Propagation and population re-establishment for tall bugbane (*Cimicifuga elata*) on the Salem District, BLM

Second year report
October 2001

Thomas N. Kaye
Institute for Applied Ecology

A Cooperative Challenge Cost Share Project funded jointly by:

Salem District,
Bureau of Land Management
and
Institute for Applied Ecology

PREFACE

This report is the result of a cooperative Challenge Cost Share project between the Institute for Applied Ecology (IAE) and a federal agency. IAE is a non-profit organization dedicated to natural resource conservation, research, and education. Our aim is to provide a service to public and private agencies and individuals by developing and communicating information on ecosystems, species, and effective management strategies and by conducting research, monitoring, and experiments. IAE offers educational opportunities through 3-4 month internships. Our current activities are concentrated on rare and endangered plants and invasive species.

Questions regarding this report or IAE should be directed to:

Thomas N. Kaye
Institute for Applied Ecology
phone: 541-753-3099
fax: 541-753-3098
email: kayet@peak.org

Mail:
P.O. Box 758
Philomath, Oregon 97370

Street:
4550 SW Nash
Corvallis, Oregon 97333

ACKNOWLEDGMENTS

We wish to thank Suzanne DiGiacomo, Ron Pace and Kurt Heckeroth (BLM) for their assistance with finding the study sites and conducting field work. Christina Nelson, Genii Masluk, Lauren Spaderna and Djibo Zanzot (IAE staff) assisted with field work and field organization.

EXECUTIVE SUMMARY

Title: Propagation and population re-establishment for tall bugbane (*Cimicifuga elata)* on the Salem District, BLM

Background:

Tall bugbane is a Bureau of Land Management Special Status species that occurs in forest habitats west of the Cascade Range in British Columbia, Washington, and Oregon. To maintain the viability of this species, an interagency Conservation Strategy (Wogen et al., 1996) calls for monitoring throughout the plant's range on USFS, BLM, and ACOE lands in Oregon and targeted research on population enhancement techniques.

Objectives:

The specific objectives of this cooperative project were to develop propagation techniques for tall bugbane and re-establish the species at the Humdinger site. The propagation phase focused on developing germination techniques for the species and attempting greenhouse cultivation. Field transplanting for re-establishment centered on evaluating fertilizer as a tool to improve transplant success, contrasting spring and fall transplanting seasons, and comparing growth of plants from two source populations.

Findings:

1. Seed germination of this species requires warm stratification (15°C/25°C) for 2 weeks followed by cold stratification (5°C) for 3 months. After that, seeds placed in an environment of alternating warm temperatures (15°C/25°C) germinate up to 96%, depending on the source population.
2. Plants grown from seed in potting soil in a greenhouse environment grow well and have high survival. A potting medium amended with commercial mycorrhizae, however, yielded poor survival.
3. Survival of field transplants at the Humdinger site was significantly affected by season of planting, with fall (2000) transplants having higher survival (82%) into the second season of growth (2001) than spring (2000) transplants (59%).
4. Herbivory by deer and mountain beaver was very high. Most plants were damaged to some degree; on average, 27% to 80% of plant tissue was eaten, depending on seed source, season of planting and whether or not plants were fertilized.

Conclusions:

1. Tall bugbane can be cultivated in a greenhouse environment (*ex situ*).
2. Plants may be out-planted to field sites, but damage from herbivores may be high.
3. Continued monitoring to document second and third year survival will benefit this project.
4. Further research is needed to explore the success of techniques (such as application of pepper extract) to reduce herbivory on transplants and increase plant survival and growth.

INTRODUCTION

Cimicifuga elata, tall bugbane (Figure 1), is listed as a sensitive plant species by the U.S. Forest Service (USFS) and Bureau of Land Management (BLM). It is considered endangered and threatened by Oregon Natural Heritage Program (1998). *Cimicifuga elata* is known to occur in British Columbia and west of the Cascade range in Washington and Oregon. Oregon populations of *C. elata* occur on land managed by USFS in the Willamette, Mt. Hood, Umpqua, and Rogue River National Forests and in the Salem, Eugene, Roseburg, and Medford BLM Districts. To maintain the viability of this species, an interagency Conservation Strategy (Wogen et al., 1996) calls for monitoring throughout the plant's range on USFS, BLM, and ACOE lands in Oregon and targeted research on population enhancement techniques.

Figure 1. *Cimicifuga elata* Nutt. (tall bugbane) is a 1-2 meter tall herbaceous perennial with divided leaves and sprays of white, apetalous flowers.

Previous cooperative studies by BLM, USFS, and Oregon Department of Agriculture (ODA) evaluated the short-term effects of timber harvest on the species, and resulted in the establishment of long-term monitoring plots at several sites (Kaye and Kirkland 1999). One population, known as "Humdinger" (T5S R7W S21, NE1/4 SW1/4), occurred in a tree plantation that formed a dense canopy which shaded the forest floor. Over time, this population declined to very low levels (Larry Scofield, personal communication). However, this site was recently restored to a more open forest structure suitable for tall bugbane. The purpose of this project is to re-establish tall bugbane to the Humdinger location by collecting and germinating seeds, then transplanting greenhouse-grown plants to the site. This is a multi-year process and this report describes the results of the first two years: germination tests and first season field growth. Germination tests with these seeds were performed under a challenge cost share project between ODA and Salem BLM. The Institute for Applied Ecology (IAE) is continuing this research and grew seedlings in greenhouse facilities and conducted out-planting and monitoring. Information from prior years of this project is reported elsewhere (Kaye 2000), but is repeated here for completeness. Data on population re-establishment will provide useful information for the existing Conservation Strategy for the species.

OBJECTIVES

The specific objectives of this cooperative project were to develop propagation techniques for *Cimicifuga elata* and re-establish the species at the Humdinger site. The propagation phase focused on developing germination techniques for the species and attempting greenhouse cultivation. Field transplanting for re-establishment centered on evaluating fertilizer as a tool to improve transplant success and comparing growth of plants from two source populations.

STUDY SITE

The Humdinger site is located northwest of Willamina, and is accessed via the Tindle Creek Road. From Willamina Creek Road (paved), take Tindle Creek Road (gravel) west 1.9 mi, veer left, go another 1.2 mil, veer left again, then proceed another 0.8 mi and veer left once more. After a further 0.7 mi, park at the end of the road. The total distance from the start of Tindle Creek Road is 4.6 mi. The site was clearcut then burned (2 years later?) in late September 1988.   The site did not burn hot except in concentrations of slash, although 95% of the unit had some fire. The site was replanted, but in early 1999 part of the plantation in the area of the former *Cimicifuga elata* population was cut down to open the habitat to big leaf maple (*Acer macrophyllum*) growth. *Acer macrophyllum* is a primary habitat indicator for *C. elata* over the majority of its range. After this work, we discovered several surviving *C. elata* plants in the plantation, the majority non-reproductive.

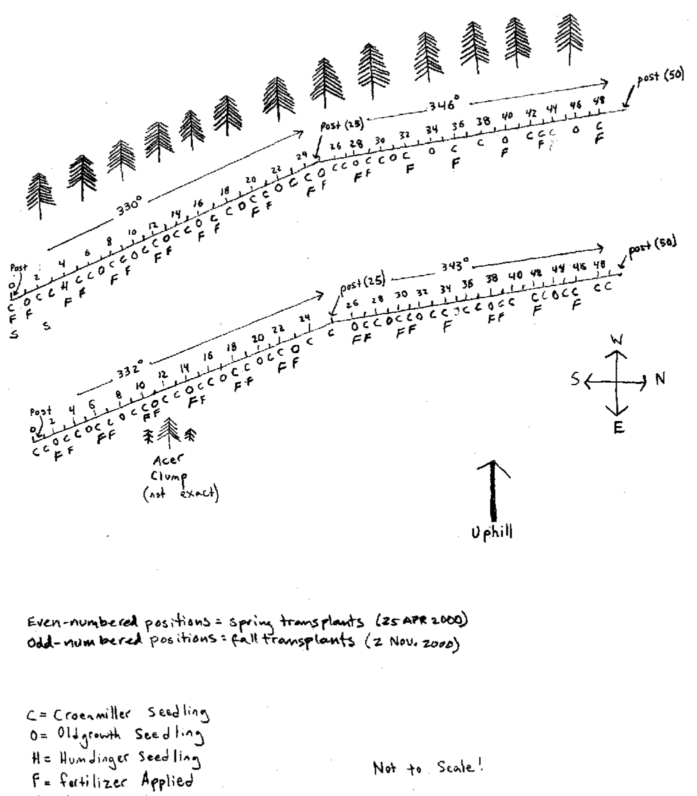

Figure 2. Planting layout at the Humdinger site.

SEED GERMINATION TESTS

Germination methods: Seeds were collected from three individual plants at the Humdinger site (Yamhill County) and two additional locations in the OSU Research Forests near Corvallis (Benton County), Oregon. The three plants at Humdinger produced few seeds (about 300), and these were used in the germination tests. At the OSU Research Forest, the two sites were Cronemiller Lake and Old Growth Trail, where several reproductive plants were sampled and many seeds were available.

Two treatments were applied to the *Cimicifuga elata* seeds:

1) cold stratification, and
2) warm stratification for 2 weeks followed by cold stratification.

These tests were initiated on 4 October 1999. Cold stratification was conducted at 4°C and warm stratification was at alternating 15°C/25°C. For seeds from Humdinger, one sample of 150 seeds was used for each treatment. For the other sites, 5 replicate samples of 50 seeds each were used. Initial germination of the radicle occurred in mid-December, 8-10 weeks after the germination trials were begun. However, prolonged cold treatment is required to completely break dormancy in some *Cimicifuga* species due to epicotyl dormancy of embryos (Baskin 1985). Therefore, total germination was recorded in early February of 2000, just prior to greenhouse propagation.

Germination results: Warm stratification was required to break dormancy of seeds of *Cimicifuga elata*. With cold stratification only, no seeds germinated. However, with two weeks of warm stratification at 15°C/25°C, mean germination was 96% with seeds from Cronemiller Lake and 83% from Old Growth Trail (Figure 3). Seeds from the Humdinger source yielded only 23% germination, suggesting that either seed viability was lower from this site or dormancy was not completely broken by the treatments.

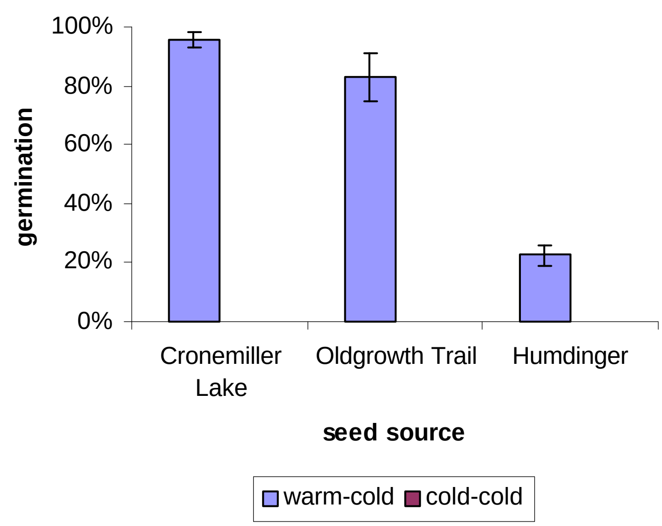

Figure 3. Germination response of *Cimicifuga elata* seeds exposed to different stratification temperatures.

PLANT PROPAGATION

In February 2000, seeds were removed from the germinator and placed in pots in a heated greenhouse. Most plants were potted (4 inch pots) in a standard potting soil (1 part loam, 1 part pumice, 1 part sand and 2 parts peat), while a smaller number were placed in an experimental medium of 4 parts potting soil and 1 part mycorrhizal mix (from BioTerra). Mortality in the mycorrhizal soil was very high (>75%), but most plants (>80%) survived in the plain potting soil. The high mortality in the mycorrhizal soil appeared to be the result of damping-off disease, which is caused by fungal pathogens. Apparently, the mycorrhizal soil created an environment strongly favorable to fungal pathogens and appeared to be unnecessary and unwarranted for propagating *Cimicifuga elata*, at least at the seedling stage.

Half of the surviving plants were grown in pots until 25 April 2000 at which time they were transplanted to the Humdinger site (see below). The remaining plants were transpotted into 1 gallon pots and were grown in an irrigated/shaded area all summer, after which they were transplanted to Humdinger in November 2000.

FIELD PLANTING

Planting methods: Field planting occurred on 25 April and 2 November 2000 at the Humdinger site. Weather conditions at the time and immediately following both transplanting events were very rainy and the soils were saturated, so plants were not additionally watered. A total of 50 plants were placed at the site in April, 34 from Cronemiller and 15 from Old Growth Trail. In November, 43 plants were planted, 33 from Cronemiller and 10 from Old Growth Trail. Due to poor germination and seedling survival, only one seedling grown from seed collected at Humdinger was available to plant in April. Most spring transplants were at the stage where their first tripartite leaves were beginning to grow, while those transplanted in the fall had 3-4 full leaves each. All plants were randomly assigned to two 50 meter rows that ran across the slope in a roughly SSE to NNW direction. The transects ran parallel to one another about two meters apart (see Figure 3 for planting layout). Each end was marked with a hollow aluminum pole about two feet high with a yellow flag at the top. An aluminum pole with a yellow flag was also placed at the 25 meter mark where there was a slight bend in each of the transects. Seedlings were planted at every meter, starting at 0 meters on the southern end of the transect and ending at 49 meters on the northern end of the transect. A square blue flag was placed roughly 10 cm to the south of each transplant.

The upper most (westernmost) transect ran just below the line of trees on the ground that were felled and not removed. The bearing from the southern end, north to the kink at 25 meters was 330° from the kink to the northern end bearing was 346°. Fertilizer (2 teaspoons of Osmocote 14-14-14 slow release) was applied to every other seedling starting at 0 meters. On 28 August 2000 we revisited the site and measured each transplant, recording survival, number of leaves, largest leaf length and width (to calculate leaf area), and percentage herbivory of leaves by deer. This sample was repeated in 2001 on 28 June and 5 September to determine second year survival, growth and herbivory.

Planting results: Herbivory by deer was very high on the transplants, averaging 60% of the leaf material in 2000 and 51% in 2001, and ranging as high as 100% in both years. This intensity of herbivory made some plant size measurements difficult to take, but we recorded these measurements from whatever plant material remained. Herbivory of transplants differed among seed sources, planting dates, and fertilizer treatments in a complex three-way statistical interaction (Figure 4). For example, herbivory was greater on fall transplants (fertilized or not) and fertilized spring transplants than non-fertilized spring transplants from Cronemiller Lake. This pattern was different on plants from Old Growth Trail, which had higher levels of browsing on fertilized fall and non-fertilized spring transplants than other types. The reasons for these differences are not known, but it is clear that herbivory is a common and intense problem for tall bugbane transplants at the Humdinger site.

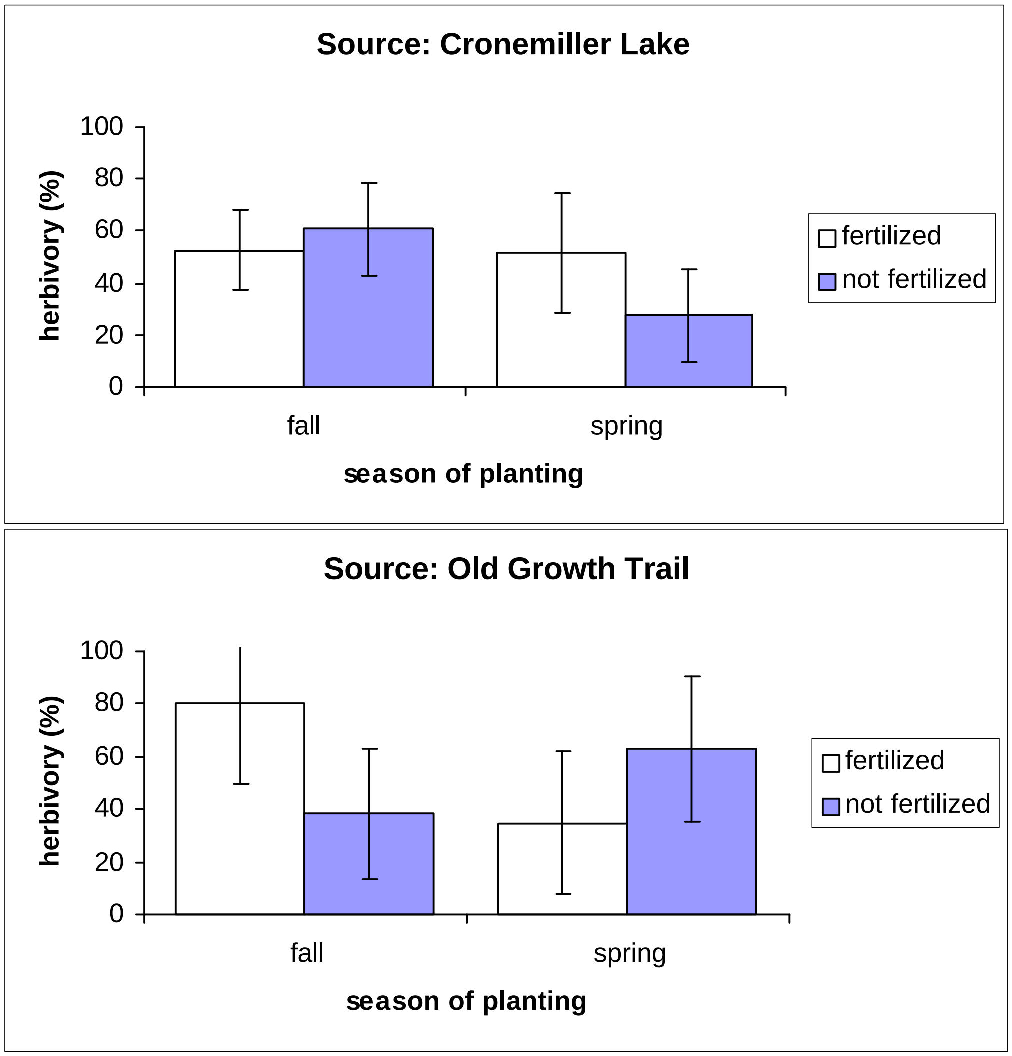

Figure 4. Herbivory by deer and mountain beaver on tall bugbane transplants in 2001 differed among seed sources, planting dates, and fertilizer treatments in a three-way statistical interaction (*P*=0.004). Herbivory was either higher or lower when plants were fertilized, depending on season of planting and seed source.

Transplant survival was affected only by season of planting (logistic regression, *P*=0.02), not by fertilization or seed source (*P*>0.9) (Figure 5). A total of 82% of fall transplants survived through September of 2001, compared to 59% of spring transplants.

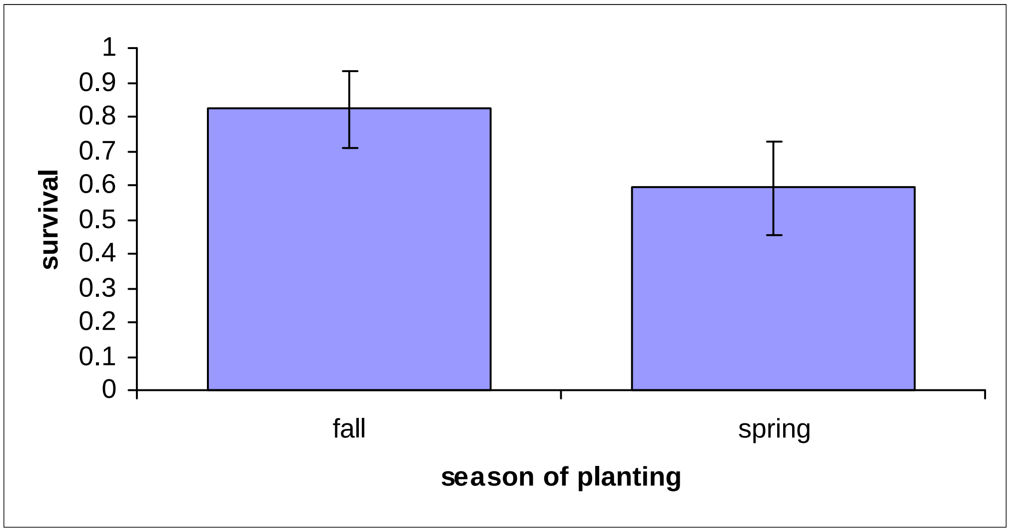

Figure 5. Effect of season of planting in 2000 on survival to September 2001.

Plant size, as measured by number of leaves, was also affected by season of planting, but also by fertilization and source population in a three-way interaction (Figure 6). For example, for plants from Cronemiller Lake, fertilizer had no effect on plant size, while fall 2000 transplants (ca. 3.5 leaves) produced significantly more leaves than spring 2000 transplants (ca. 1.7 leaves). The picture was more complicated with plants from Old Growth Trail, in which fall transplants were larger than spring transplants only if they were fertilized (Figure 6). Without fertilizer, fall and spring transplants were of equal size (about 2.5 leaves).

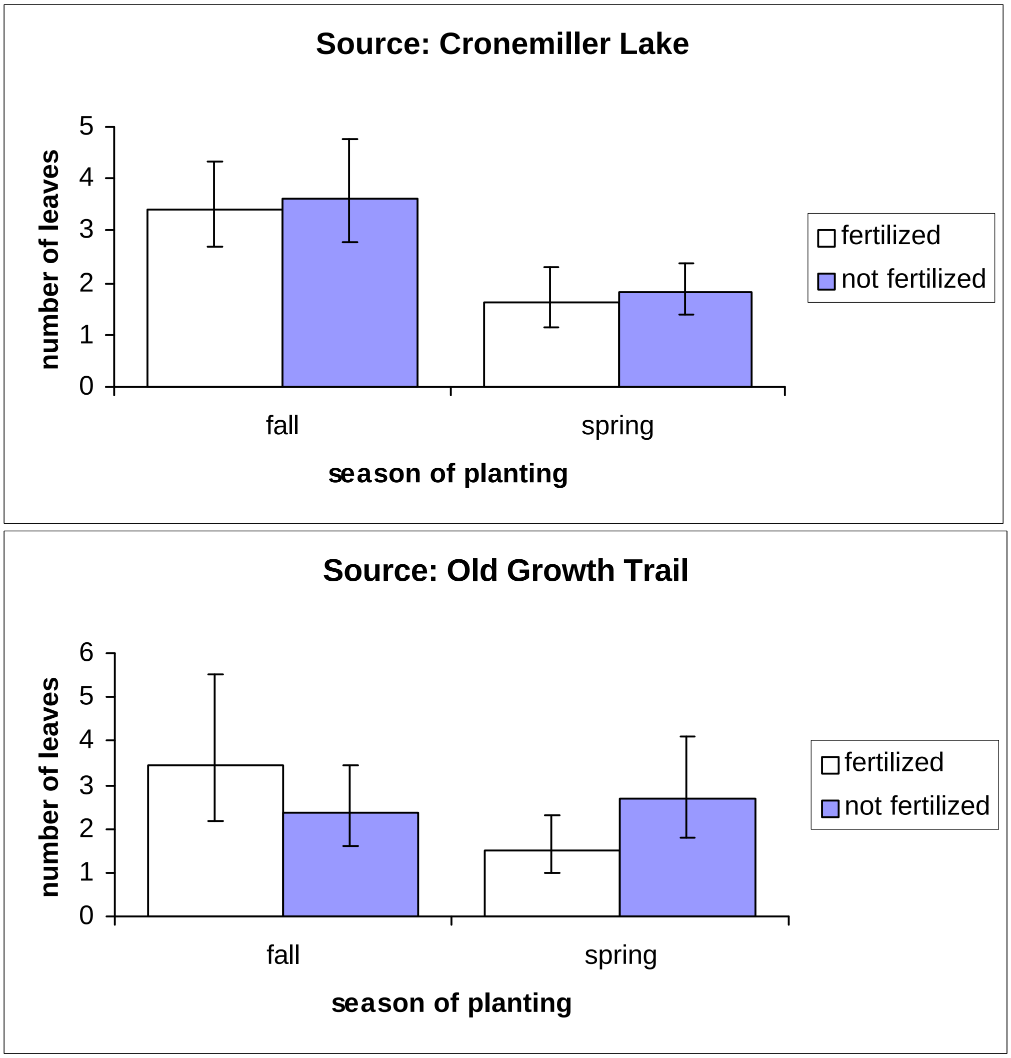

Figure 6. Plant size (as measured by number of leaves) differed among source populations and planting season.

CONTINUED RESEARCH AND MONITORING

Propagation, planting, and growth of tall bugbane *ex situ* and at field sites appears to be a viable method of reintroducing the species or augmenting existing populations. However, herbivory by deer and mountain beaver is a substantial threat to the success of these efforts. Also, our results to date are for only one full year of growth, and only a small percentage of the transplants have reached a reproductive state; most transplants remain small and stunted due to animal damage.

Results of this project will be improved with continued monitoring of the transplants to document their second and third year survival. In addition, efforts to reduce herbivory will likely result in larger plants, a greater number of reproductive individuals, and higher survival over the long term. Techniques that reduce damage by deer and mountain beaver, such as application of pepper extract to plant foliage, should be explored.

LITERATURE CITED

Baskin, J.M. and C.C. Baskin. 1985. Epicotyl dormancy in seeds of *Cimicifuga racemosa* and *Hepatica acutiloba*. Bulletin of the Torrey Botanical Club 112:253-257.

Hitchcock, C.L., A. Cronquist, M. Ownbey, and J.W. Thompson. 1964. Vascular Plants of the Pacific Northwest. Part 2: Salicaceae to Saxifragaceae. University of Washington Press, Seattle.

Kaye, T.N. and M. Kirkland. 1994. *Cimicifuga elata*: status, habitat analysis, monitoring, inventory, and effects of timber management. Final report. A Cooperative Challenge Cost Share Report between Oregon Department of Agriculture, U.S. Bureau of Land Management, and U.S. Forest Service.

Kaye, T.N. and M. Kirkland. 1999. The effect of timber harvest on *Cimicifuga elata*, a rare plant of western forests. Northwest Science 73:159-167.

Kaye, T.N. 2000. Propagation and population re-establishment for tall bugbane (*Cimicifuga elata)* on the Salem District, BLM, Preliminary Report. A Cooperative Challenge Cost Share Report between Institute for Applied Ecology and U.S. Forest Service.

Wogen, N., K. Pendergrass, M. Widmer, C. Mayrsohn, J. Seevers, M. Stein, B. Mumblo, R. Holmes, L. Scofield, C. Hibler, K. Neal, E. Muench, R. Helliwell, J. Dimling, and A. Smith. 1996. Conservation strategy for *Cimicifuga elata*, tall bugbane. U.S. Forest Service, U.S. Bureau of Land Management, U.S. Army Corps of Engineers.