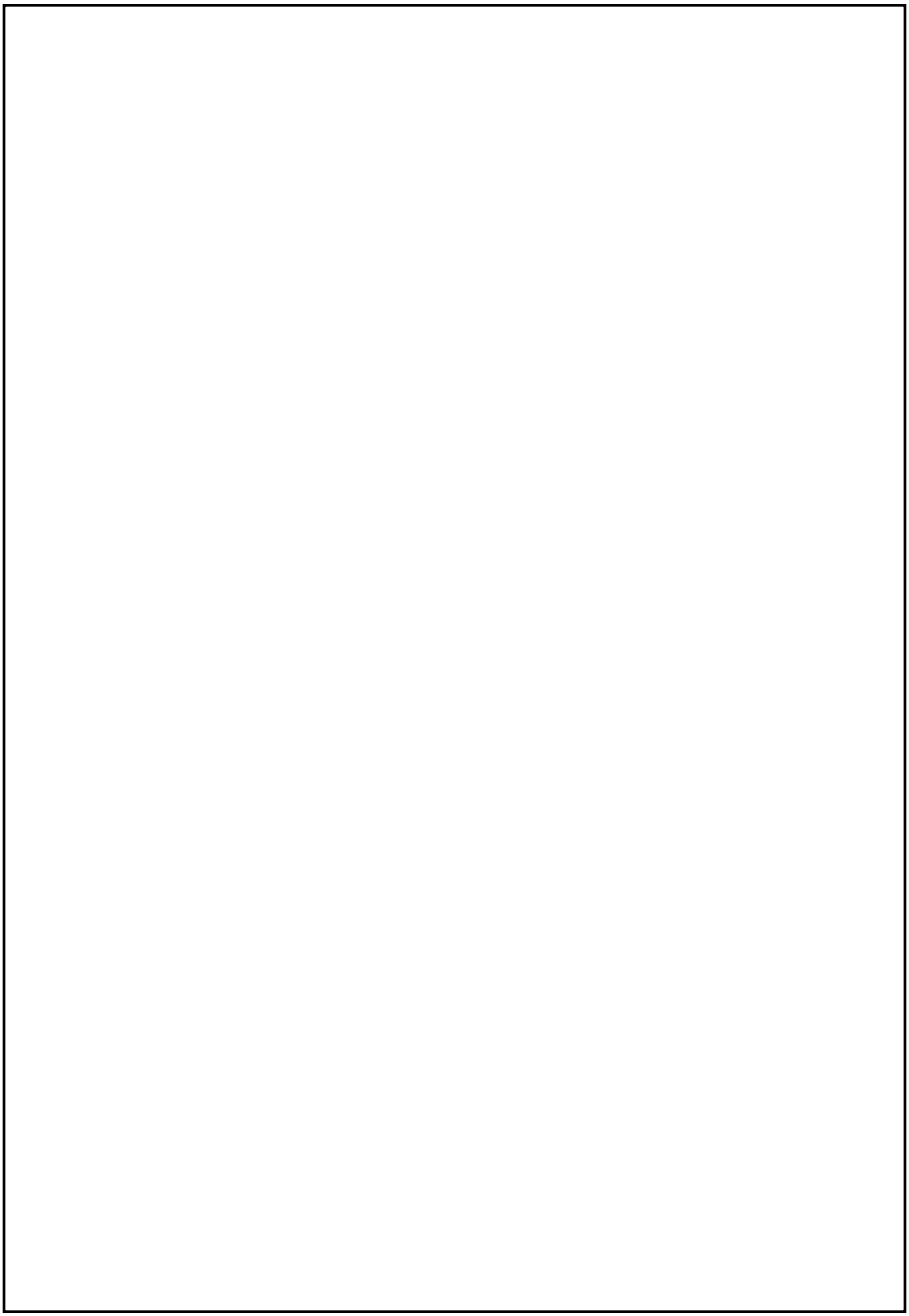

Figure 2. Illustration of *Amerorchis rotundifolia* by Jeanne Janish. Reprinted from: Hitchcock, C.L., A. Cronquist, and M. Ownbey. 1969. Pt. 1. Vascular Cryptograms, Gymnosperms, and Monocotyledons. *In*: C.L. Hitchcock, A. Cronquist, M. Ownbey, and J.W. Thompson, editors. Vascular Plants of the Pacific Northwest. University of Washington Publications in Biology 17(1):1-914.

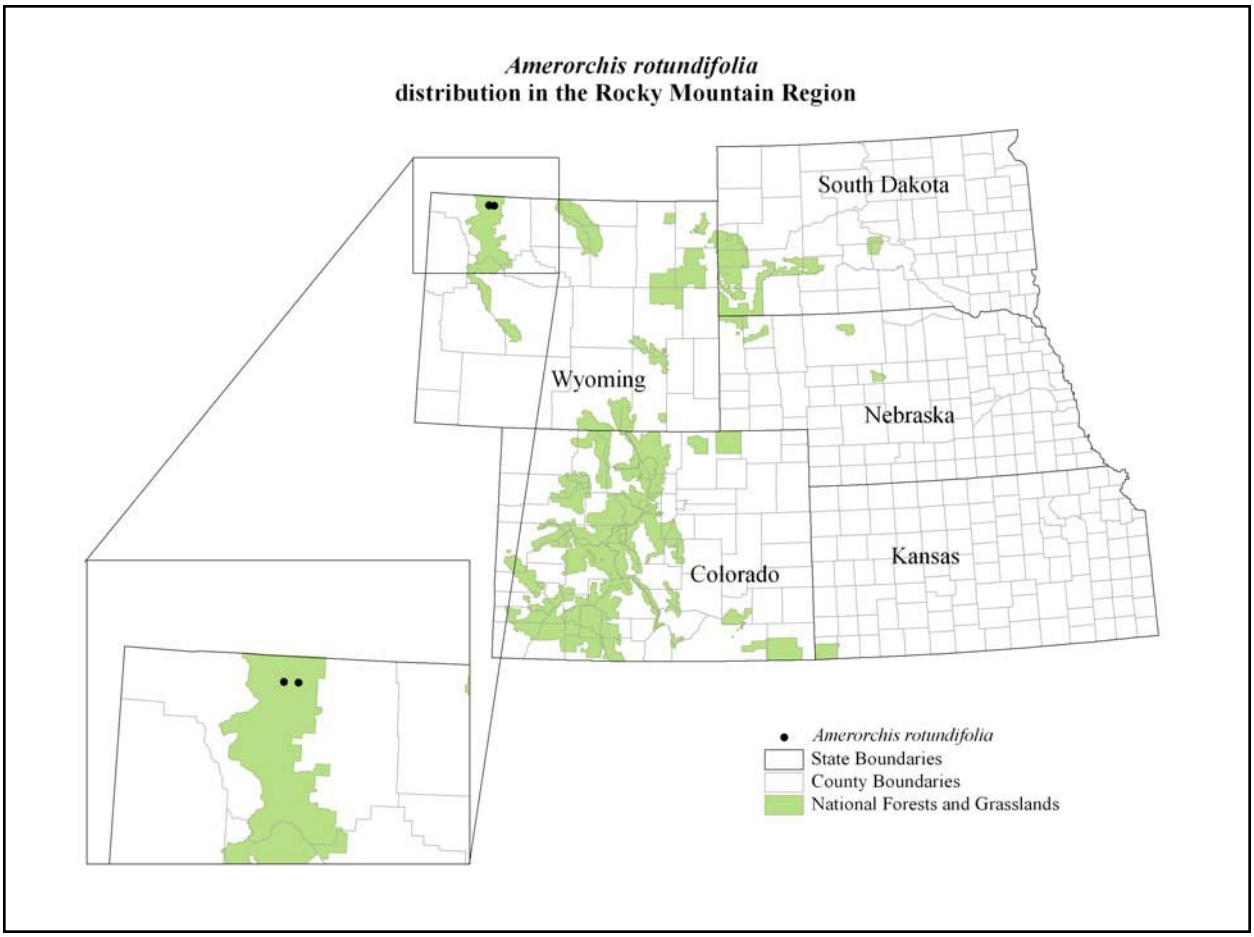

Figure 3. Map of *Amerorchis rotundifolia* populations in Rocky Mountain Region (from Wyoming Natural Diversity Database 2003)

aggregation or isolation in both occurrences may help to elucidate the situation.

Second, stem counts overlook vegetative plants, represented by a solitary basal leaf. Vegetative plants are not as easily discerned as the flowering stems (Shefferson et al. 2003). Basal leaves may also be linked underground to flowering stems. The ratios of flowering to vegetative shoots that make up a genet or represent discrete genets within a sub-occurrence are variable. Thus, vegetative plants increase the likelihood of the species being overlooked. In this regard, annual fluxes between flowering and non-flowering stages may produce misleading trend results.

Third, census of flowering stems also overlooks juvenile and seasonally dormant mature plants that persist underground. These are not possible to discern, and the ratios of juvenile and seasonally dormant plants to flowering and vegetative plants are not known. A census count without baseline monitoring data to address seasonal dormancy will also be an underestimate. All three reasons taken together mean that stem census data are only an initial approximation of occurrence size that produce the most conclusive results when permanently-marked plants are monitored over consecutive years.

Rangewide distribution

Amerorchis rotundifolia is a North American species with an arctic and boreal distribution pattern, extending from Greenland to western Alaska (Luer 1975, Cody 1996). It occurs in nearly all Canadian provinces and territories, southward into Maine, Michigan, Wisconsin, Minnesota, Montana, and Wyoming. Within each state, province, and territory, the species' distribution and plant abundance vary greatly. At more northerly latitudes, the plant is generally abundant, widely scattered and less exacting in its requirements. To the south, it becomes increasingly rare and restricted to moist, shady sites (Luer 1975). In Greenland, distribution is limited to a small area along the southwestern coast. On the island of Newfoundland, it is considered rare, occurring only on the tip of the

Great Northern Peninsula, with a disjunct occurrence about 100 miles (160 km) to the south near Corner Brook (Bouchard et al. 1991, Boland 2001). It is also rare in New Brunswick where it is found mainly in the northern counties at widely scattered locations (Hinds 1983). All other Canadian provinces and territories where it exists have large enough occurrences that the species is not of conservation concern.

Within the contiguous United States, *Amerorchis rotundifolia* reaches the southern limit of its range. The only New England state with extant occurrences is Maine, with seven known occurrences. There are historical records for Vermont and New Hampshire. The plant is considered to be extirpated from New York (St. Hilaire 2002). NatureServe (2003) lists New Jersey and Idaho as two of the states of occurrence, but there is no corroborating literature to support this claim. Within the Rocky Mountains, it is peripheral in Montana where it is known from 27 occurrences (Montana Natural Heritage Program 2003), and it is disjunct in Wyoming where it is known from two occurrences (Wyoming Natural Diversity Database 2003). There are no other extant occurrences of *A. rotundifolia* that are so widely separated from the core of the species' distribution as those in the Rocky Mountain Region. It is possible that the species is a glacial relict in this setting.

Population trend

Trend data are preliminary or lacking for both occurrences of *Amerorchis rotundifolia* in the Region 2. The size of the Swamp Lake occurrence was estimated in two different years by Walter Fertig, but in the second visit it was found to be more extensive than originally mapped. Fertig attributed the increase in occurrence size from "approximately 75" in 1992 to "several hundred" in the most recent 1996 estimate, at least in part, to the expanded survey area. The 1992 survey was also made when the species was in fruit and less conspicuous. In this survey, Fertig described the local distribution pattern as widely-scattered groups of two to seven individuals, indicating a local pattern of distribution that is patchy and of low density. It is likely that the existing census information at Swamp Lake refers to flowering stems, and the possible implications of this are discussed in the preceding section. It is now known along much of the southern border of Swamp Lake, with outliers in the same basin, and in two small isolated wetlands nearby.

The first collection of *Amerorchis rotundifolia* from Swamp Lake (*Evert 7841*) was made in 1985, and the collection label reports it from both sections 11 and 14. It may be significant that section 11 is on the northeast side of Swamp Lake and the occurrence of approximately 12 plants was not found in section 11 in 1992 and 1996 surveys by Fertig. Observations made in 2002, compared with aerial photographs that pre-date the fire and highway reconstruction, indicate that peatland habitat has been inundated in section 11 (Heidel and Laursen 2003; discussed in Threats section).

The sub-occurrence numbers at Oliver Gulch, an outlier of the Swamp Lake occurrence, were reported as "probably 15-20 plants" in 1982 by Erwin Evert and Robert Lichvar. Re-survey at the same site in 2004 by Erwin Evert, censused "only 3 plants." All upslope tree cover and most of the tree cover around the perimeters of this wetland site were killed in the intense fire in 1988, and it is likely that the decline in occurrence numbers reflects habitat loss.

By contrast, the occurrence numbers at Camp Creek were originally reported at about 20 to 30 plants in 1985 when first collected by Erwin Evert. The site was surveyed by Bonnie Heidel in 2004, and numbers were estimated between 200 and 300. This change is thought to reflect the expanded survey effort in a site that is more difficult to get an overview of because it is not associated with any discrete wetland basin, is more heavily forested, and has clusters of plants at opposite ends of the swamp.

Population trend monitoring is complicated by the same factors that complicate a census of population numbers: vegetative reproduction, the relative inconspicuousness of vegetative plants, and the absence of aboveground parts in juvenile and seasonally-dormant plants. It is not possible to differentiate individuals without destructive excavation, but repeated monitoring of marked plants over multiple years can provide an indication of whether clusters of flowering stems function together or separately. It is possible to monitor individual vegetative plants as long as the monitoring is set up with permanent marking of plants or plant-clusters. It is also possible to determine population trends for species that are seasonally dormant as long as the number of years for monitoring is extended to establish a baseline, and extends longer than the mean length of seasonal dormancy episodes (Lesica and Steele 1994).

The changes to the landscapes that surround the two occurrences in the wake of wildfire, salvage logging, hydrological changes, and weed invasion are discussed in the section on Threats, and raise the

importance of documenting population numbers, trends, and local distribution patterns.

Habitat

Rocky Mountain Region habitat

Within the Rocky Mountains of Wyoming and Montana, *Amerorchis rotundifolia* occupies habitat characterized as "along streams and in wet woods, but usually where the drainage is good, often on limestone" (Hitchcock et al. 1969).

Both occurrences known in the USFS Rocky Mountain Region are in the vicinity of Swamp Lake and the Cathedral Cliffs (**Figure 4**) between 6,600 and 6,840 ft. (2,010 and 2,080 m) (Fertig 2000, with updates). The Swamp Lake occurrence of *Amerorchis rotundifolia* is concentrated along a narrow 2-mile (3.2-km) band of wet white spruce forest at the base of the limestone cliff slopes (Fertig and Jones 1992, Fertig 2000). This forest is characterized, in part, by a closed canopy of *Picea glauca* (white spruce) with an understory that varies in response to soil moisture. The species occurs on microsites within the shaded forest, mostly on raised, mossy surfaces of woody lateral roots of large spruce trees. It was referred to as spruce muskeg by Evert (1984). Typical associated species at Swamp Lake include *Equisetum arvense* (field horsetail), *Platanthera hyperborea* (northern green orchid), *Carex gynocrates* (northern bog sedge), *Juncus balticus* (Baltic rush), *Petasites sagittata* (arrowleaf sweet coltsfoot), *C. disperma* (softleaf sedge), *Pyrola chlorantha* (greenflowered wintergreen), and *Stellaria longifolia* (longleaf starwort). Associated moss species include *Plagiomnium ellipticum* and *Tomenthypnum nitens* (Wyoming Natural Diversity Database 2003). Other rare species occupy the same wet spruce forest stand on Swamp Lake, including *Arctostaphylos rubra* (red fruit bearberry; the only occurrence in the contiguous United States), *C. leptalea* (bristlystalked sedge), and *Salix myrtillifolia* var. *myrtillifolia* (blueberry willow). By contrast, the associated species at Camp Creek include local dominance of *C. leptalea* rather than a trace. Besides *Picea glauca* and *Equisetum arvense*, the Camp Creek associated species include *Alnus viridis* (green alder), *Platanthera huronensis* (Huron green orchid), *Listera borealis* (northern twayblade), *Glyceria borealis* (small floating mannagrass), *Geranium richardsonii* (Richardson's geranium), *Linnaea borealis* (twinflower), *Moneses uniflora* (single delight), and *Parnassia* spp. (grass of Parnassus).

The habitats at the two outlying sub-occurrence near Swamp Lake are also wetland margins dominated by *Picea glauca*. The Oliver Gulch wetland was previously described by Erwin Evert as "moist areas at head of spring in spruce-pine swamp forest". At present, Oliver Gulch has only a small corner with unburned *P. glauca* cover; otherwise the wetland margins are dominated by shrubs or robust graminoids. The sub-occurrence north of Highway 296 is in deep shade, on moist turf that drops abruptly 0.5 m (20 inches) to a seasonally-inundated wetland of robust graminoids. The conditions at the margin might indicate a past drop in water table levels.

The habitat at the Camp Creek occurrence was previously described by Erwin Evert as "wet areas in spruce forest." This was expanded in 2004 surveys in which it is described by Bonnie Heidel as "white spruce swamp fed by seepage, in a broad band along a contour interval surrounded by mesic forest, with partial shade and scattered deadfall, blanketed by semi-continuous moss and liverwort cover." It lies on gentle slopes with no apparent break in topography from surrounding terrestrial vegetation and no associated wetland basin. Habitat information is summarized in **Table 3**.

Wet spruce habitat as occupied by *Amerorchis rotundifolia* in Wyoming represents the only forested peatland vegetation in the state. **Figure 5** displays the relative position of *Picea glauca* forest, relative to water depth and the other plant communities of the extremely rich fen represented at Swamp Lake. Groundwater is discharged at the surface of *A. rotundifolia* habitat that maintains peat-forming conditions. The groundwater is strongly calcareous due to the proximity of Pilgrim Limestone comprising the base of the adjacent Cathedral Cliffs. Surface and groundwater tested at various points within Swamp Lake disclosed a pH ranging from 8.0 to 8.4 at "alkaline springs" by Evert (1984) and 6.9 to 7.9 by Fertig and Jones (1992). The pH-sampling locales may not have included or represented the habitat and microhabitat of *A. rotundifolia*, and the pH values associated with peatland microtopography can vary with small-scale vegetation patterns and depth to water.

The Crandall Creek weather station is located west of the two westernmost occurrences of *Amerorchis rotundifolia* in Wyoming, at a slightly lower elevation than Swamp Lake. The long-term data collected there since 1913 document a cool, montane climate without a drought period and with high contribution of snowfall to net annual precipitation (**Table 4**; USDI National

Figure 4. Photograph of Swamp Lake, from east end. *Amerorchis rotundifolia* habitat is in the band of wet spruce forest bordering open habitat. By Hollis Marriott on 5 Aug 1987.

Table 3. Habitat descriptions of *Amerorchis rotundifolia* occurrences in the USDA Forest Service Rocky Mountain Region. All are located on the Shoshone National Forest in Wyoming.

Occurrence Number	County	Site name	Management / Ownership	Elevation range (ft.)	General habitat description	Associated species
002	Park	Swamp Lake	USFS	6,600 to 6,740	Moist, shady white spruce forest bordering large wetland basin of peatland. Typically found at base of *Picea glauca* on moss-covered root crowns (main Swamp Lake population). Also: Moist areas at head of spring in white spruce swamp forest (Oliver Gulch subpopulation).	*Equisetum arvense*, *Juncus balticus*, *Platanthera hyperborea*, *Carex gynocrates*, *Petasites sagittatus*, *Picea glauca*, *Juniperus horizontalis* (main Swamp Lake population). Also: *Senecio* spp., *Equisetum* spp., *Epilobium* spp., *Saxifraga* spp. *Platanthera obtusata*, *Glyceria striata*, *Carex interior*, *Carex dioica*, *Listera cordata*, *Carex leptalea*, *Carex capillaris*, *Picea* spp., *Petasites sagittatus* (Oliver Gulch subpopulation).
003	Park	Camp Creek	USFS	6,840 to 6,880	White spruce swamp fed by seepage, in a broad band surrounded by mesic forest, and with partial shade and scattered deadfall, blanketed by semi-continuous moss and liverwort cover.	*Platanthera hyperborea*, *Platanthera obtusata*, *Listera borealis*, *Carex disperma*, *Lappula echinata*, *Viola adunca*, *Viola macloskeyi*, *Corallorhiza trifida*, *Carex capillaris*.

Figure 5. Schematic cross-section of vegetation zones and water levels at Swamp Lake. *Amerorchis rotundifolia* habitat is in the wet spruce (*Picea glauca*) forest. By Walter Fertig

Table 4. Climate summary from the Crandall Creek weather station (1971-2003).

Average Maximum Monthly Temperature (ºF)	Average Minimum Monthly Temperature (ºF)	Average Total Annual Precipitation (inches)	Average Total Annual Snowfall (inches)
54.6	21.8	14.86	86.9

Oceanic and Atmospheric Administration 2003). The microclimate conditions of *A. rotundifolia* habitat are probably even cooler and moister than the rest of the valley. That is because it is in shade and on mossy substrate fed by cool groundwater. These climate conditions are suited to boreal species at the southern limits of their ranges.

Potential habitat in the Rocky Mountain Region

The wet spruce habitat of *Amerorchis rotundifolia* in the Rocky Mountain Region is a localized feature on the landscape that has not been segregated in the riparian habitat mapping on Shoshone National Forest (Kent Houston personal communication 2003). Surveys to date have been conducted on a small scale, without the benefit of aerial photo-interpretation and GIS layers such as National Wetland Inventory mapping. Suitable habitat for *A. rotundifolia* has been surveyed by Walter Fertig between Swamp Lake and the Clarks Fork River to the north without finding additional occurrences. A small detachment of the Swamp Creek sub-occurrence was surveyed in a proposed prescribed burn unit in 2004 by Bonnie Heidel. There is potential wet spruce habitat for the species east of Swamp Lake in the vicinity of Deadman Creek (Kent Houston personal communication 2003). There may also be additional potential habitat in the Camp Creek watershed. It is possible that the 7-mile (11.3-km) segment where the species occurs in the Clarks Fork River valley is the only area with potential habitat in the Shoshone National Forest, but this remains to be determined.

Rangewide habitat

Characteristics of *Amerorchis rotundifolia* habitat vary across its range, but the descriptions of shade, temperature, water regime, soil chemistry, and vegetation help to clarify its requirements in the Rocky Mountain Region. Case (1964) and St. Hilaire (2002) report that the most important habitat feature cited for *A. rotundifolia* is cold substrate, and other features such as light levels and moisture regime vary. In the far north, on cold open tundra or limestone barrens, the species grows dwarfed but abundantly in full sunlight. In northern boreal forest it may thrive on the humus of dry spruce needles. However,

further south it becomes increasingly rare and is found in ever more sheltered habitats, generally restricted to shaded bogs where cool, moist beds of *Sphagnum* or other mosses offer summer air conditioning (Luer 1975). In the contiguous United States, *A. rotundifolia* is at its southernmost limits and requires an overstory to maintain the cold substrate and to protect it from temperature extremes, particularly heat.

Amerorchis rotundifolia also requires wet or moist, aerated substrate. Luer (1975) asserts that "good drainage of a constant, water supply of sufficiently high pH is essential for the frail roots which can tolerate neither heat nor acid." Throughout its range of occurrence in the lower 48 United States, *A. rotundifolia* is a wetland obligate, meaning that at least 99 percent of the time, the taxon will be found in wetland habitat. However, in Alaska, it is designated a facultative wetland species, occurring in wetlands 67 to 99 percent of the time (USDI Fish and Wildlife Service 1988). In the literature, *A. rotundifolia* is referred to as a terrestrial species (e.g., Sheviak 1990), a term that serves only to distinguish it from epiphytic species of orchids as found in the tropics.

Another feature that appears to consistently characterize *Amerorchis rotundifolia* sites is calcareous soil and/or groundwater. Most occurrences are reported to be in habitats on or near calcareous substrates including limestone and marl, and the Wisconsin Department of Natural Resources (2003) claims that the plant possibly occurs only on calcareous deposits. Research indicates that it has a strong preference for near-neutral or only slightly acidic soils (Luer 1975, Cameron 1976).

In the northeastern United States, the species occupies *Thuja occidentalis* (white cedar) forests and wetlands. All occurrences of *Amerorchis rotundifolia* in Maine are in communities classified as either white cedar swamp or cedar-spruce seepage forest, typically found in poorly drained basins along streams or small ponds (St. Hilaire 2002). In the upper Midwest (Michigan and Wisconsin), it is found almost exclusively in very cold *Abies balsamea* (balsam fir) - *Picea mariana* (black spruce) - *Thuja occidentalis* (white cedar) bogs (Case 1964), while in northern Minnesota, it is in a variety of coniferous swamps, usually under a canopy of *T. occidentalis*, *Larix laricina* (tamarack), or *Picea* spp. (spruce), often on a substrate of deep *Sphagnum* moss (Smith 1993).

In the Rocky Mountains (Montana and Wyoming), where *Thuja occidentalis* does not occur, *Amerorchis rotundifolia* is found in *Picea* spp. swamps, generally in association with seeps, springs, or streams (Shelly 1988, Fertig 2000), and it is usually if not always on or near limestone or marl. Of the 27 occurrences for Montana, all but one reported the presence of either *P. engelmannii* or *P. glauca*, with *Equisetum arvense* co-dominant or at least present. It can also occur with *Pseudotsuga menziesii* (Douglas-fir) and *Pinus contorta* var. *latifolia* (lodgepole pine) (**Table 5**).

Reproductive biology and autecology

Reproduction

In Wyoming, *Amerorchis rotundifolia* flowers from mid-June to mid-July, and fruit is produced from July to August (Fertig 2000). Of the *A. rotundifolia* collections at the Rocky Mountain Herbarium, only one by Fertig (*13370*) on August 18, 1992 is in fruit. The length of anthesis is not known.

Flowering in orchids is sensitive to environmental conditions, such as rainfall, during certain parts of the current or previous growing seasons, and unfavorable conditions may redirect energy resources into vegetative reproduction. Wells (1981) found a significant relationship between summer rainfall, late winter soil temperatures, and flowering in *Spiranthes* and *Herminium*. Blinova (2002) found that the flower buds and other new growth of *Cypripedium calceolus* are negatively impacted by early frosts when they are being formed in the fall. It may be assumed that any damage to growing buds of *Amerorchis rotundifolia* in the fall, whether from frost, herbivory, disease, or other means, will negatively impact flowering abundance during the following growing season (St. Hilaire 2002).

Amerorchis rotundifolia can reproduce by seed and possibly by asexual means via rhizomes or stolons. It is said to reproduce by vegetative means in Maine (Van der Cingel 2001 as cited in St. Hilaire 2002), but it is not clear from the statement whether the author refers to development of clones or *de facto* asexual reproduction in which ramets become physically separated from the genets. The applicability of this generalization to Rocky Mountain Region populations is not known.

Pollinators and pollination ecology

Specific pollinators of *Amerorchis rotundifolia* are not known. The flowers contain no nectar (Van der Cingel 2001 as cited in St. Hilaire 2002) and therefore provide no reward for pollinators. Christensen (1994 as cited in St. Hilaire 2002) reports that the important

Table 5. Habitat descriptions of *Amerorchis rotundifolia* occurrences in the USDA Forest Service Northern Region. All are located in Montana.

County	Site name	Management / Ownership	Elevation range (ft.)	General habitat description	Associated species
Lewis and Clark	Green Timber Basin	USFS	4,920 to 5,400	Near calcareous springs, organic soil; moist spruce woods.	*Equisetum arvense*, *Equisetum scirpoides*, *Angelica arguta*, *Cornus stolonifera*, *Listera chilensis*, *Pyrola uniflora*, *Pyrola asarifolia*, mosses.
Powell	Butcher Mountain Meadows	USFS	4,750	Moist, mossy areas on edges of bogs; mostly under *Picea engelmannii*, but also in more open *Salix* spp. and *Ledum glandulosum* shrub.	*Equisetum*,*arvense*, *Cypripedium passerinum*, *Mitella nuda*, *Habenaria obtusata*, *Streptopus amplexifolius*, *Carex aurea*.
Powell	White River	USFS	4,560	Shaded banks and slope along river, in moist mossy areas.	*Picea engelmannii*, *Equisetum arvense*, *Habenaria hyperborea*, *Linnaea borealis*, *Cypripedum passerinum*, *Pyrola uniflora*.
Teton	Blacktail Gulch	USFS	4,960	In mossy seepage area; *Picea engelmannii/Equisetum arvense* habitat.	*Pyrola uniflora*, *Equisetum scirpoides*, *Salix scouleriana*, *Mitella nuda*.
Teton	Mortimer Gulch	USFS	5,400 to 5,680	Mossy seepage area in *Picea engelmannii* forest.	*Listera borealis*, *Equisetum arvense*, *Pyrola uniflora*, *Equisetum scirpoides*, *Mitella nuda*.
Lewis and Clark	Lange Creek drainage	USFS	5,700	Moist seepage area in forest opening.	*Picea engelmannii*, *Equisetum arvense*, *Habenaria hyperborea*, *Pyrola uniflora*, *Carex gynocrates*, *Equisetum scirpoides*.
Lewis and Clark	Leavitt Creek	USFS	5,430	Mossy seepage areas along drainage.	*Picea engelmannii*, *Equisetum arvense*, *Equisetum scirpoides*, *Pyrola uniflora*, *Parnassia fimbriata*, *Carex aurea*.
Teton	Ear Mountain	Other	5,640	Willow bog in calcareous loam; beneath *Picea engelmannii*.	*Salix drummondiana*, *Dodecatheon* spp., *Fragaria virginiana*, *Pyrola asarifolia*.
Lewis and Clark	Joslin Basin	Other	5,300	Seepage area, around margins of old beaver ponds in valley bottom.	*Picea engelmannii*, *Pseudotsuga menziesii*, *Cornus stolonifera*, *Symphoricarpos albus*, *Equisetum* spp.
Teton	Arsenic Creek	USFS	5,350	Hummocks, swales, and drainway edges, in *Picea engelmannii/Equisetum arvense* habitat type.	*Equisetum scirpoides*, *Habenaria hyperborea*, *Habenaria obtusata*.
Teton	Clary Coulee	USFS	5,600	Margins of seepy areas.	*Picea engelmannii*, *Carex gynocrates*, *Carex aurea*, *Linnaea borealis*, *Parnassia fimbriata*, *Cypripedium passerinum*.
Pondera	North Fork Birch Creek	USFS	5,040	Seepage areas in gullies, on more stable edges; *Picea engelmannii/Galium triflorum* habitat type.	*Cypripedium passerinum*, *Antennaria pulcherrima*.
Teton	Green Gulch	USFS	5,920	Along the edges of two willow bogs; beneath *Picea engelmannii*.	*Habenaria dilatata*, *Habenaria obtusata*, *Parnassia kotzebuei*, *Linnaea borealis*.
Lewis and Clark	Falls Creek	Other	4,910	Spring seep above creek bottom.	*Picea engelmannii*, *Salix* spp., *Cornus stolonifera*, *Populus tremuloides*, *Parnassia fimbriata*, *Angelica arguta*, *Cypripedium calceolus*.

Table 5 (Cont.).

County	Site name	Management / Ownership	Elevation range (ft.)	General habitat description	Associated species
Lewis and Clark	Falls Creek ford	USFS	4990	Moss layer, on bench above creek; canopy of *Picea engelmannii*, *Cornus stolonifera*.	*Potentilla fruticosa*, *Habenaria hyperborea*, *Swertia perennis*.
Flathead	Bent Flat Fen	USFS	3,990	Partial shade exposure on lower straight slope; moist area on benchland above river. Limestone parent material in adjacent mountains. *Picea/ Equisetum* arvense habitat type.	*Cypripedium passerinum*, *Cypripedium calceolus*, *Rhamnus alnifolia*, *Betula glandulosa*, *Potentilla fruticosa*, *Menziesia ferruginea*, *Aster conspicuus*, *Petasites sagittatus*, *Rosa sayi*, *Valeriana dioica*, *Carex dioica*, *Pyrola asarifolia*, *Cornus stolonifera*, *Shepherdia canadensis*, *Cornus canadensis*, *Linnaea borealis*, *Carex rostrata*, *Betula occidentalis*, *Salix bebbiana*.
Lewis and Clark	West Fork Beaver Creek	USFS	5,700	Shaded to partially-open midslope; moist.	*Viola orbiculata*, *Salix* spp., *Alnus* spp., *Platanthera* spp., *Picea* spp., *Equisetum* spp., *Clintonia uniflora*, *Cornus canadensis*, *Lonicera* spp., *Menziesia ferruginea*, *Habenaria* spp., *Cornus stolonifera*, *Carex* spp.
Lincoln	Brimstone Creek	USFS	3,500 to 3,640	Mostly shaded with partial openings, in a saturated stream bottom. Silt loam soil of calcareous glacial till parent material. *Picea/ Equisetum* arvense habitat type.	*Betula papyrifera*, *Cornus stolonifera*, *Alnus sinuata*, *Rhamnus alnifolia*, *Cornus canadensis*, *Petasites sagittatus*, *Habenaria hyperborea*, *Glyceria striata*, *Galium triflorum*, moss spp., *Berberis repens*, *Smilicina racemosa*, *Spiaea betulifolia*, *Arnica latifolia*, *Bromus inermis*, *Pseudotsuga menziesii*, *Aralia nudicaulis*, *Linnaea borealis*.
Lincoln	Hidden Lake	USFS	3,360 to 3,600	Partially open, saturated bottomland. Plants located on wetland ecotone with the adjacent forest, and at the mouth of a small drainage. *Picea/Cornus stolonifera* habitat type.	*Alnus sinuata*, *Rhamnus alnifola*, *Betula glandulosa*, *Salix candida*, *Salix bebbiana*, *Cornus canadensis*, *Petasites sagittatus*, *Carex lasiocarpa*, *Cypripedium calceolus* var. *parviflorum*, *Zigadenus elegans*, *Equisetum arvense*, *Menyanthes trifoliata*.
Flathead	Lime Creek	USFS	3,750	Plants located in wetland ecotone with the adjacent forest at the mouth of a small drainage, where creek is braided into small 1-3 ft. channels, forming a broad riparian zone. *Picea/ Equisetum arvense* habitat type.	*Alnus sinuata*, *Rhamnus alnifolia*, *Betula glandulosa*, *Salix candida*, *Salix bebbiana*, *Cornus canadensis*, *Petasites sagittatus, Carex lasiocarpa*, *Cypripedium calceolus* var. *parviflorum*, *Zigadenus elegans*, *Equisetum arvense*, *Menyanthes trifoliata.*

Table 5 (Concluded).

County	Site name	Management / Ownership	Elevation range (ft.)	General habitat description	Associated species
Flathead	Magnesia Creek	USFS	3,520 to 3,800	Plants are located in ecotone between closed *Picea/ Equisetum arvense* stand and more open area. *Picea/ Equisetum arvense* habitat type.	*Betula glandulosa*, *Carex vesicaria*, *Carex capillaris*, *Carex disperma*, *Carex leptalea*, *Mitella nuda*, *Rhamnus alnifolia*, *Cornus canadensis*, *Linnaea borealis*, *Cypripedium calceolus* var. *parviflorum*, *Galium boreale*, *Equisetum scirpoides*, *Smilacina racemosa*, *Geocaulon lividum*, *Pedicularis racemosa*, *Betula occidentalis*, *Carex rostrata*, *Rosa* spp., *Viola* spp., *Smilicina stellata*, *Geum macrophyllum*, *Arnica latifolia*, *Galium trifolium*.
Flathead	Trail Creek Fen	USFS	4,230	Partial to full shade exposure on lower straight slope. Moist ecotonal margin on benchland above river. Soil texture: mostly rooted in moss layers, limestone in area. *Picea/ Equisetum arvense*, in ecotone with adjacent fen.	*Betula glandulosa*, *Cornus canadensis*, *Menziesia ferruginea*, *Linnaea borealis*, *Rhamnus alnifolia*, *Galium boreale*, *Habenaria obtusata*.
Lincoln	Jumbo Lake	USFS	3,350	Partially open exposure on straight slope. Saturated area in bottom adjacent to stream channel in glacially scoured trough. Silty soil with coarser fragments of precipitated calcium carbonate deposits underlying organic (moss) surface horizon. *Picea/ Equisetum arvense* habitat type.	*Betula papyrifera*, *Cornus stolonifera*, *Lonicera involucrata*, *Cornus canadensis*, *Equisetum laevigatum*, *Habenaria dilatata*, *Zigadenus elegans*, *Galium boreale*, *Cypripedium calceolus* var. *parviflorum*, *Cypripedium passerinum*.
Glacier	Lee Creek, GNP	Other	5,200	Calcareous fen. Partially shaded, saturated, straight lower slope.	*Picea engelmannii*, *Marchantia* spp., *Habenaria* spp., *Carex* spp., *Eriophorum* spp., *Betula* spp.
Powell	Ayres Creek Trail	USFS	5,200	Wet, partially shaded creek bottom fen.	Mosses, lichens, grasses.
Lincoln	White Creek Fen	USFS	3,700	On wet marl banks and hummocks in saturated soils on strongly calcareous parent. With sparse, stunted spruce trees.	*Picea glauca*, *Betula glandulosa*, *Carex utriculata*, *Parnassia fimbriata*, *Equisetum arvense*, *Juncus balticus*, *Carex vaginata*, *Chamalpericlymeum canadense*, *Aster* spp.
Lincoln	Spruce Swamp	USFS	3,500	In a rich spruce swamp with a small unnamed perennial stream running through. Area pristine.	Not reported.

pollinators in other members of the subtribe Orchidinae are bees, wasps, moths, and butterflies, with flies as common visitors also. Johnson et al. (2003) found that non-rewarding orchids may benefit from the presence of nectar-producing plants in the local habitat, particularly if they are similar in color. It is possible that *A. rotundifolia* is able to take advantage of the pollinators of *Platanthera* spp. (bog orchids) in the vicinity, even though the latter are white.

The pollen is contained in two pollinia per flower, composed of 50 to 100 subunits called massulae. Pollinators can remove one or both pollinia, and pollen may be deposited on a stigma as one or more massulae (Proctor and Harder 1994). A study of pollen load, capsule weight, and seed production found capsule weight predicted seed production in *Amerorchis rotundifolia*, while capsule weight and stalk height jointly predicted the number of seeds occupied by embryos (Proctor and Harder 1994). Embryo production was significantly greater in hand-pollinated flowers of *A. rotundifolia* than in those naturally pollinated, indicating fewer massulae are being deposited naturally and the species may be pollinator-limited in parts of its range. They also postulated that inbreeding depression may cause the widely disparate numbers and often high percentages of seeds without embryos.

Flowers of *Amerorchis rotundifolia* mature from the base of the inflorescence to the apex. The staggered development of the inflorescence and the protandrous development within individual flowers foster out-crossing. Self-compatibility has not been evaluated. It is hypothesized that in out-crossing orchid species, pollinator limitation could be evolutionarily stable if the correlation between seed production and seedling recruitment is sufficiently low, i.e., if the low levels of seedling recruitment per fruit are enough to overcome the cost of fruiting (Calvo 1993).

The occurrences of *Amerorchis rotundifolia* in the Rocky Mountain Region are in relatively close proximity to one another. Gene flow between populations may occur through either pollination or seed dispersal, but this has not been documented.

Dispersal mechanisms

The minute, light seeds of orchids can be dispersed on the slightest breeze and are easily transported over long distances. They offer no nourishment or attachments for animal dispersers. The orchid embryo is not differentiated into distinct organs, as are most plant embryos. The lack of a nutrient storage compartment is consistent with dependence on mycorrhizal fungi for seedling development, and may limit the length of time that seeds can survive without germination in nature.

Hybridization

Amerorchis rotundifolia is the only species within the genus, and it is not known to hybridize with members of any other orchid genera. Although it is a member of the subtribe Orchidinae, which is known to have many natural hybrids, its closest relative is in Europe and it is not known to hybridize (Dressler 1990).

Phenotypic plasticity

There is no evidence of phenotypic plasticity for *Amerorchis rotundifolia* in the Rocky Mountain Region as indicated in herbarium specimen review, collection labels, and survey records. The occurrences of *A. rotundifolia* in this Region are relatively close together and in very similar environments, situations that are not conducive to phenotypic plasticity. In more northerly parts of its range, the plant tends to be smaller (Luer 1975), possibly due to the more open habitat on the tundra. The size differences may represent the genetic differences of ecotype development, other forms, or phenotypic plasticity. Infraspecific ranks of *A. rotundifolia* that may indicate phenotypic plasticity are discussed in the Systematics and synonymy section.

Life history

The life history of *Amerorchis rotundifolia* can be characterized from *in vitro* data and studies of other orchid species. Terrestrial orchids have at least five life cycle stages: seed, protocorm, vegetative plant, flowering plant, and seasonally dormant plant. The life cycle diagram in **Figure 6** presents the stages and inferred transitions that are discussed here. The length of the stages and the species' longevity are not known. Population viability analysis cannot be conducted without more information on the stages, the associated mortality rates, and the transitions between them.

Seed viability and germination requirements

Rasmussen and Whigham (1993 as cited in St. Hilaire 2002) state that seeds of many orchids germinate in the spring after over-wintering in the soil. Snow cover at the time of seed dispersal is known to reduce germination in *Cypripedium calceolus* (Blinova 2002). Orchid seeds are very small and deficient in nutrition for the developing embryo, and mycorrhizal associations are essential to orchids for germination

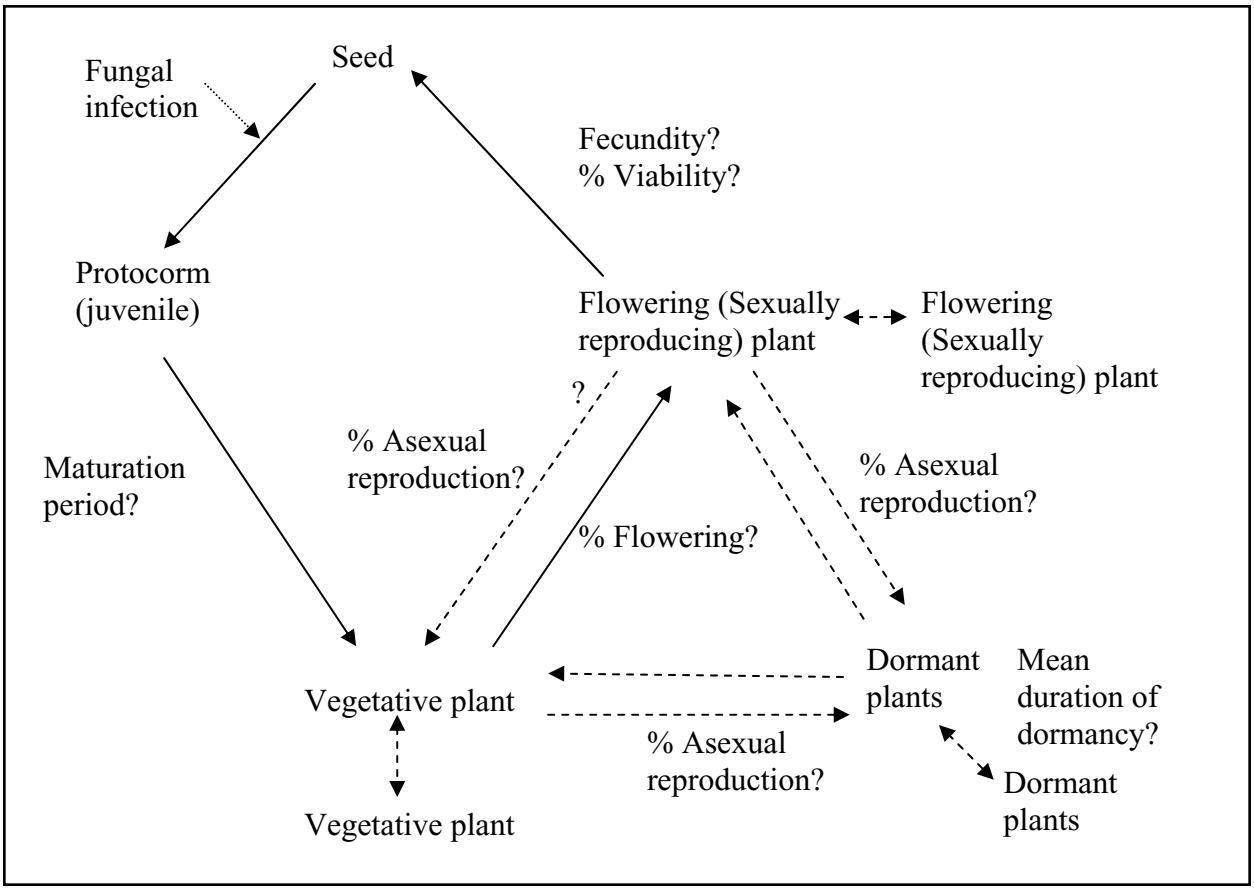

Figure 6. Schematic illustration of life cycle of *Amerorchis rotundifolia*.

and the survival of the subterranean seedling (Wells 1981). It is postulated that the texture of bryophytes may provide safe germination sites for *Amerorchis rotundifolia* and habitat for its mycorrhizal symbionts (St. Hilaire 2002).

Cryptic phase – protocorm

After germination of orchid seeds, an underground juvenile stage called the protocorm develops. The juvenile does not become a mature plant until it develops a perennating organ and basal leaf. Some orchids persist in this juvenile underground stage for one to fifteen years, during which time the protocorm is vulnerable to many negative environmental factors such as drought, water-logging, mechanical damage, and predation (Wells 1981). *In vitro* research by Lindén (1980) found that some orchid species do not tolerate strong light at the early stages of seedling and protocorm development. This study indicated that protocorms on growth media developed a shoot from one half to one year after germination and rhizomatous orchids developed several roots within one to two years after germination. Smerciu and Currah (1989) found that *Amerorchis rotundifolia* seeds germinated to the basal leaf stage on Fast's medium in 21 to 27 weeks, while other treatments did not perform much better than the seeds on the control cellulose agar. The components of this medium included $Ca(NO_3)_2$, NH_4NO_3, $MgSO_4$, KH_2PO_4, KCl, Fetrilon, sucrose, fructose, Pepton, yeast, and agar. It is not known if the short juvenile stage under these greenhouse conditions reflects development in the wild. Fungal hyphae substitute for roots in the developing juvenile, providing it water and soil nutrients (Wells 1981). The fungal symbiont also provides carbohydrates, so the juvenile is essentially a saprophyte.

Vegetative plant

Vegetative plants are represented by a solitary green leaf. Two sheaths encircle the leaf base, and the leaf is oriented upright to nearly horizontal (Shelly 1988). Emergence of the leaf marks maturation from the juvenile protocorm stage.

From the vegetative stage, the individual plant may develop into flowering stage, or presumably

develop into seasonally dormant stage or remain as a vegetative plant in subsequent years. In the course of vegetative reproduction, it is likely that new buds from rhizomes or stolons also develop into vegetative shoots before becoming flowering shoots or seasonally dormant.

Flowering plant

The flowering stage is but one of three mature phases, which also include the vegetative and seasonally dormant stages. It is not known when *Amerorchis rotundifolia* reaches reproductive maturity, but many native orchid species must be 12 to 16 years old before they flower, passing through the protocorm and vegetative plant stages (Stuckey 1967). Terrestrial orchids are iteroparous, and the cost of reproduction is compensated in part by not flowering every year. More detailed information on flowering is presented in the previous section on reproduction.

Cryptic phase – seasonally dormant plant

Dormancy among mature plants is common in many geophytic orchids (Shefferson et al. 2003), including *Amerorchis rotundifolia* (Gawler 1983 as cited in St. Hilaire 2002). Shefferson et al. (2003) assert two hypotheses on the function of dormancy. It may arise from an inability to compensate for inhospitable environmental conditions or herbivory as proposed by Tamm (1972) and Kull (1995), causing a loss of photosynthetic potential and increasing the likelihood of mortality. Conversely, it could be an evasion strategy that allows plants to conserve energy during times of potential environmental stress and to safeguard the population against catastrophic events (Shefferson et al. 2003). In *Cypripedium calceolus* var. *parviflorum*, dormancy was found to be a cost to survival, with dormant plants having a significantly higher mortality rate than either vegetative or flowering plants (Shefferson et al. 2003). It was also found that vegetative individuals were more prone to become dormant or to return to the vegetative state in subsequent years than were flowering individuals. One explanation of these findings is that flowering individuals may be in microsites with better resources. The Orchid family is distinct from most others in having seasonal dormancy that usually lasts longer than one year (Lesica and Steele 1994) and may be as long as 15 years (Tamm 1972).

Community ecology

Amerorchis rotundifolia is a habitat specialist that fits the pattern of a glacial relict as it occurs in the Rocky Mountain Region, because it only occurs with other disjunct and peripheral boreal species in a cool, moist, and stable habitat. The key resources for this species appear to be its moist, circumneutral substrate in a cool, sheltered setting (**Figure 7**). These resources are probably also needed by associated mycorrhizal fungi. This symbiotic relation is presented in **Figure 7** as a separate requirement, but the substrate and setting requirements of the fungi may in fact govern those of its host. The relationships are further described below.

Mycorrhizal relationships

Orchids are characterized by their mycotrophic habitat, numerous small seeds, and lack of endosperm (Cronquist 1988). The nutrition usually provided to a developing embryo by endosperm is provided instead by fungal hyphae. Mycorrhizal fungi are important for the germination and seedling establishment of *Amerorchis rotundifolia* in the wild. Following germination, orchid seedlings continue to be entirely mycotrophic until they are able to photosynthesize. Temperate terrestrial orchids are partly mycotrophic into adulthood (Zettler 1997). Terrestrial orchids utilize this alternative source of energy and nutrition during dormancy, and as a supplement during the growing season (Zettler 1997). Terrestrial orchids have been found to maintain mycorrhizal relationships throughout their life cycle.

Mycorrhizal associations in orchids may be unique in that the orchid appears to parasitize the fungus, providing little or no benefit to the fungus. Fungal hyphae proliferate within cortical cells forming extensive coils called “peletons”. The orchids digest the peletons at a controlled rate balanced between digestion and re-infection, perhaps as a way to control pathogenicity (Fitter and Moyersoen 1997). Orchids are effectively “fungus managers” (Zettler 1997). The relation is often referred to as symbiotic, without information on the benefit to the mycorrhizae.

The associated species of fungi and their specificity to orchid species are unknown (Arditti 1992). It is also unclear whether the same symbionts are required for germinating, maturing, and mature plants of the same species. Zelmer and Currah (1995) described the anamorph *Epulorhiza calendulina*, a member of the *Rhizoctonia* complex, isolated from the roots of *Amerorchis rotundifolia* in Calahoo, Alberta. Currah et al. (1987) identified another *Rhizoctonia* from an *A. rotundifolia* root in Edmonton, Alberta as the teleomorph *Ceratobasidium obscurum*. The symbiotic fungi in the *Rhizoctonia* genus are considered a “taxonomic nightmare” because most do not produce

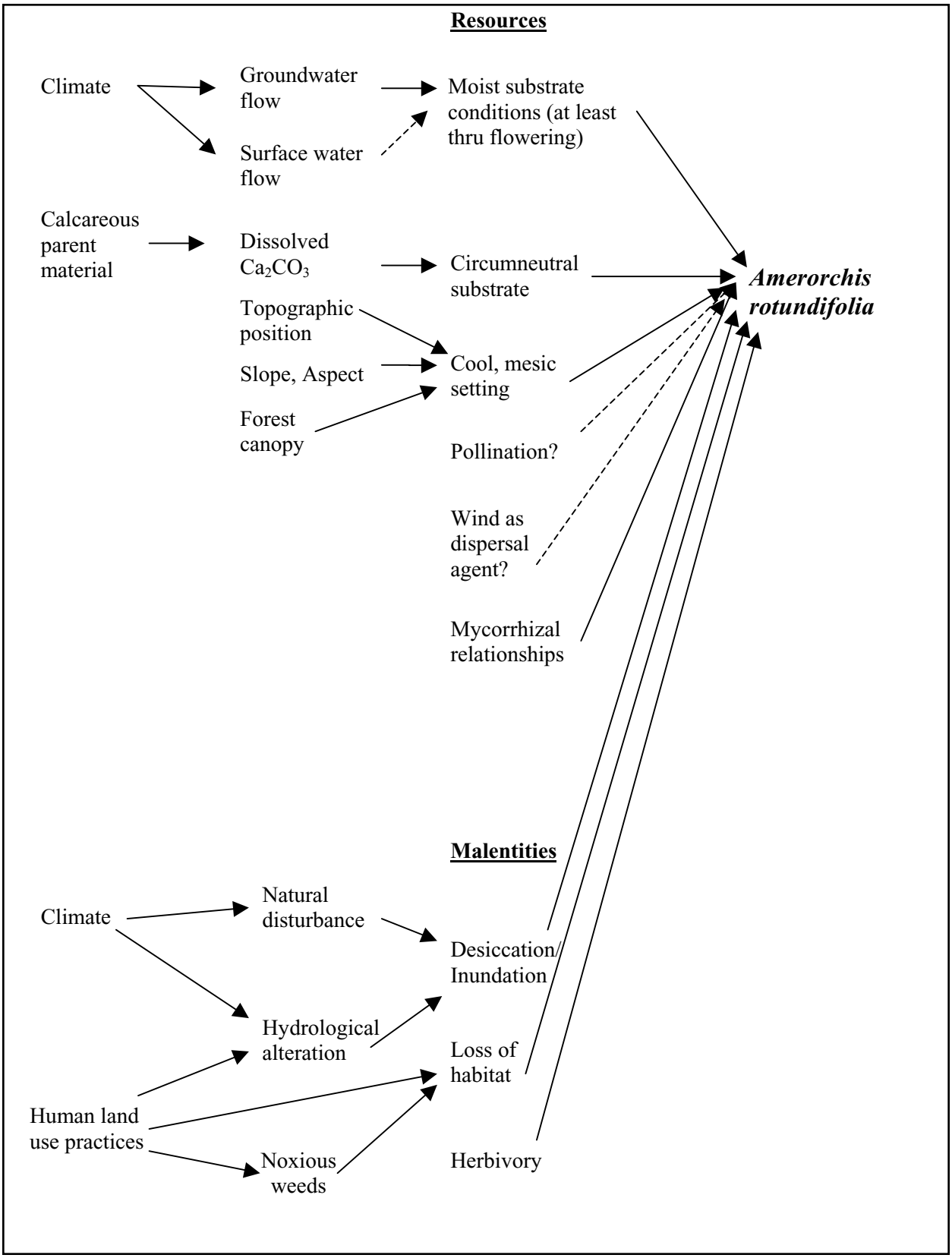

Figure 7. Envirogram of key resources for *Amerorchis rotundifolia* in the USDA Forest Service Rocky Mountain Region.

stable forms with fruiting structures in pure cultures (Zettler 1997). A hyphomycete, *Phialocephala fortinii*, was found on the root of *A. rotundifolia* in the Wagner Natural Area in Alberta. This species has also been described from the pseudomycorrhizae of two conifer species (Wang and Wilcox 1985 as cited in Currah et al. 1987) indicating a potential source of infection and a potential three-way species symbiosis.

Not all mycorrhizal fungi are species-specific, and in at least one case, the presence of a common orchid species provided a resource base for a symbiotic fungal species that was also hosted by a rare orchid species (Zettler and Hofer 1998). The presence of other orchid species in *Amerorchis rotundifolia* habitat may indirectly facilitate symbiotic relationships if they interact with the same fungal species.

Competition

Amerorchis rotundifolia grows in areas with low competition among vascular plants (Luer 1975). The vegetation cover and stature of occupied habitat are generally low. Despite this poor competitive ability, *A. rotundifolia* generally occurs in areas with high moss cover. Whether this association is needed for life history stages such as germination, maintenance of moist habitat conditions, or merely a coincidental pattern of distribution is not known. *Sphagnum* moss mats characterize *A. rotundifolia* habitat in Maine, but there are no *Sphagnum* species at Swamp Lake.

The occurrences of *Amerorchis rotundifolia* in the Rocky Mountain Region are considered disjunct and are at the southern extent of the species' range. This distribution may be that of a glacial relict, adapted to conditions that are no longer present or reduced in availability. The colonizing propensity and positive responses to disturbance that are evident in some orchid species have not been demonstrated for *A. rotundifolia* in general or at this outlying portion of its range in particular. Therefore, the species and its habitat may be more vulnerable in Wyoming to habitat change, including reduction of overstory, changes in hydrology and pH levels, and loss of mycorrhizal associations necessary for germination and survival, than in its core distribution.

Herbivory

There are no reports of herbivory on *Amerorchis rotundifolia* or evidence of browse on herbarium specimens, so any affects are hypothetical. However, many orchids are palatable to deer, rabbits, skunks (Stuckey 1967), and a species such as *A. rotundifolia* with an elevated inflorescence and single leaf might be expected to be vulnerable if it is palatable. That is, *A. rotundifolia* consolidates all photosynthetic activity into a single leaf and all reproductive activity into a single inflorescence. The plant does not have subterranean storage organs, so it would be difficult or impossible for it to replace a leaf or a flowering stalk that has been removed. In addition, wildlife may affect the species by altering its habitat or biology. Domestic stock grazing is discussed in detail in the following sections on Threats and Conservation.

CONSERVATION

Threats

Rocky Mountain Region threats

Amerorchis rotundifolia is restricted to lower montane elevation settings that are readily accessible in the Rocky Mountain Region. Both occurrences are located within one mile of Wyoming Highway 296, so the species' habitat on public lands is readily accessible for use and on nearby corridors or private lands available for development. Swamp Lake has the largest occurrence of *A. rotundifolia* and lies within Management Area 9A in the Forest Plan (Johnston 1987), with emphasis on riparian area management. The road that passes through the south side of Swamp Lake Botanical Area is closed to motorized use. The other two outlying Swamp Lake sub-occurrences and the Camp Creek occurrence are located on National Forest System land managed for multiple use.

Fertig and Jones (1992) suggested that the pattern of vegetation types at Swamp Lake may be controlled in large part by depth of water, so changes in the hydrology probably constitute the greatest threats to the survival of rare plant species in Swamp Lake. Eastman (as cited in St. Hilaire 2002) notes that any activity that impedes the lateral flow of groundwater is a threat to *Amerorchis rotundifolia*. Disruptive changes could result from a variety of events, both natural and human-induced.

There is evidence that the hydrology of Swamp Lake may have been altered. The above assertion by Fertig and Jones gathers support from Heidel and Laursen (2003) who provide several indications of increased water depth following highway re-construction and accompanying re-positioning of a culvert at the outflow arm of Swamp Lake higher than the streambed it replaced in 1987. Inundation of habitat that once supported *Salix candida* (hoary

willow) and *Carex diandra* (lesser panicled sedge), both Rocky Mountain Region sensitive species and Wyoming species of special concern, was noted at the outflow arm in section 11. The first collection of *Amerorchis rotundifolia* from Swamp Lake (*Evert 7841*) was reported from both sections 11 and 14. Section 11 includes the outflow arm, but *A. rotundifolia* has not been found in section 11 in subsequent inventories by Fertig.

The removal of forest cover by an intense fire in 1988 that killed both overstory and understory vegetation throughout much of the watershed, subsequent timber harvest of snags, and unusually high precipitation levels in the post-fire years all probably affected hydrological conditions. The entire upper slopes at Cathedral Cliffs burned in the crown fire, significantly reducing the forested cover that was south of Swamp Lake. Refer to the photograph of the unburned landscape in **Figure 4**.

Peat meadows on private lands due west of Swamp Lake have been ditched and drained for agricultural use. The meadows feed into Corral Creek and into Swamp Lake and may carry agricultural pollutants. In addition, noxious weed surveys on an adjoining tract have documented large, expanding occurrences of Canada thistle (*Cirsium arvense*), bull thistle (*C. vulgare*), and musk thistle (*Carduus nutans*) associated with these developments (Kent Houston personal communication 2003). The effects of upstream ditching and draining, upslope wildfires, and downstream road construction that elevated the outlet level may interact with one another to produce a cumulative effect that is greater than the separate effects.

The Oliver Gulch sub-occurrence of *Amerorchis rotundifolia* was burned in an intense fire that killed both overstory and understory vegetation in 1988. All upslope forest cover and most of the tree cover in the wetlands were killed. Accelerated surface run-off or less stable groundwater flows higher up in the Corral Creek watershed may also have impacted this population even where the tree canopy survived. The open terrain also makes the wetland habitat more accessible to livestock, where their trampling if not grazing further affects the species.

A survey of the Camp Creek occurrence was completed in 2004. This occurrence is located above the highway, but its hydrology is not apparently affected by the highway. There are signs of historical removal of individual trees adjoining the habitat, but there are no associated surface disturbances or alterations evident. The habitat lies near a meadow opening that is grazed, but signs of livestock use and accompanying habitat effects were scarce in the forested wetland.

Grazing, recreational activity, and timber harvest have been identified as potential and current threats in similar habitat settings of the USFS Northern Region (Shelly 1988, Jones 2002). The Swamp Lake occurrence lies within a special use permit area for pasturing horses. However, the far western end of the occurrence where *Amerorchis rotundifolia* is most concentrated is fenced off from grazing (Kent Houston personal communication 2003). The Oliver Gulch sub-occurrence had the greatest amount of hummock formation due to trampling of all places where *A. rotundifolia* occurs, as noted in 2004 survey by Erwin Evert. In addition, cattle are trailed across the northern boundary of Swamp Lake, on the side opposite from the occurrence. Grazing has been identified as a current threat to the species in Montana (Shelly 1988) whether due to direct grazing, habitat trampling, or other habitat degradation. Wet spruce swamps filled with *Equisetum arvense* offer low forage and are not likely to receive concentrated grazing, but the shelter and accessibility to water associated with this setting mean that any grazing in the area is likely to bring stock into *A. rotundifolia* habitat with some level of habitat effects.

The Botanical Area designation and riparian management area guidelines preclude logging of *Amerorchis rotundifolia* habitat at Swamp Lake. However, salvage logging of snags was conducted above Swamp Lake after the 1988 wildfire. Logging in directly adjacent areas could impact the *A. rotundifolia* populations. Loss of the tree canopy to wildfire in occupied habitat can result in complete eradication of populations due to increased heat and aridity. Loss of the tree canopy above occupied habitat can increase surface runoff and decrease percolation, modifying the hydrologic regime. A reseeding program included a non-native species, *Astragalus cicer* (cicer milkvetch), that has spread with at least a few plants to the Swamp Lake margins. The fire may also foster the spread of Canada thistle insofar as the loss or reduction of the woody vegetation to wildfire may expose bare ground and improve conditions for establishment of wind-borne Canada thistle seeds.

In the USFS Northern Region, riparian area guidelines establish buffers around peatland habitat for 8 to 30 m (26 to 98 ft.) (USDA Forest Service 1991 as cited in Jones 2002). The effects of timber harvest and road building on vascular plant diversity and soil nutrient levels in peatlands were evaluated by Jones (2002) on the Kootenai National Forest in northwestern

Montana. Two *Amerorchis rotundifolia* occurrences were among the 12 study sites. Jones (2002) concluded that upland land uses may be increasing nutrient loadings in peatlands at distances of up to 100 m (328 ft.) from peatland boundaries. This in turn could adversely affect species composition and rare peatland species populations. The results are presented as preliminary and would be expected to vary by topographic setting and other conditions that were not fully represented in the sample size. However, they provide a starting point for management planning.

Recreational activities are not known to affect *Amerorchis rotundifolia* in the Rocky Mountain Region. Road closures preclude motorized travel south of Swamp Lake within Special Botanical Area boundaries. Elsewhere, the localized hunting camp use and pack animal use at trailside springs were identified as potentially impacting the species at select Montana occurrences (Shelly 1988).

Fertig and Jones (1992) state that "due to its beauty and rarity, *Amerorchis rotundifolia* is vulnerable to over-collecting by orchid enthusiasts." For this reason, they recommend that information on the location of this species at the Swamp Lake Botanical Area be considered "data sensitive" to prevent exploitation by poachers. All records for this species are treated as sensitive by the Wyoming Natural Diversity Database. The USFS is expected to release this type of information subject to a Freedom of Information Act request unless a biological evaluation can demonstrate that the release of the information will lead to a trend toward federal listing.

It is important to note that not all threats are human-induced. Beaver activity and windthrow can open a canopy just as effectively as timber harvest, and a flooding event fostered by beavers could inundate existing occurrences. Therefore, it is important to maintain as much occupied habitat as possible.

Rangewide threats

Many of the threats that have been identified for *Amerorchis rotundifolia* are similar to those that pressure other rare plants and, in particular, orchid species. The life history and exacting habitat requirements of members of this group render them vulnerable to changes in land use and hydrology (Sheviak as cited in St. Hilaire 2002). In some cases, a particular activity may favor one (or more) species at the expense of another. St. Hilaire (2003) points out an increase in populations of *Cypripedium reginae* and *C. parviflorum* in response to opening the canopy along power lines. *Amerorchis rotundifolia*, however, completely disappeared from the opening and, after ten years, had not reappeared. Some of these changes may affect *A. rotundifolia* insofar as they affect the associated mycorrhizae. In any case, *A. rotundifolia* is a habitat specialist of cool, sheltered habitats at the southern ends of its distribution.

St. Hilaire (2003) identifies a number of commercial operations that deal in the harvest and sale of rare orchids. Elsewhere in its range, the Alaskan Flower Essence Project specifically targets *Amerorchis rotundifolia* as an herbal remedy (Alaska Essences 2001), harvesting "healthy flowers at the peak of their blossoming cycle," making it extremely at risk to poaching. Commercial harvest of plant material is regulated on National Forest System lands so as to be sustainable at some level. It is possible that any collecting pressure on *A. rotundifolia* is unsustainable.

Conservation Status in the Rocky Mountain Region

Amerorchis rotundifolia is a habitat specialist with no known colonizing propensity or positive response to disturbance, and it fits the pattern of a glacial relict species as present in the Rocky Mountain Region. It is vulnerable to direct and indirect impacts on its habitat, though population trends are not known. Water levels were elevated at Swamp Lake due to highway reconstruction in 1987 when a culvert level was installed at the lake outlet higher than previous streambed levels. Wildfire, ditching, and draining probably increased inflow into Swamp Lake. Wildfire removed tree cover in the Oliver Gulch sub-occurrence, a likely reduction in habitat quantity and quality. There are no known past or prospective impacts at the Camp Creek occurrence, though habitat suitability could be affected by management actions along the nearby highway and meadow as well as direct habitat alterations.

Swamp Lake Botanical Area has the most extensive and probably the largest occurrence of *Amerorchis rotundifolia* in the Rocky Mountain Region. It also lies within Management Area 9A in the Forest Plan (Johnston 1987), a management unit emphasizing riparian area management. The accompanying guidelines for riparian area management and for special botanical area management provide a protection framework for maintaining the unique wetland plant species and vegetation of Swamp Lake. A re-census and detailed mapping effort would help to evaluate whether guidelines are being met.

The Camp Creek occurrence is not mapped within the riparian area management zone. It may have been omitted because of its small size, but it does warrant consideration.

Potential Management in the Rocky Mountain Region

The primary element necessary to maintaining the species in a healthy condition is sheltered, stable habitat. Thus, effective management would focus on maintaining or reinstating sheltered, stable habitat. Inventory and monitoring of the species and its habitat are prerequisites.

Revision began on the Shoshone National Forest Land and Resource Management Plan in 2004, and the placement of both occurrences within Management Area 9A or some comparable riparian management zone warrants consideration. It might be appropriate to construct an exclosure at the Oliver Gulch sub-occurrence. The small sub-occurrence that is north of the highway at Swamp Lake is in dense timber but close enough to the margins of a proposed prescribed burn unit that the margins might be shifted without substantial change to management objectives. In general, steps for assessing the potential impacts are a key part of sensitive species policy effectiveness, to be followed by remediation if appropriate and as feasible.

Tools and practices

Census of known occurrences of *Amerorchis rotundifolia* is needed, including mapping of all clusters or sub-occurrences. It would be valuable to identify any signs of decline or questions about stability such as aborted fruits, heavy browse, disease, signs of stress, invasive species, low numbers, or possible declines from previous census estimates during surveys.

A review of monitoring needs at Swamp Lake and elsewhere is also needed, with attention to monitoring and management objectives (Menges and Gordon 1996, Elzinga et al. 1998). Wells (1981) suggests careful monitoring of orchid populations on an annual basis, proposing a demographic technique that enables the same individuals to be recorded and examined each year. Such monitoring would provide the basic facts about the population from which predictions can be made. It would be most efficient to complete a detailed one-time census and mapping before considering repeated annual census or demographic monitoring. If the census tally of flowering stems is significantly lower than the 1996 estimate of 200+ stems (e.g., below 175), or if the climate conditions in the year of census are unusual, then repeated annual census would be needed to determine the reason for the apparent decline. Demographic monitoring would be needed in combination with disturbance history research if the census tally of flowering stems is significantly lower than the 1996 estimate.

Systematic inventory of *Amerorchis rotundifolia* is needed throughout the seven-mile valley segment where it is present, and the likelihood of potential habitat elsewhere should also be evaluated. An inventory might be conducted in combination with a one-time census at Swamp Lake. Techniques for peatland inventory have been tested in the Medicine Bow National Forest that may address *A. rotundifolia* habitat on the Shoshone National Forest (Heidel and Thurston 2004). The techniques include use of soils maps (histosol units) and National Wetlands Inventory maps (saturated wetland types), identification of polygons of potential habitat on aerial photos, and direct field evaluation.

Information and Research Needs

Fertig and Jones (1992) and Heidel and Laursen (2003) ascertained several research needs at Swamp Lake. Because there are many sensitive species in this area, many of these research needs would apply to the preservation of the various species collectively and the uniqueness of the plant community as a whole. Four of the five core research tasks identified by Heidel and Laursen (2003) pertain directly to *Amerorchis rotundifolia* information and research needs. They are presented below, with emphasis on *A. rotundifolia*, reiterating some of the inventory and monitoring objectives described previously.

1. Re-census and precisely map rare plant sub-occurrences and clusters and record accompanying habitat conditions. Identify any signs of decline or questions about stability such as aborted fruits, heavy browse, disease, signs of stress, invasive species, or low numbers. This is an elaboration on this research need identified by Fertig and Jones (1992) to re-survey the Swamp Lake Botanical Area at three-year intervals for rare plant distribution and numbers.

2. Conduct systematic inventory of *Amerorchis rotundifolia* in the Clarks Fork Ranger District using aerial photographs, remote-sensing, and ground-truthing. This is needed to address the species' status throughout the Shoshone

National Forest, and it might be made a component of peatland features inventory.

3. Evaluate the alteration to Swamp Lake hydrology before and after the 1988 fire by assembling all available surface and aerial photography for direct comparisons to document change, evaluating tree mortality in the wet spruce forest, and monitoring water levels at critical places and times. This is an elaboration of the two research needs identified by Fertig and Jones (1992) to re-map the vegetation pattern (with the benefit of higher resolution aerial photography), and to establish stations for measuring water levels for evidence of habitat changes.

4. Expand information on species' habitat and microhabitat. Conduct vegetation sampling to document micro-topography patterns present in select vegetation types and associated environmental attributes including the wet spruce forest, with particular attention to water chemistry, non-native species distribution, and dominant moss species.

The same research needs and tasks generally pertain to the Camp Creek population, though there is no evidence of landscape alteration from the 1988 wildfires or impeded surface water flow.

If surveys at the known sites suggest a marked change in distribution or plant numbers, then an annual monitoring program would be appropriate. If the results of the annual monitoring results document decline, then a study program that includes demographic monitoring would be warranted, taking into consideration all available disturbance history documentation and habitat requirement information. The Oliver Gulch sub-occurrence of Swamp Lake may warrant census and microhabitat documentation that addresses the effects of livestock grazing and trampling.

At least three other basic information and research needs were identified in preparing this assessment, but the priority for pursuing them depends on the outcomes of the previously-described research. The pollination vectors for *Amerorchis rotundifolia* are not known. If there is a low incidence of fruiting, then they may be important to identify. The mycorrhizal symbionts are not known. If there is reason to expect that mycorrhizae may be lost with habitat change and degradation, as determined by consulting mycologists, and if there is reason to expect that long-term habitat change is underway, then it would be important to identify them. Life history stages are not known for the species. If a study program with demographic monitoring is identified as a priority, then a life history component to the study would help to elucidate results and generate additional valuable data. The recommendations presented in this section represent a process rather than a start-to-finish prescription for developing effective species conservation.

DEFINITIONS

Anamorph – Asexual form of fungi (Lincoln et al. 1998).

Anthesis – The period during which a flower is fully expanded and functional, ready to shed or receive pollen.

Bog – A peatland deriving water and nutrients only from the atmosphere; but this term is used colloquially in citations that refer to saturated wetlands in general.

Calcareous – Rich in calcium bicarbonate.

Capsule – Dry dehiscent fruit with more than one carpel.

Clade – A group of all the organisms that share a particular common ancestor and therefore have similar features. The members of a clade are closely related to each other.

Diploid – Having a double set of homologous chromosomes, typical of many plant organisms derived from fertilized egg cells.

Disjunct – Distinctly separate, in the case of a discontinuous range in which one or more populations are separated from other potentially interbreeding populations by sufficient distance to preclude gene flow between them. In Wyoming, this term is usually reserved for populations separated over 300 miles (483 kilometers) from their core distribution.

Endosperm – The nutritive tissue formed within the embryo sac of most seed plants.

Fen – A type of peatland that receives significant inputs of water and dissolved solids from a mineral source, such as runoff from mineral soil or groundwater discharge.

Form – The lowest category in botanical classification, representing any minor variant of a species.

Genet – A genetically homogeneous unit, usually referring to a plant with only one shoot.

Glacial relict – A species that has survived from a Pleistocene fauna or flora, typically in a restricted location or habitat.

Glabrous – Smooth, lacking hairs.

Hypha – Thread-like filament that is the structural unit of many fungi.

Inbreeding depression – Reduced fitness and vigor by increased homozygosity as a result of inbreeding in a normally outbreeding population.

Iteroparous – Flowering more than once in the life cycle.

Lip – The lower median petal in flowers of the orchid family, one of three petals which is usually larger and different in shape from the other two.

Marl – A deposit of calcium carbonate resulting from biotically induced changes in the carbonate – bicarbonate balance in freshwater basins.

Massula – A packet of pollen in subunits that comprise the pollinium.

Mycorrhizae – The association between a fungus and the root system of a vascular plant.

Occurrence – A spatially explicit record of a species supported by survey and/or specimen documentation. Occurrences are delimited using best professional judgment of what is likely to constitute a population, based on likelihood of gene exchange across suitable and unsuitable habitats, as conditioned by habitat connectivity.

Peat – An accumulation of unconsolidated, partially decomposed plant material found in more or less waterlogged habitats of fen or bog.

Peatland – Any waterlogged area containing an accumulation of peat 30 cm or more thick.

Peleton – Tightly coiled hyphal structure of fungi.

Perennial – Persisting more than two years.

Petal – An outer, usually conspicuously-colored flower part.

Plasticity – The capacity of an organism to vary morphologically or physiologically as a result of environmental change.

Pollinium – A coherent cluster of many pollen grains, transported as a unit in pollination (Arditti 1992).

Population – A group of individuals with common ancestry that are much more likely to mate with one another than with individuals from another such group (World Resources Institute 1992).

Protandrous – A flower in which the pollen is shed before the stigma is receptive.

Protocorm – An ovoid or top-shaped mass of cells formed upon germination and growth of the orchid embryo, producing root hairs and living underground.

Raceme – An indeterminate inflorescence with single flowers on pedicels arranged along the rachis.

Ramet – A member or modular unit of a clone that may follow an independent existence if separated from the parent plant.

Rank – NatureServe and the Natural Heritage Program use a ranking system (Internet site: http://www.natureserve.org/explorer/granks.htm). A rank of "G5" indicates that *Amerorchis rotundifolia* is "demonstrably secure globally" though it may be very rare and local in parts of its range. A rank of "S1" indicates that it is critically imperiled at the state (sub-nation) level because it is very rare or local, or because of some other factor(s) making it very prone to extirpation from the state (NatureServe 2003).

Recruitment – The input of new members into a plant population by reproduction.

Rhizome – An elongated, underground stem.

Seasonally dormant – Persistence of the mature plant underground through an entire growing season.

Self-compatible – Capable of forming viable seeds from the transfer of pollen from anther to stigma of the same flower or to another flower on the same plant.

Sepal – Outermost flower structure which usually encloses the other flower parts in the bud.

Spur – An elongate modified petal structure that projects behind the flower, in a funnel form that has the capacity to hold nectar.

Swamp – A forested wetland, flooded during part of the year or with moving groundwater, well aerated, rich in minerals, and storing little or no peat.

Symbiosis – The relationship between two different organisms living together.

Stolon – A stem that grows horizontally along the ground surface.

Teleomorph – Asexual form of fungi

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