Viburnum opulus L. var. *americanum* (Mill.) Ait. (American cranberrybush): A Technical Conservation Assessment

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

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AUTHOR'S BIOGRAPHY

James E. Nellessen has an extensive background in botany, biology, ecology, and plant pathology. He is experienced in environmental compliance surveys, including threatened and endangered species surveys, vegetation analysis and mapping, wetland delineation, and baseline biological surveying. He obtained his Ph.D. in Botany in 1989 from Ohio University. His Ph.D. research work centered on the population biology and physiological ecology of the grass, *Andropogon virginicus*, in abandoned coal strip mine and old field habitats in Ohio. He obtained an M.S. in Plant Pathology in 1983 from Virginia Tech. His research there focused on the impacts of air pollution to vegetation. He has a B.S. in Biology from the University of Minnesota. He did postdoctoral work at the University of Oklahoma where he worked on developing computer databases containing information on the toxicity and accumulation of environmental contaminants in plants. This work was funded by the U.S. Environmental Protection Agency. He has been working in New Mexico since 1994. He has previously worked with the New Mexico Environment Department and the New Mexico State Highway and Transportation Department. He has written biological assessments for the Lincoln National Forest (Scott Able Fire) and Santa Fe National Forest (Cerro Grande Fire) in New Mexico. He has written brief but comprehensive reports on the biology and ecology of 13 species of shrubs for the USDA Forest Service Shrub Sciences Lab in Provo, Utah (as part of the Wildland Shrub Project). He is also experienced in conducting noxious weed surveys and management planning, research designs, rangeland health assessments, air quality regulations, air toxics programs, smoke management plans, plant toxicity, and contaminated soil bioremediation. Jim has given numerous meeting presentations on biological and environmental topics and has published many articles between 1983 and 2004. Jim is a member of the American Institute of Biological Sciences, the Society for Ecological Restoration, the Association of Southwestern Naturalists, the Native Plant Society of New Mexico, and the American Society of Mining and Reclamation.

COVER PHOTO CREDIT

Photographs of *Viburnum opulus* var. *americanum*. (Left) Full view of the plant (from USDA Natural Resources Conservation Service PLANTS database); (right) a close up photo of the flower from the plant (photograph by Robert W. Freckmann).

Summary of Key Components for Conservation of *Viburnum opulus* var. *americanum*

Status

Viburnum opulus var. *americanum* (American cranberrybush) has a global ranking of G5 (secure). It is much more common in the eastern portion of North America than in the USDA Forest Service (USFS) Rocky Mountain Region (Region 2), which is situated along the southwestern edge of the species' overall distribution. USFS Region 2 first determined *V. opulus* var. *americanum* to be a sensitive species in 2003, and this taxon is on the current Regional Forester's Sensitive Species List. The review process for this eventual listing began in 2001. The only other conservation ranking status for the species in USFS Region 2 is in Wyoming. The Wyoming Natural Heritage Program has classified it as S1 (critically imperiled), but has stated that the species is of medium conservation concern. Although considered an important part of this species' rangewide botanical value, the Wyoming populations are peripheral. This species occurs with greater frequency in South Dakota than in Wyoming, but these populations are also considered peripheral. In addition, all known South Dakota and Wyoming occurrences would be considered disjunct in Region 2 because of the geographic gap separating these occurrences from occurrences farther east (e.g., Minnesota).

Primary Threats

The primary threats to *Viburnum opulus* var. *americanum* and its habitats were derived from a few well known general threats and from a variety of sources that identify specific threats. While the following summary is not a prioritized list, items near the top may be of greater concern. Any one of these threats could be of greater or lesser concern to a particular occurrence of *V. opulus* var. *americanum* in USFS Region 2 at a particular point in time.

1) Habitat loss (including loss of wetlands), as well as population fragmentation and loss of connectivity at local scales.

2) Alterations to existing hydrologic regimes in riparian and wetland sites.

3) Impacts to the soil substrate, causing soil erosion, topsoil loss, and loss of nutrients.

4) Intense fires with frequent return cycles.

5) Trampling by livestock of seedlings, saplings, and the soil surface leading to topsoil loss.

6) Grazing impacts (direct consumption) by sheep, moose, and perhaps over-abundant populations of deer; impacts from cattle appear to be more limited to trampling of young plants and the soil substrate; rabbits may cause temporary impacts.

7) Impacts that may alter the balance of sun and shade in the habitat (seedlings do best in moderate shade).

8) Small population sizes of existing sites.

9) Indiscriminant use of pesticides (e.g., insecticides) that kill beneficial insects that are required to pollinate the species.

10) Indiscriminant use of herbicides; *Viburnum opulus* var. *americanum* has an intermediate sensitivity to certain herbicides.

11) Introduction of *Viburnum opulus* var. *opulus* (European cranberrybush) into the wild, which could result in hybridization and dilution of *V. opulus* var. *americanum* gene pools and also direct replacement of *V. opulus* var. *americanum*.

12) Invasive species (mostly non-native).

13) Diseases and pests (e.g., fungal pathogens to seedlings, the viburnum leaf beetle to mature plants); although none of these are probably substantial threats alone, in combination with other environmental stressors, they could be detrimental to small populations.

14) Local and long distance input of air pollutants (i.e., NO and NO_2 from local sources, O_3 from long distance sources); these may cause both direct impacts and act as stressors allowing for secondary impacts (e.g., increased aphid feeding activity).

15) Use of plant materials from small populations for natural and alternative medicinal purposes.

16) Road construction, as it may pertain to specific/localized sites.

Primary Conservation Elements, Management Implications and Considerations

Primary conservation elements and management implications were derived from an evaluation of the literature on *Viburnum opulus* var. *americanum*, including information available on *V. opulus* var. *opulus*, the closely related European variety. Protection and conservation of riparian and wetland habitats appears to be an over-arching element and/or connecting thread to several more specific elements towards the conservation and management of *V. opulus* var. *americanum* in USFS Region 2. The following list of conservation elements is not in a prioritized order. Land managers are encouraged to carefully evaluate the situation at each *V. opulus* var. *americanum* site and make their own determination on which elements are most appropriate for a particular site at a particular point in time.

1) Protect and preserve wetlands through proactive approaches such as maintaining continuous riparian habitat, and mitigate impacts to wetlands.

2) Protect the greater habitat matrix, including upland habitat in the same watershed surrounding the riparian areas and other small wetland and mesic sites containing *Viburnum opulus* var. *americanum*.

3) Minimize and avoid trampling by livestock of suitable and potentially suitable habitat.

4) Minimize and avoid direct consumption of plants by grazing animals, whether they be managed livestock (e.g., sheep) or native wild species (e.g., moose, deer), which can impact plant populations by altering their demographic makeup and reproductive and recruitment capabilities; while direct consumption by cattle appears to be of lesser concern, these livestock do cause trampling of young plants and the soil substrate (item 3 above).

5) Minimize and avoid alterations or changes in the balance of sun and shade in the habitat as this may affect the species' ability to recruit new individuals into the population; seedlings do best in moderate shade and are subject to drought stress, much more so if receiving more exposure to direct sunlight; sites with *Viburnum opulus* var. *americanum* are probably best managed under a low intensity, longer-term fire return cycle.

6) Maintain moist, nutrient-rich substrates as seedlings do best under these conditions.

7) Conserve seed-dispersing birds and small to medium-sized mammals and their habitats.

8) Maintain the integrity of multiple riparian systems, wetlands, and watersheds in the Black Hills area to reduce the possibility that the small populations within USFS Region 2 may be subject to stochastic (random) events outside the control of some management practices.

9) Minimize the indiscriminant use of insecticides that can kill beneficial insects that are required to pollinate this species, which is an obligate out-crosser.

10) Minimize the indiscriminant use of herbicides that can have unintended negative side effects on populations of *Viburnum opulus* var. *americanum*; the species has a known intermediate sensitivity to certain herbicides.

11) Be aware of the potential presence of the commonly cultivated *Viburnum opulus* var. *opulus*, which is frequently known to escape into the wild; its hybridization with the American variety can result in an introgression of the two forms and a dilution of the American variety gene pool; the European variety can also directly replace the American variety; if the European variety is discovered, some management may be necessary.

12) Minimize activities that could result in the introduction of invasive non-native species that may adversely interact with existing populations of *Viburnum opulus* var. *americanum*.

13) Examine populations periodically for the presence of diseases and pests, which by themselves are not anticipated to have substantial effects on populations, but in combination with other environmental stressors, could be detrimental to small populations.

14) Be aware of the potential effects of air pollution; populations adjacent to busy roads could be impacted by local accumulations of oxides of nitrogen (e.g., NO and NO_2) emitted from automobiles; all populations, regardless of location, could experience impacts from the long-distance transport of air pollutants (ozone being of primary concern); air pollutant impacts may cause both direct impacts and act as stressors allowing for secondary impacts (e.g., increased aphid feeding activity); at the present time, such impacts to *Viburnum opulus* var. *americanum* are not known in USFS Region 2.

15) Consider monitoring sites for signs of harvesting; the collection and use of plant materials from small populations, such as those in the Black Hills, by persons seeking natural and alternative medicinal purposes can have unintended negative effects on their reproductive capabilities.

16) Begin a propagation program using local Region 2 sources of this frequently cultivated taxon; restoration activities could be included as a component of the overall conservation strategy.

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INTRODUCTION

This assessment is one of many being produced to support the Species Conservation Project for the USDA Forest Service (USFS) Rocky Mountain Region (Region 2). *Viburnum opulus* var. *americanum* (American cranberrybush) is the focus of an assessment because it is uncommon in Region 2 and because in 2003, it was placed on the Regional Forester's Sensitive Species List (USDA Forest Service 2005a). 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 or significant current or predicted downward trends in habitat capability that would reduce its distribution (Forest Service Manual 2670.5 (19)). A sensitive species requires special management, so knowledge of its biology and ecology is critical.

This assessment addresses the biology of *Viburnum opulus* var. *americanum* (**Figure 1**, **Figure 2**) throughout its entire range and its range in Region 2. The broad nature of the assessment leads to some constraints on the specificity of information for particular locales. This introduction defines the goal of the assessment, outlines its scope, and describes the process used in its production. The scientific name of this species will be used throughout this document, and occasionally its common name, American cranberrybush, will also be used (USDA Natural Resources Conservation Service 2005). The terms American variety (referring to *V. opulus*

Figure 1. Photograph of *Viburnum opulus* var. *americanum*. Source: USDA Natural Resources Conservation Service PLANTS database/Herman, D.E. et al. 1996.

Figure 2. Photograph of *Viburnum opulus* var. *americanum* in bloom. Source: Courtesy of Freckmann Herbarium, University of Wisconsin (2005); photograph by Paul Drobot.

var. *americanum*) and European variety (referring to *V. opulus* var. *opulus*) will be used when the discussion makes repetitive comparisons or reference to both of these taxa. Also in this document, the term population will include both its most generally understood ecological meaning (i.e., a group of interbreeding individuals) and occurrences of the species (i.e., sites or locations where the species exists). Since dispersal of seed by birds is an important component in the life cycle of this species, it may be very difficult to differentiate between populations and occurrences of this species.

Goal

Species conservation assessments produced as part of the Species Conservation Project are designed to provide forest managers, research biologists, and the public with a thorough discussion of the biology, ecology, conservation status, and management of certain species based on available scientific knowledge. The assessment goals limit the scope of the work to critical summaries of scientific knowledge, discussions 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 ecological background upon which management must be based and focuses on the consequences of changes in the environment that result from management (i.e., management implications) that managers can then use to direct land management decisions. Furthermore, this assessment cites management recommendations proposed elsewhere and examines the success of those recommendations that have been implemented.

Scope

This assessment examines the biology, ecology, conservation status, and management of *Viburnum opulus* var. *americanum* with specific reference to the geographic and ecological characteristics of the USFS Region 2. Although much of the literature on this species originates from field investigations outside the region, and from the very closely related *V. opulus* var. *opulus* taxon (European cranberrybush), this document places that literature in the ecological and social context of the

central Rocky Mountains. Similarly, this assessment is concerned with reproductive behavior, population dynamics, and other characteristics of *V. opulus* var. *americanum* in the context of the current environment rather than under historical conditions. The evolutionary environment of the species is considered in conducting the synthesis, but it is placed in a current context.

In producing the assessment, refereed literature, non-refereed publications, research reports, and data accumulated by resource management agencies were reviewed. Not all publications on *Viburnum opulus* var. *americanum* are referenced in the assessment, nor were all published materials considered equally reliable. The assessment emphasizes refereed literature because this is the accepted standard in science. Non-refereed publications or reports were regarded with greater skepticism and used only when information was unavailable elsewhere. Unpublished data (e.g., Natural Heritage Program records) were important in estimating the geographic distribution of this species. These data required special attention because of the diversity of persons and methods used in collection.

The scope of this assessment is relatively broad. The USFS Region 2 administrative boundaries encompass national forest units within the states of Kansas, Nebraska, South Dakota, Colorado, and Wyoming, which form the southwestern edge of this species' much larger range. However, the biology, ecology, and distribution of *Viburnum opulus* var. *americanum* cannot be fully understood unless information across its entire range of existence is assessed. Consequently, while this assessment will focus on concerns in USFS Region 2, it will discuss the species across its entire North American range. The reported historical presence of this species will be discussed in conjunction with its presently known range within the region. This document is intended to supply USFS Region 2 managers with much more information than was previously used to list the species as sensitive, but there continue to be USFS Region 2 locality-specific information limitations concerning the ecology of the species.

There is some published biological and ecological research on *Viburnum opulus* var. *americanum*, but there is much more on *V. opulus* (i.e., inclusive of both American and European varieties), and much more of this has focused on the European variety, *V. opulus* var. *opulus*. Since the American variety is very closely related to its European counterpart, which has been widely cultivated and has escaped into North America, and may be hybridizing with and possibly displacing the American variety, a certain amount of information regarding the European variety is included in this report as supporting information. The most comprehensive monograph written on *V. opulus* (Kollmann and Grubb 2002) does cover both varieties, but unfortunately focuses on the European variety in Great Britain, will be cited several places in this document where it supplies useful information that would similarly or potentially pertain to the American variety. There is very little published information on *V. opulus* var. *americanum* that specifically applies to sites, occurrences, and populations in USFS Region 2, which is why this larger body of information needs to be discussed and evaluated for its potential applicability to the biology and conservation of the species in USFS Region 2.

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 of the world are always incomplete and our observations are 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). Although critical experiments in the ecological sciences can be conducted, due to the numerous ecological and environmental variables involved, the results are often not straight forward. In the ecological sciences, multi-year experiments are preferred, but observations and results from one or two-year studies are still useful towards understanding the species. Consequently, sometimes general (or short-term) observations, inference, good thinking, and models must be relied upon to guide the understanding of ecological relationships (Chamberlain 1897, Hilborn and Mangel 1997).

In this assessment, the strength of evidence for particular ideas is noted, and alternative explanations are described when appropriate. While well-executed experiments represent a strong approach to developing knowledge, alternative approaches such as modeling, critical assessment of observations, and inference were accepted as sound approaches to understanding *Viburnum opulus* var. *americanum*. The level of uncertainty regarding this taxon will be mentioned in general terms; it is not reasonable to place a numerical figure on the kinds of uncertainty discussed in this document. Consequently, in the Conservation section of this document, when known information is synthesized into management approaches, a certain level of speculation and inference is used.

Publication of Assessment on the World Wide Web

To facilitate the use of this species assessment as part of the Species Conservation Project, it is being published on the USFS Region 2 World Wide Web site at: www.fs.fed.us/r2/projects/scp/assessments/index.shtml. Placing this document on the Web makes it available to agency biologists and the public more rapidly than publishing it as a report. More importantly, it facilitates revision of the assessment, which will be accomplished based on guidelines established by USFS Region 2.

Peer Review

Assessments developed for the Species Conservation Project have been peer reviewed prior to their release on the Web. This assessment was reviewed through a process administered by the Society for Conservation Biology, which employed two recognized experts in 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

Viburnum opulus var. *americanum* became a part of this species assessment process when David Ode first evaluated it for potential USFS Region 2 sensitive listing on November 5, 2001 (USDA Forest Service 2001). It has a limited distribution in USFS Region 2; it can be found in the Black Hills of Wyoming and South Dakota (Black Hills National Forest) and at a few other sites in eastern Nebraska and South Dakota (USDA Forest Service 2001). Altered hydrology and degradation of riparian habitats, livestock trampling of stream banks, and lost habitat to road construction were listed as potential threats to the species and its habitat (USDA Forest Service 2001). Joy Handley, Bonnie Heidel, and Scott Laursen made a second evaluation of *V. opulus* var. *americanum* on June 4, 2002 (USDA Forest Service 2002). This evaluation supplied some additional site-specific information for Wyoming (i.e., the Dugout Gulch and the Sand Creek Late Successional Landscape populations) and mentioned the small sizes of the known populations as potential threats to the species (USDA Forest Service 2002, Wyoming Natural Diversity Database 2005). The final recommendation for listing the species as sensitive in USFS Region 2 was given on March 17, 2003, by Nancy Warren, with David Ode, Joy Handley, Bonnie Heidel and Scott Laursen as non-Forest Service experts assigned to help in the evaluation (USDA Forest Service 2003a). The ultimate rationale given for listing *V. opulus* var. *americanum* as a sensitive species was its rarity in USFS Region 2, its isolated (disjunct) distribution within the region, and threats to its habitat.

Table 1 lists the management status classifications for *Viburnum opulus* var. *americanum* under various levels of global, national, state, and agency oversight. Because of its wide distribution across North America, NatureServe (2005) gives the species a global ranking of G5 (secure), and neither the United States nor Canada federally lists it as threatened, endangered, or a species of concern. NatureServe (2005) ranks the species in Canada as N5 (secure), and it is similarly listed (S5) across the provinces of Saskatchewan, Manitoba, Ontario, New Brunswick, and Nova Scotia. In the Canadian provinces of Newfoundland and Prince Edward Island, it is listed as S4 (apparently secure). The only Canadian province in which the species receives a ranking that would bear concern is British Columbia, where it is ranked S3 (vulnerable). The only other province listed in the natural range of the species is Alberta, and it is not ranked in that province. In general, the species appears secure across Canada. In the United States, because several state natural heritage programs have rankings less than S4 (apparently secure), NatureServe (2005) has given the United States a national ranking of N4N5 (apparently secure to secure). **Figure 3** depicts the various state and provincial conservation rankings; although this map has some inaccuracies, it was included because it shows both the general rangewide distribution and state/provincial status.

Natural Heritage Program biologists in Wyoming have assigned the species an S1 (critically imperiled) ranking (Wyoming Natural Diversity Database 2005). Despite this S1 ranking, the State of Wyoming has given it no official designation and has placed a medium conservation priority on this taxon; Wyoming populations do contribute botanical importance to the species' rangewide persistence, but they are peripheral to its range (Wyoming Natural Diversity Database 2005). A population in Dugout Gulch in Crook County (northeastern corner of the state) does have some protection on the Black Hills National Forest as the Dugout Gulch Botanical Management Area (Wyoming Natural Diversity Database 2005). Proposed protection for this area began back in 1983 when the Wyoming Native Plant Society promoted its conservation (Fertig 2001). Currently, the Sand

Table 1. Summary of the known status of *Viburnum opulus* var. *americanum* across its range in North America.

Nation	State/Province	State/Province Designation	Natural Heritage Program Rank
Global	—	—	G5 secure
United States	—	—	N4N5 secure to apparently secure
Canada	—	—	N5 secure
United States	Idaho		X extirpated
United States	Indiana	Endangered	S1 critically imperiled
United States	New Jersey		S3 vulnerable
United States	Ohio	Threatened	S2 imperiled
United States	Pennsylvania		S3S4 vulnerable to apparently secure
United States	West Virginia		S1 critically imperiled
United States	Wyoming		S1 critically imperiled
Canada	British Columbia		S3S4 vulnerable to apparently secure
Canada	Manitoba		S5 secure
Canada	New Brunswick		S5 secure
Canada	Newfoundland Island		S3S5 vulnerable to secure
Canada	Nova Scotia		S5 secure
Canada	Ontario		S5 secure
Canada	Prince Edward Island		S4 apparently secure
Canada	Saskatchewan		S5 secure
All other states and provinces			NR not ranked

Creek area that contains one of the Wyoming populations is being evaluated for Research Natural Area status; this would result in a higher level of site protection (USDA Forest Service 2004a).

The South Dakota Natural Heritage Program (2005) lists *Viburnum edule* (squashberry; S3) as the only tracked species of *Viburnum*. In Colorado, there are no tracked species of *Viburnum* (Colorado Natural Heritage Program 2005). In Nebraska, the only tracked species of *Viburnum* is *V. lentago*, which is ranked S1 and listed as a species of "special concern" (Nebraska Natural Heritage Program 2005). In Kansas, there are no tracked species of *Viburnum* (Kansas Natural Heritage Program 2005).

West of Region 2, the Idaho Fish and Game Conservation Data Center (2005) lists *Viburnum opulus* var. *americanum* as possibly extirpated from the state. It was known from northern Idaho but has not been collected in many years, thus its listing as extirpated. It is also listed as a special status species for Boundary County (the northern-most tip of the panhandle), where it historically occurred. The Montana Natural Heritage Program (2005) lists *V. lentago* (nannyberry; S1) as the only tracked species of *Viburnum*.

In Pennsylvania, both NatureServe (2005) and the Pennsylvania Natural Heritage Program under the Pennsylvania Department of Conservation and Natural Resources (DCNR) (2005) list *Viburnum opulus* var. *americanum* as S3S4 (vulnerable to apparently secure) although the NatureServe (2005) map depicts the more conservative S3 ranking. The Pennsylvania DCNR (2005) also classifies the species at the state level as "rare," but with a "tentatively undetermined" status. The New Jersey Department of Environmental Protection (2005) lists *V. opulus* var. *americanum* as S3 (vulnerable). Two other species of *Viburnum* have less secure rankings in New Jersey; *V. dentatum* var. *venosum* is S2 (imperiled) and *V. alnifolium* (*V. lantanoides*) is S1 (critically imperiled) (New Jersey Department of Environmental Protection 2005). In West Virginia, the Natural Heritage Program under the West Virginia Department of Natural Resources (2005) lists *V. opulus* var. *americanum* as S1 (critically imperiled).

In Ohio, in 1984, *Viburnum opulus* var. *americanum* was not listed as endangered, threatened, or as a potentially threatened species (McCance and Burns 1984). However, by 1986 it was considered a potentially threatened species (Ohio Division of Natural Areas and Preserves 1986), and in 1988 the

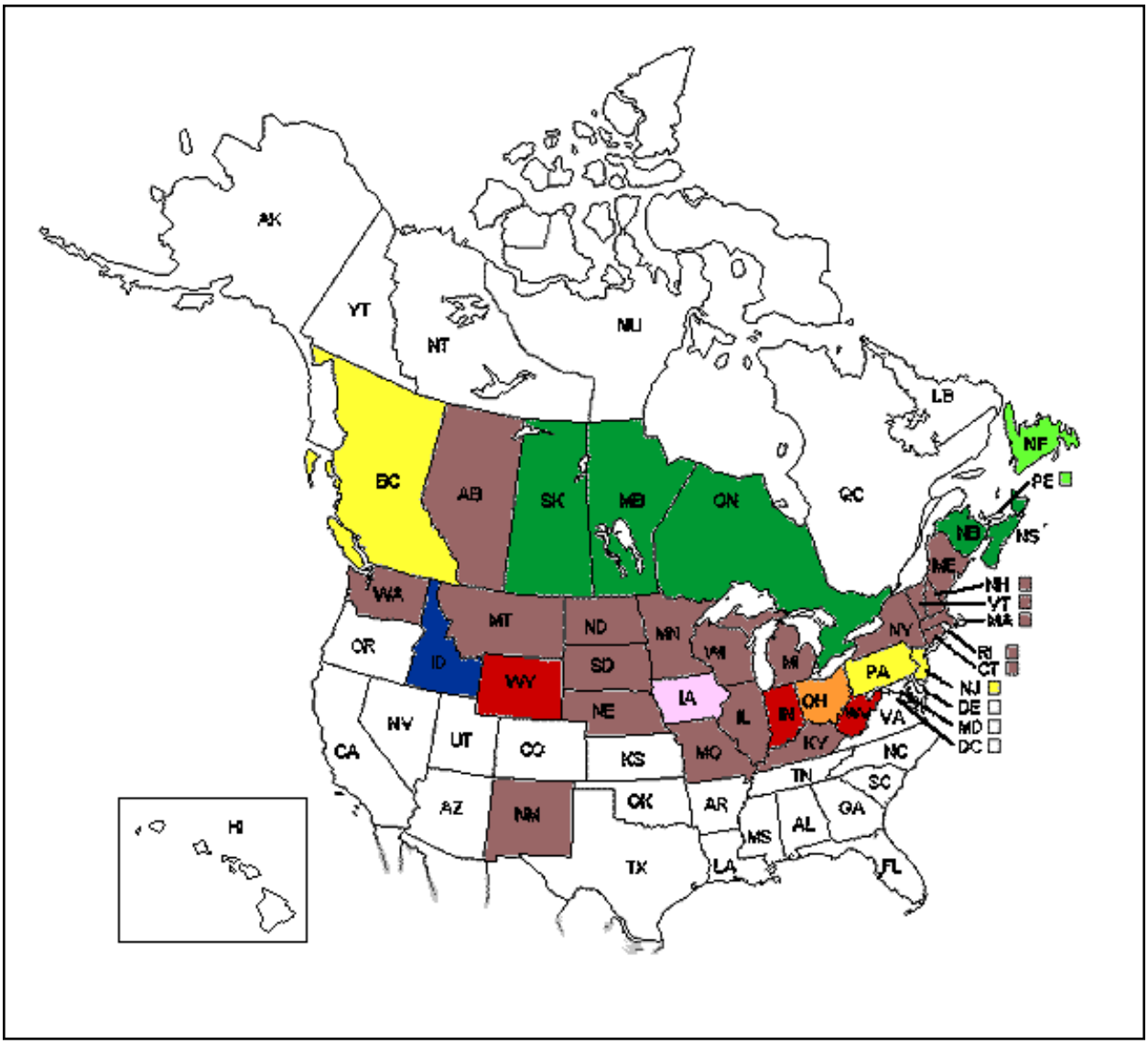

Figure 3. Distribution and status map for *Viburnum opulus* var. *americanum* across North America. Status rankings: dark green-S5, light green-S4, yellow-S3, orange-S2, red-S1, blue-extirpated, pink-exotic, brown-not ranked. The exotic classification for Iowa is incorrect, and the mapping of New Mexico is also incorrect. Source: NatureServe 2005.

Ohio Department of Natural Resources (2005) elevated it to the threatened status. As currently reported on NatureServe (2005), it is classified as S2 (imperiled) in Ohio. In Indiana, *V. opulus* var. *americanum* is listed as a state endangered species (Indiana Department of Natural Resources 2005) with a corresponding S1 rank by the Natural Heritage Program (NatureServe 2005). In Illinois, the Illinois Natural History Survey (2005) lists only *V. molle* (arrowwood) as state threatened, among several species of *Viburnum*.

For Iowa, NatureServe (2005) has a peculiar ranking for *Viburnum opulus* var. *americanum* (**Figure 3**). It is categorized as an exotic plant. *Viburnum opulus* var. *americanum* is a native species that is reported to occur in Iowa (to be discussed under the section on Distribution and abundance) and that occurs in most states surrounding Iowa (all states surrounding Iowa according to NatureServe (2005)), yet NatureServe identifies this native plant as exotic in Iowa. This represents a good example of the caution researchers must take when reviewing Internet data sources that have not been properly validated. Ultimately, the Iowa Department of Natural Resources (2005) does not have a classification for *V. opulus* var. *americanum*, but it does classify three other species of *Viburnum* (*V.*

acerifolium, *V. molle*, and *V. prunifolium*) as special concern species. In Minnesota, there are no species of *Viburnum* of concern (Minnesota Department of Natural Resources 2005), and in Missouri, there are no tracked species of *Viburnum* (Missouri Department of Conservation 2005).

For comparative purposes, the status of *Viburnum opulus* var. *opulus* in Poland is apparently becoming increasingly rare due to deforestation and the subsequent drying of impacted habitats (Czekalski 1984). The species has been officially classified as a medicinal plant by Poland's Ministry of Forestry and Wood Industry, which gives it some partial government protection, and it continues to be considered a rare and protected plant (Kepczynksi and Cyzman 1995, Fojcik 1997, Cabala and Gren 2002). On the other hand, *V. opulus* var. *opulus* in Great Britain appears to be stable and even shows slight tendencies to increase because of its ability to invade fallow wetlands and to spread from cultivated plantings on uplands (Kollmann and Grubb 2002).

Existing Regulatory Mechanisms, Management Plans, and Conservation Strategies

Rangewide, there are not many regulatory mechanisms, management plans, or conservation strategies for *Viburnum opulus* var. *americanum*. This is likely due to its widespread occurrence across North America and Canada, its G5 natural heritage programs global ranking, and the lack of ranking at national levels. The only two states with an official regulatory ranking for this species are Ohio and Indiana, where it is listed as state threatened and state endangered, respectively. These status rankings most likely provide the species some protection under each state's respective regulatory language.

During its evaluations, USFS Region 2 identified several potential threats to *Viburnum opulus* var. *americanum* at currently known sites under its jurisdiction. These threats include altered hydrology, grazing disturbance and other disturbances to wetland and riparian habitats, possibly impacts from road building, and its small population sizes (USDA Forest Service 2001, 2002, 2003a). On the Black Hills National Forest in Wyoming, the Dugout Gulch and Upper Sand Creek populations have been included in the Dugout Gulch and Upper Sand Creek Botanical Management Areas (Fertig and Oblad 2000, Wyoming Natural Diversity Database 2005). The USFS follows guidelines from the Forest Service Manual (FSM) regarding the designation of botanical areas. Under FSM 2372.05, a botanical area is defined as "a unit of land that contains plant specimens, plant groups, or plant communities that are significant because of their form, color, occurrence, habitat, location, life history, arrangement, ecology, rarity, or other features." Management emphasis in designated botanical areas is to protect or enhance and, where appropriate, to develop and interpret for public education and recreation areas of unusual botanical characteristics. Management of fire, livestock grazing, recreational use, and timber and minerals extraction can all be part of such management plans and can be tailored to the particular biological and ecological requirements of the area.

The Sand Creek Roadless Area is a partially protected site (Fertig and Oblad 2000). In the Black Hills of South Dakota, Upper Pine Creek (1190 acres) has been a designated Research Natural Area since 1932 (USDA Forest Service 2005b). This area protects tall shrubs like *Viburnum opulus* var. *americanum* from grazing impacts. It is also one of the largest roadless areas on the Black Hills National Forest. RNAs are permanently protected areas maintained in their natural state for the purpose of conserving biological diversity, to conduct and monitor research in a non-manipulative manner, and to foster education (USDA Forest Service 2004a). These areas become removed from the suitable timber base and also generally make fuel reduction treatments inappropriate (depending on the ecological requirements necessary to maintain a particular plant community). Hunting and recreation are usually allowed unless detrimental effects are noted, and such sites are carefully evaluated for the appropriateness of livestock grazing. Other sites with *V. opulus* var. *americanum* in the Black Hills National Forest (encompassing both South Dakota and Wyoming) that have been proposed for either Botanical Area status or RNA status are Cranberry Springs (including Upper Sand Creek), Bear/Beaver Gulches, and Little Spearfish Creek.

The fact that *Viburnum opulus* var. *americanum* is classified as a wetland plant (U.S. Fish and Wildlife Service 1988, 1996) essentially means that the strongest existing regulatory mechanism concerning its management and conservation are the federal wetland regulations administered by the U.S. Army Corps of Engineers (USACE) (Section 404 of the Clean Water Act (CWA), codified in 33 CFR Parts 320-330). Regarding individual species or their habitats, these regulations are non-specific; they are aimed at protecting all kinds of natural wetland habitats across the United States. Under these regulations, small pieces of wetlands may be lost for individual projects, but the general national

level policy is "no net loss." This policy was ultimately derived from Executive Order 11990 (Protection of Wetlands 1977). The USACE and numerous federal and state agencies have implemented mitigation of losses through restoration (onsite or offsite) and through banking (eventual restoration at a later time and/or location). More recently the USACE has been adopting new mitigation guidelines published by the National Research Council (2001). Most USFS roads and trails exist under a silvicultural exemption from Section 404 permitting (Roche personal communication 2005, and see 33 CFR Part 323). At various administrative levels the, USFS has additional directions for protecting wetlands and wetland habitat (e.g., Forest Service Manuals and Handbooks 2500, Medicine Bow National Forest Revised Land and Resource Management Plan) (USDA Forest Service 2003b).

Based on the current global and national ranking for *Viburnum opulus* var. *americanum* and its widespread occurrence across the United States and Canada, it would appear that existing laws and regulations, at least at the national level, are adequate for protecting the species as a whole. Concurrently, the enforcement of existing laws and regulations (e.g., Section 404 laws on wetlands) should be adequate to protect the species overall. The question arises as to how much regional and local regulation is important towards conserving specific sites that support *V. opulus* var. *americanum*. This question becomes potentially more difficult to discern on the periphery of its distribution (e.g., USFS Region 2). Two states (Ohio and Indiana) that could be considered to be on the southern periphery of this species' distribution have already taken steps towards locally protecting the species. These issues will be discussed further in this document under the Management of *Viburnum opulus* var. *americanum* in Region 2 section.

Biology and Ecology

Classification and description

Classification and taxonomy

The species herein described and identified is *Viburnum opulus* var. *americanum* (**Figure 1** and **Figure 2**). The genus *Viburnum* is placed within the plant kingdom in the following hierarchical classification (NatureServe 2005, USDA Natural Resources Conservation Service 2005):

Kingdom Plantae (plants)
Subkingdom Tracheobionta (vascular plants)
Division Magnoliophyta or Phylum Anthophyta (flowering plants)
Class Magnoliopsida or Dicotyledoneae (dicotyledons)
Subclass Asteridae
Order Dipsacales
Family Caprifoliaceae (honeysuckle family)
Genus *Viburnum*

The family Caprifoliaceae is one of the smaller plant families, containing 18 genera and over 450 species (Heywood 1978). Of these 450 species, the genus *Viburnum* is one of the largest in the family with about 230 species worldwide (Malecot 2002). *Viburnum* is Latin for "wayfaring tree," *opulus* is Latin for "rich" or "wealthy," and *americanum* simply means "American" (Borror 1960). Some authors have proposed new circumscriptions for the *Viburnum* genus by placing it in either a new family, Viburnaceae (Benko-Iseppon and Morawetz 2000), or by transferring it to the Adoxaceae family (Backlund and Bremer 1997, Winkworth and Donoghue 2005).

Viburnum opulus L. var. *americanum* Ait. is variously known by the common names, highbush cranberry, American highbush cranberry, American cranberrybush, cranberry-tree, cranberry viburnum, pembina, and crampbark (Deam 1940, Petrides 1972, Hitchcock and Cronquist 1973, Moss and Packer 1983, Great Plains Flora Association 1986, Rhoads and Klein 1993, Wasson 2003, NatureServe 2005). The plant has been given the name cranberry due to the resemblance of its fruit to the true cranberry (genus *Vaccinium*). The name pembina is a reduced form of the Chippewa (Ojibwa) word for this plant, pembina meaning "born first by a river" (Clements et al. 1912). Several older common names that are little used today are marsh-elder, rose-elder, water-elder, white dogwood, whitten tree, dog rowan tree, gaiter-tree or gatten, cherry-wood, and May-rose (Britton and Brown 1913). Many of these names are likely derived from European sources concerning the very closely related *V. opulus* var. *opulus*. Some discussion of *V. opulus* var. *opulus* will be included throughout this document as this variety has been widely introduced, cultivated, and escaped into North America. The following taxonomic synonymy has been applied to *V. opulus* var. *americanum* (Clements et al. 1912, Britton and Brown 1913, Schaffner 1932, Deam 1940, Bailey and Bailey 1949, Gleason and

Cronquist 1963, Great Plains Flora Association 1986, Kartesz 1994, Dorn 2001, Wasson 2003, Wisconsin Botanical Information System 2005):

Viburnum trilobum Marsh.
Viburnum americanum Mill.
Viburnum americanum Auth. (not Mill.)
Viburnum opulus L. ssp. *trilobum* (Marsh.) Clausen
Viburnum opulus L. var. *trilobum* (Marsh.) McAtee
Viburnum opulus L. var. *americanum* (Mill.) Ait.

The name *Viburnum americanum* is an old name that is not always considered a synonym anymore. The identification of *V. opulus* var. *edule* Michx. as a synonym of *V. edule* (Hultén 1968) may cause some momentary confusion, but nearly all botanical researchers consistently consider *V. opulus* and *V. edule* as distinct species.

The European cranberrybush (*Viburnum opulus* L. var. *opulus*) is known by the following additional common names: European cranberry, common snowball, European snowball, European highbush cranberry, Guelder rose, snowball bush, snowball tree, hobble, and pincushion tree (Britton and Brown 1913, Wasson 2003). *Viburnum opulus* var. *opulus* has the following taxonomic synonymies (Schaffner 1932, Kartesz 1994, Kollmann and Grubb 2002):

Viburnum opulus L. var. *opulus*
Viburnum opulus L. var. *roseum* L.
Viburnum roseum (L.) Steud.
Viburnum opulus L. var. *sterile* DC.
Viburnum lobatum Lam.
Opulus vulgaris Borkh.

What has previously been identified as the variety *roseum* (also known as variety *sterile*) is the fruitless sterile form of *Viburnum opulus* var. *opulus* now classified as a cultivar, *V. opulus* var. *opulus* cv. 'Roseum' (Kenyon 2001). *Viburnum opulus* var. *opulus* needs to be considered and discussed within this species assessment to some extent because it has historically been introduced and cultivated in North America. Its biology and ecology are also very similar and applicable to the American variety. The introduction potential of the European variety continues in recent times as plants from Yugoslavia have been tested in the north-central United States, and the species was rated as one of the most promising and broadly adapted landscape plants for this region (Widrlechner et al. 1992). The scientific name *V. opulus*, without a varietal specification, is used in this document when the source of information did not specify a variety, it was not easily possible to determine whether the European or American variety was being discussed, or information being presented applies or potentially applies to both forms.

Most botanists today consider the American and European varieties as part of the same species. The name *Viburnum trilobum* reflects past attempts to elevate the American variety to a species rank. The two varieties are considered to be hybridizing, and in numerous cases, the European variety may be either directly replacing and or blending (called introgression) its gene pool into the American variety. One author has stated that the two varieties, as circumscribed, have enough variability that they are not always easily distinguishable (Voss 1996). The concept of what defines and constitutes a species has been a long and difficult one in the scientific community. Most plant species exhibit a certain range of variation within what defines the species, some species with much greater ranges of variation than others. Numerous plant species have been demonstrated to hybridize either naturally or artificially, blurring some of the lines defining species (Mayr 1957, Briggs and Walters 1984). Many taxonomists seek consistently reproducible characteristics to help define a species. Many plant ecologists and evolutionary biologists tend to view species more broadly, as sets of interbreeding populations (Mayr 1957, Briggs and Walters 1984). It is a natural human inclination to define, categorize, and order what we observe in the natural environment. However, with biological entities that are dynamic and changing over time and space, it often becomes much harder to categorize biological entities. Since the American and European varieties were separated geologically for a great period of time before humans brought them back together again, it is not surprising that they do have some genetic differences due to genetic drift alone, causing them to be varieties. It is always possible that even the disjunct populations of *V. opulus* var. *americanum* (e.g., the Black Hills of Wyoming and South Dakota) may have developed some genetic differences from the main body of the population to the east. In this regard, the conservation of genetic diversity could be considered an integral subcomponent of conserving greater biodiversity. Populations of plants have frequently demonstrated selective change, forming ecotypes (Turesson 1922, 1930, Clausen et al. 1940), even in periods of time as short as 30 to 60 years (Antonovics et al. 1971, Bradshaw and McNeilly 1981). Although for a long-lived woody species such as *V. opulus* var. *americanum*, much more time would be necessary for ecotypic differences between populations to occur. The relationship between local and regional

populations of *V. opulus* var. *americanum* (including its European counter part) will potentially be affected by cross pollination and hybridization, natural selection pressures in the local environment, and redistribution of the species (e.g., bird dispersal) across the geographic landscape. These on-going natural processes may from time to time cause some uncertainty in our understanding of the varieties, and local populations, but this is nothing that cannot be overcome with additional investigation and research.

Description

Viburnum opulus var. *americanum* is a tall, multi-stemmed, sturdy, deciduous shrub that may reach 5 m in height (**Figure 1**, **Figure 2**). It often occurs in small colonies or clusters (Stephens 1973). The bark on young twigs is smooth and gray to tan-brown while the bark on older stems is light gray-brown with irregular cracks. The leaves are opposite, simple, palmately 3-lobed, dark green, strongly to lightly toothed, 3 to 13 cm long, 4 to 12 cm wide, and hairy beneath (mostly along veins); they turn red to slightly purplish in the autumn (Clements et al. 1912, McAtee 1956, Gleason and Cronquist 1963, Stephens 1973, Dorn 1977, Great Plains Flora Association 1986, Lackschewitz 1991, Wasson 2003). The petioles are 1 to 3 cm long, with slender stipules where they attach to the stem and broad, flat-bottomed grooves along the upper surface (Blackburn 1952). At the base of the leaf blades, there are one to six stalked glands that are round-topped (e.g., convex). The flower clusters (inflorescences) are showy, white, and flat-topped; the entire cluster measures 5 to 15 cm across (**Figure 4**). The flower cluster consists of an outer perimeter set of large, sterile (e.g., neutral with no stamens or pistils) flowers, with five petals, measuring 13 to 25 mm across (Britton and Brown 1913, Deam 1940, Gleason and Cronquist 1963, Hitchcock and Cronquist 1973, Stephens 1973, Vance et al. 1984, Mohlenbrock 1986, Lackschewitz 1991, Gleason and Cronquist 1991, Dorn 2001). In the center of the flower cluster, there are small, perfect (i.e., containing one pistil and five stamens) flowers 2 to 4 mm across (Dorn 1977, Lackschewitz 1991, Wasson 2003). It produces bright red to orange berries (called drupes) that contain one seed, are somewhat oval in shape, 8 to 15 mm long, 7 to 10 mm wide, semi-translucent, and hang on the plant until spring (**Figure 5**). The specific epithet "*opulus*" likely refers to the rich display of flowers and fruit. The native *V. opulus* var. *americanum* has been widely developed as a cultivated species with some of the cultivated names being:

Figure 4. Flowers of *Viburnum opulus* var. *americanum*. Source: Courtesy of Freckmann Herbarium, University of Wisconsin (2005); photograph by Robert W. Freckmann.

Figure 5. Fruits of *Viburnum opulus* var. *americanum*. Source: Courtesy of Freckmann Herbarium, University of Wisconsin (2005); photograph by Robert W. Freckmann.

'Andrews,' 'Bailey Compact,' 'Compactum,' 'Hahs,' 'Hogg's Red,' 'Manitou,' 'Phillips,' and 'Wentworth' (Wasson 2003, USDA Natural Resources Conservation Service 2005). It is tolerant of damp soil and hardy in zones 2 through 8 in North America.

Bassett and Crompton (1970) have studied the pollen morphology in the Caprifoliaceae and developed a key to identifying Canadian species of *Viburnum* (including *V. opulus*) by their pollen. Wenham and Cusick (1975) have reported on the growth of secondary wood fibers in *V. opulus*.

In USFS Region 2, *Viburnum opulus* var. *americanum* is most likely to be confused with *V. edule* (squashberry, mooseberry, or sometimes also called bush cranberry, or even highbush cranberry). *Viburnum edule* also has 3-lobed leaves, but the lobing is shallow and the flowers are all fertile and of the same size (medium-sized), as opposed to the two sizes of flowers in *V. opulus*. Furthermore, *V. edule* is not as tall (1 to 2 m) as *V. opulus*, and it lacks stipules while *V. opulus* has stipules. The fruits of *V. edule* tend to be mostly round while those of *V. opulus* tend to be more oval in shape. Other species of *Viburnum* within USFS Region 2 (*V. lentago* and *V. lantana*) do not have 3-lobed leaves or reddish-colored fruit (i.e., they have blue-black fruit). *Viburnum acerifolium* (arrowwood or maple-leaved viburnum) also has the 3-lobed, maple-like leaves, but with shallower lobing, and as in *V. edule* the flowers are all of the same size. Although *V. acerifolium* is an eastern species that does not naturally occur in USFS Region 2, it is possible this species could be encountered as a cultivated species, with some potential to persist once cultivated sites are abandoned and to escape from cultivation.

Concerning differences between *Viburnum opulus* var. *americanum* (American variety) and *V. opulus* var. *opulus* (European variety), the American variety has stipules that are thickened at the top while the stipules of the European variety are threadlike (McAtee 1956, Seymour 1969). However, one can find plants with both stipule characteristics on the same plant. The groove on the upper surface of the petiole in the European variety tends to be narrow and v-shaped as opposed to broad and flat-bottomed (Blackburn 1952). The glands at the base of the petioles on the American variety are stalked

with a convex apex while those on the European variety are generally not stalked (i.e., they are sessile) with a concave apex (Gleason and Cronquist 1963). The flower clusters of the snowball form of the European variety (*V. opulus* var. *opulus* cv. 'Roseum') contain only the enlarged, neutral (sterile) flowers.

Being a showy species frequently used in cultivation, there are numerous sources for photographs of *Viburnum opulus* var. *americanum*, including:

- Wisconsin Botanical Information System (2005);
- Freckmann Herbarium, University of Wisconsin (2005);
- USDA Natural Resources Conservation Service (2005).

There are numerous sources on the description of *V. opulus* var. *americanum* in floras from across the continent. Those perhaps more readily available/ applicable, broad based, and/or reliable may be listed as follows:

- Flora of Wyoming (Dorn 2001)
- Flora of the Northeastern United States and Adjacent Canada (Gleason and Cronquist 1963, 1991)
- Great Plains Flora Association (1986)
- North Central Plains Woody Plants (Stephens 1973)
- Encyclopedia of Trees and Shrubs (Wasson 2003)
- Wisconsin Botanical Information System (2005)
- Flora of Alberta (Moss and Packer 1983)
- Flora of Illinois (Mohlenbrock 1986).

Distribution and abundance

Rangewide

Numerous sources report *Viburnum opulus* var. *americanum* as having a wide distribution across North America. It occurs from the east coast in the United States and Canada, westward to the Pacific Coast in Canada, south to Pennsylvania, Ohio, Illinois, Iowa, South Dakota, and Wyoming (Deam 1940, Gleason and Cronquist 1963, Petrides 1972). In the United States, NatureServe (2005) lists the species for 27 states: Connecticut, Idaho, Illinois, Indiana, Iowa, Kentucky, Maine, Massachusetts, Michigan, Minnesota, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New Mexico, New York, North Dakota, Ohio, Pennsylvania, Rhode Island, South Dakota, Vermont, Washington, Wisconsin, West Virginia, and Wyoming (**Figure 3**). It should be pointed out that New Mexico and perhaps also Missouri and Kentucky are not natural occurrences. The distribution of this species as mapped by the USDA Natural Resources Conservation Service (2005) had reflected very closely that from NatureServe (2005). The only previous difference was that the former did not show the species in New Mexico as NatureServe did, but as of March 27, 2006, even the USDA Natural Resources Conservation Service PLANTS Database now maps New Mexico. In Canada, this species is reported in nine provinces: Alberta, British Columbia, Manitoba, New Brunswick, Newfoundland, Nova Scotia, Ontario, Prince Edward Island, and Saskatchewan (NatureServe 2005). Although numerous sources report similar overall continental distributions, not all sources indicate the exact state or provincial distribution. NatureServe (2005) presents distribution information, potentially confusing to the inexperienced person, by displaying maps for: 1) *Viburnum opulus* var. *americanum* (American cranberrybush), 2) *Viburnum opulus* var. *opulus* (European cranberrybush), and 3) *Viburnum opulus* (no variety specified, but called the Guelder-rose viburnum, a name commonly associated with the European variety). The distribution map for *V. opulus* (unspecified variety) shows additional occurrences in the states of Oregon and Virginia (NatureServe 2005). The presence of the widely cultivated European variety and its escape into the wild in North America (discussion and citations ahead) are the likely causes for such confusion. Although the focus of this report is on *V. opulus* var. *americanum* in Region 2, understanding its widespread occurrence elsewhere is integral towards understanding the significance of its occurrence in Region 2. The following paragraphs will present a summary of the historical, regional, and current distribution of *V. opulus* var. *americanum*.

In the northeastern portion of the continent, *Viburnum opulus* var. *americanum* has a general distribution, with frequent occurrences (particularly over low wet sites), from Newfoundland to Pennsylvania and westward (Hyland and Steinmetz 1944, Graves 1952, Pease 1964, Seymour 1969). *Viburnum opulus*

var. *opulus* (European variety) has been cultivated and escaped throughout this area (Hyland and Steinmetz 1944, Seymour 1969).

NatureServe (2005) does not show that *Viburnum opulus* var. *americanum* occurs in Quebec, Canada. Based on its distribution in adjoining areas, it would seem that it should at least occur naturally in southern Quebec. Information from herbarium labels from specimens housed at the University of Wyoming Herbarium (2005) indicates several collections made from Quebec. At least two of these are from the Montreal area in the southern part of the province. *Viburnum opulus* as the cultivated form 'Compactum' was described as hardy at eight sites tested in Quebec, but it did the best in the Montreal area of Quebec (Richer-Leclerc et al. 1993). In Ontario, *V. opulus* var. *americanum* is reported as common across the southern portion of the province, extending west to Lake Superior and Lake of the Woods, then north to James Bay (on Hudson Bay), with a northern limit of about 52º N latitude (Soper and Heimburger 1982). *Viburnum opulus* var. *opulus* is cultivated and escaped across Ontario. In Alberta, Canada, *V. opulus* var. *americanum* occurs along rivers (Moss and Packer 1983). This source also describes the rangewide distribution from Newfoundland to British Columbia, Washington, Idaho, Wyoming, South Dakota, Nebraska, Iowa, Illinois, and Pennsylvania.

In Massachusetts, *Viburnum opulus* var. *americanum* was described as occasional, with herbarium records dating from 1877 to 1963 (Harris 1975). The European variety is also identified as having an occasional distribution as an introduced and escaped taxon with herbarium collections dating from 1895 to 1957 (Harris 1975). Currently the USDA-NRCS (2005) reports that *V. opulus* var. *americanum* occurs in 14 out of 15 counties in Maine, seven out of 13 counties in Massachusetts, four out of 8 counties in Connecticut, 10 out of 10 counties in New Hampshire, and 11 out of 15 counties in Vermont. For New Jersey, NatureServe (2005) indicates only one county of occurrence. The State of New York has records of occurrence in nearly all counties of the state (New York Flora Atlas 2005), but this database search is for generic *V. opulus* and likely encompasses both the American and European varieties. A search of The New York Botanical Garden Herbarium on-line database yields one specimen record on file for New York (along a lake shore) and one for Wisconsin (New York Botanical Garden 2005). In Pennsylvania, *V. opulus* var. *americanum* is reported to occur in 16 to 18 of the 67 counties (Rhoads and Klein 1993, Pennsylvania Flora Project 2005 (managed by the University of Pennsylvania)). Contrastingly, NatureServe (2005) only indicates 11 counties of occurrence for Pennsylvania. Both cultivated *V. opulus* var. *americanum* and *V. opulus* var. *opulus* are known to escape from cultivation in Pennsylvania, and currently *V. opulus* var. *opulus* has a greater distribution at 21 counties in Pennsylvania (Pennsylvania Flora Project 2005). The type locality for *V. opulus* var. *americanum* is in Pennsylvania (Jones and Fuller 1955). West Virginia was considered the southernmost-known location for *V. opulus* var. *americanum* (Strausbaugh and Core 1970-77). Both the USDA Natural Resources Conservation Service (2005) and NatureServe (2005) indicate only two counties of *V. opulus* var. *americanum* occurrence in West Virginia, these being in the northeastern part of the state.

In Kentucky the USDA Natural Resources Conservation Service (2005) shows one county of occurrence for *Viburnum opulus* var. *americanum*, in the northeastern part of the state. *Viburnum opulus* var. *americanum* was not listed as occurring in the state in the early 1970's (Wharton and Barbour 1973), but its recent naturalized appearance in Kentucky (Weckman et al. 2002) is a possible cause for mapping Kentucky within the range of this species. Evidence has been found that *V. opulus* var. *americanum* is being promoted for cultivation outside of its natural range of distribution by horticultural and dendrology specialists (North Carolina State University 2005, Oregon State University 2005, Virginia Tech 2005).

In the early part of the 1900's, *Viburnum opulus* var. *americanum* was known to occur in four counties in Ohio (Schaffner 1932). At this time, *V. opulus* var. *opulus* was much planted, especially the variety *sterile* (snowball). NatureServe (2005) now indicates eight counties of occurrence. *Viburnum opulus* var. *americanum* has a combined historical and current range of 14 counties, and some specimens in Ohio are intermediate in characteristics between the American and European varieties (Ohio Department of Natural Resources 2005). In Indiana, *V. opulus* var. *americanum* was restricted to the lake area in four northern counties of Indiana (Deam 1940), and it is still listed for only four counties today (NatureServe 2005). In Illinois it was considered rare, occurring in only three counties in the early 1940's (Tehon 1942), later reported for nine northern counties (Jones and Fuller 1955), and still considered rare and restricted to the northern half of the state, as well as Greene County in the southwestern part of the state on the Illinois River (Mohlenbrock 1986). *Viburnum opulus* var. *opulus* is cultivated and escaped in Illinois. Today the USDA Natural Resources

Conservation Service (2005) currently maps 17 counties (out of 102 counties) of *V. opulus* var. *americanum* occurrence from the central to northern part of the state. The Illinois Natural History Survey (2005) herbarium has 52 specimens on file of *V. opulus* (variety unidentified in the on-line Internet database search). All of these specimens come from the known natural range of *V. opulus* var. *americanum*, except for two specimens from Tennessee.

In Michigan, *Viburnum opulus* var. *americanum* was considered common throughout the state (Billington 1949). Today, most of the plants in Michigan are considered the American variety, but great variation and potential intergradation between the American and European varieties exist (Voss 1996). The USDA Natural Resources Conservation Service (2005) indicates that *V. opulus* var. *americanum* occurs in 53 out of 81 counties in Michigan. In Missouri, neither the taxon *V. trilobum* nor *V. opulus* is listed among the *Viburnum* species occurring in Missouri (Steyermark 1963). Similarly, the Missouri Botanical Garden (2005) does not list *V. opulus* var. *americanum* on the checklist for Missouri flora. *Viburnum opulus* (the Guelder rose) as the introduced European variety is listed. Both NatureServe (2005) and the USDA Natural Resources Conservation Service (2005) go contrary to these sources by mapping Missouri as part of the natural range of *V. opulus* var. *americanum*. Both Steyermark (1963) and the Missouri Botanical Garden (2005) should be considered reliable botanical sources of information. In addition, the Missouri Department of Conservation (2005) does not track or consider any species of *Viburnum* to be rare. It is possible that cultivated *V. opulus* var. *americanum* has escaped and gone wild in certain parts of Missouri, or that cultivated and subsequently escaped *V. opulus* var. *opulus* has been mistaken for the American variety.

For Iowa, NatureServe (2005) incorrectly lists *Viburnum opulus* var. *americanum* as an exotic plant. This is a peculiar classification for a plant that occurs in most bordering states and has been reported as native, but not common, to northern and eastern Iowa (Harrington 1940). The USDA Natural Resources Conservation Service (2005) indicates two counties of *V. opulus* var. *americanum* occurrence in Iowa, one in the central part and the other in the northeastern corner of the state. In Wisconsin, *V. opulus* var. *americanum* occurs in 51 out of 71 counties (Wisconsin Botanical Information System 2005). There are 248 records of *V. opulus* at the University of Wisconsin Herbarium system of which most are identified as subspecies *trilobum* (i.e., the American variety), but some (32) are of the European variety (subspecies *opulus*), and some are unidentified to subspecies or variety (Wisconsin Botanical Information System 2005). One of the European variety specimens dates to 1884 and another to 1890, indicating that the European variety has been introduced into the Midwest for a very long time.

In Minnesota, *Viburnum opulus* var. *americanum* was described as frequent to common across the northern and eastern portions of the state and in the "Big Woods" area in the south-central part of the state (Clements et al. 1912, Lakela 1965). The European variety was widely planted as an ornamental (Clements et al. 1912). *Viburnum opulus* var. *americanum* is one of the listed species occurring in Cedar Creek Natural History Area in east-central Minnesota (Moore 1973). In North Dakota, *V. opulus* var. *americanum* was reported for the north-central part of the state, on the Canadian border in both the Mouse River area and the Turtle Mountains within Bottineau County (Stevens 1966). It was considered common in the Turtle Mountains. Nearly a decade later (Stephens 1973) showed it occurring across most of the eastern half of North Dakota, even occurring in one locality in the northeastern corner of South Dakota. Its distribution across eastern North Dakota is along drainages and in the Turtle and Pembina mountains in northern North Dakota, near the Canadian border (Stephens 1973). Many of the locations in eastern North Dakota and the one in the northeastern corner of South Dakota are associated with drainages of the Red River of the North. These occurrences in the Dakotas are based on either observations in the field and/or observations from herbarium records (Stephens 1973). The USDA Natural Resources Conservation Service (2005) shows *V. opulus* var. *americanum* occurring in 13 out of 53 counties, from central to eastern North Dakota.

In Montana, *Viburnum opulus* var. *americanum* is described as rare along stream banks, where it is known from Rattlesnake Canyon, lower Blodgett Creek, and along the Bitterroot River near Missoula (Lackschewitz 1991). This area covers the Bitterroot River drainage, all of Ravalli County, part of Missoula County, and included 2/3 of the area in the Bitterroot and Lolo national forests. Lackschewitz (1991) described the plant as circumboreal, including southern occurrences in the states of Washington, Idaho, Wyoming, South Dakota, Illinois, and Pennsylvania. In Idaho, *V. opulus* var. *americanum* is listed as extirpated (NatureServe 2005). It was known from only a few historical collections in northern Idaho, and it has not been collected in many years and may be extirpated from the state (Idaho Fish and Game Conservation Data Center 2005). *Viburnum opulus* var. *americanum* was not listed

as occurring in any western (i.e., west of the Great Plains) national parks (Bailey and Bailey 1949). The western-most national park identified in this 1949 report where it occurred was Isle Royale, on Lake Superior, in Michigan. Although today the western-most national park in which it would occur is the now more recently designated Voyagers National Park in Minnesota. The National Park Service (2005) has considered Wind Cave National Park in South Dakota as a possible location of *V. opulus* var. *americanum*, but this has not been confirmed.

In the Pacific Northwest, *Viburnum opulus* var. *americanum* is reported to occur from the Columbia River Gorge to northern Idaho (Hitchcock and Cronquist 1973). It occurs in the central mainland area of British Columbia (Clark 1973). In Alaska, *V. edule* was the only *Viburnum* species reported for the state (Welsh 1974, Viereck and Little 1986). The same was true for Hultén (1968), but this source lists *V. opulus* var. *edule* as a synonym for *V. edule*. Two specimens of *V. opulus* (no variety given), one collected from the Kayukuk area of Alaska (central Alaska, north and west of Fairbanks) in 1941, and the second collected from the Yukon Territory in Canada in 1948, are housed at the University of New Mexico Herbarium (2004). No habitat notes are supplied for the first specimen while the second specimen is identified as growing in dense spruce woods. The specimens have not been annotated, so it is possible they are misidentified.

Oregon, Utah, and New Mexico are not part of the natural historic range of *Viburnum opulus* var. *americanum*, but both the American and European taxa have been cultivated in these localities (Welsh et al. 1987, Shaw et al. 1989, University of New Mexico Herbarium 2004, Oregon State University 2005). *Viburnum opulus* plants (referred to as 'snowball' indicating that these are *V. opulus* var. *opulus*) are known to persist long after cultivation (Welsh et al. 1987). Shaw et al. (1989) reports both *V. opulus* var. *roseum* (*V. opulus* var. *opulus* cv. 'Roseum') and *V. trilobum* (*V. opulus* var. *americanum*) as cultivated across several northern Utah counties. Whether any of these introduced cultivated sites and populations that persist have distributed themselves elsewhere and become naturalized is not known. In addition to NatureServe (2005) incorrectly mapping New Mexico as part of *V. opulus* var. *americanum* occurrences, the Texas A&M University Bioinformatics Working Group (2005) also identified New Mexico as a possible occurrence. The USDA Natural Resources Conservation Service (2005) previously had not mapped New Mexico within this species' distribution, but as of March 27, 2006, Sierra County, New Mexico (in the southern part of the state) is now mapped. The taxon is not a historical component of the New Mexico flora (Martin and Hutchins 1980-81), is an unlikely part of the New Mexico flora due to a questionable supposition of Kartesz (1999) (Allred 2005), and the only two specimens of *V. opulus* housed at the University of New Mexico Herbarium (2004) are from cultivated specimens located in the City of Albuquerque. *Viburnum opulus* var. *americanum* is not known from the wild, and no species of *Viburnum* are tracked for New Mexico (New Mexico Natural Heritage Program 2005, Tonne personal communication 2006).

To summarize the occurrence of *Viburnum opulus* var. *americanum* outside Region 2, it has a wide distribution across North America, mainly across the northern portion of the continent, but because it is also a frequently cultivated taxon (along with the European variety), it may be found in numerous other portions of the continent. In a general sense, based on the above discussion, it would appear that USFS Region 2 sits on the southwestern fringes of this taxon's natural distribution.

Region 2

The remaining discussion of the distribution and abundance of *Viburnum opulus* var. *americanum* will involve states within USFS Region 2. *Viburnum opulus* var. *americanum* was considered rare in the Rocky Mountain Region at the beginning of the 1900's (Clements and Schwartz 1914). This source covered Montana, Wyoming, Colorado, northern New Mexico, eastern Utah, and western North Dakota, South Dakota, Nebraska, and Kansas. *Viburnum opulus* was one of only three species of *Viburnum* listed for the region, the other two being *V. lentago* and *V. pauciflorum* (synonymous with *V. edule*). The observed presence of these three species of *Viburnum* within the region remains fairly consistent in most botanical sources over the past 100 years. The Great Plains Flora Association (1986) reports *V. opulus* var. *americanum* occurring in eastern Nebraska, western South Dakota, the eastern half of North Dakota, and also in Wyoming, Idaho, and Washington. In Nebraska, *V. opulus* var. *americanum* was not listed as part of the state flora in the early 1900's (Petersen 1923). Previous USFS Region 2 species evaluations for *V. opulus* var. *americanum* reported that it occurred in eastern Nebraska and northeastern South Dakota (USDA Forest Service 2001, 2002). Information pertaining to its specific location in Nebraska has not been obtained for this report, but it is most likely that if it does occur in Nebraska, it would be in the northeastern corner of the state, likely near

the Missouri River and its tributary drainages (**Figure 6**). The occurrence in Douglas County, where Omaha is located, is a recently mapped occurrence (USDA Natural Resources Conservation Service, as of March 27, 2006); whether this is attributed to a cultivated specimen in Omaha is unknown. No sources report *V. opulus* var. *americanum* in Kansas.

In Colorado, *Viburnum opulus* var. *americanum* is typically not listed as part of the flora. Harrington (1954,1964) lists only *V. lentago* and *V. pauciflorum*. Weber and Wittmann (2001a, 2001b) and Hartman and Nelson (2001) list only *V. edule*, *V. lentago*, and *V. lantana*. Nelson (1992), in addition to listing *V. edule* and *V. lentago*, also listed *V. opulus* but used the common name snowball tree, which is commonly associated with the non-native European variety (*V. opulus* var. *opulus*). This source makes no description of the species and may have been referring to cultivated plants or possibly plants escaped from cultivation. There are no specimens of *V. opulus* var. *americanum* at the University of Colorado Herbarium (2005), or at the Colorado State University Herbarium (2005); the only specimens are of the three known species, *V. edule*, *V. lentago*, and *V. lantana*. One source has *V. opulus* var. *americanum* listed as part of the flora of the Rocky Flats Environmental Technology Site in Colorado (Rocky Flats Environmental Technology Site 2005). Supposedly a voucher herbarium record of it existed at one point, but perhaps this specimen has been misplaced and/or misidentified and may only represent a cultivated plant.

In South Dakota, *Viburnum opulus* var. *americanum* is described as being frequent in wooded ravines of the northern Black Hills (Van Bruggen 1985). It is similarly described for the Black Hills of southwestern South Dakota in addition to one location in the northeastern corner of South Dakota (Roberts County; **Figure 7**; Stephens 1973). The location in the northeastern corner of South Dakota is associated with a drainage of the Red River of the North. This and other occurrences in the Dakotas are based on either observations in the field and/or observations from herbarium records (Stephens 1973). The USDA Natural Resources Conservation Service (2005) identifies *V. opulus* var. *americanum* as occurring in three out of the 65 counties in South Dakota (Butte, Lawrence, and Pennington; **Figure 7**). Across the Black Hills National Forest of both South Dakota and Wyoming, there are more than 30 reported occurrences of this species (USDA Forest Service 2005c). Eighty percent of these occurrences have been reported during 2002 to 2003. Meade and Custer counties are now part of the species' distribution (**Figure 7**). Estimated population sizes (i.e., generally reported as number of stem clusters) ranged from a low of only one plant to a high of 122 plants. Most sites had fewer than 50 plants (USDA FS 2005c). The National Park Service (NPS 2005) inventory and monitoring program for rare plants in park units of

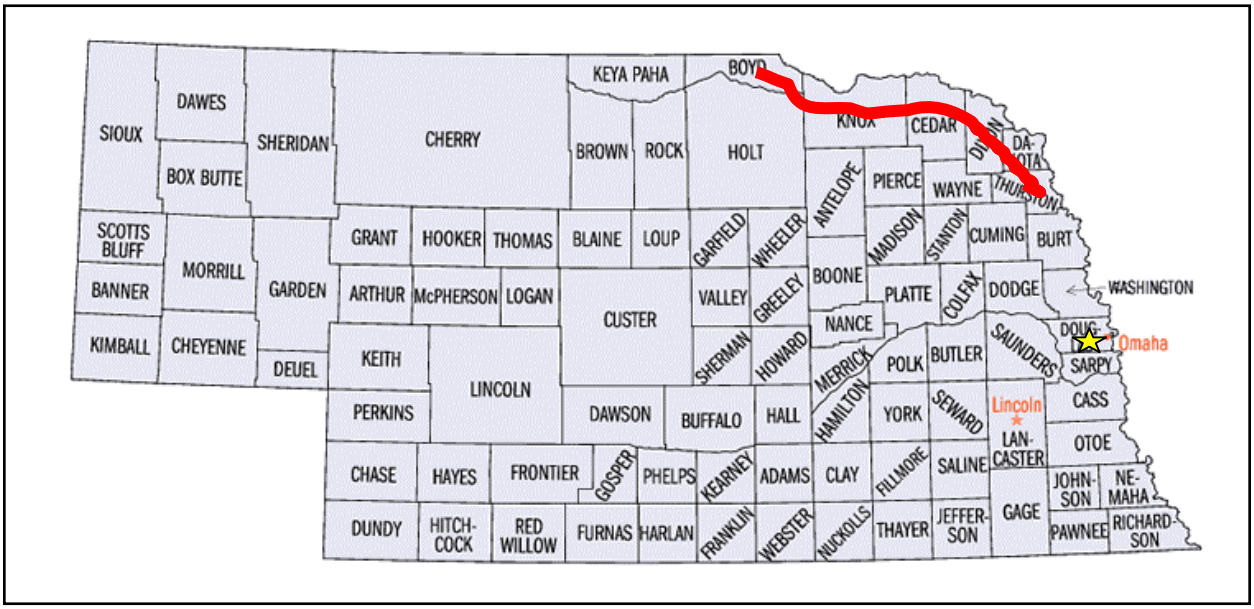

Figure 6. Potential distribution map of *Viburnum opulus* var. *americanum* in Nebraska. The red line represents a presumed or predicted area of occurrence of the species from the various sources that have indicated that Nebraska is part of the natural range of this species. The yellow star indicates a recently mapped county. Source: USDA Natural Resources Conservation Service PLANTS Database, as of March 27, 2006.

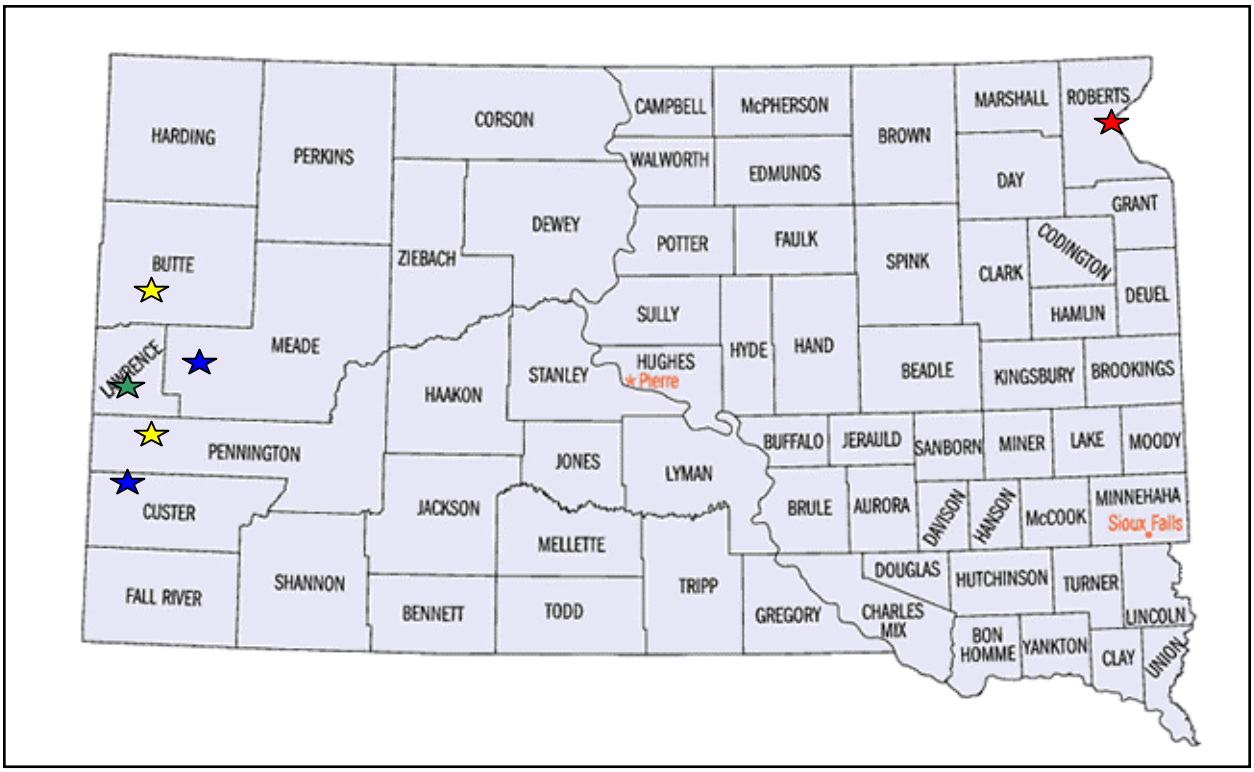

Figure 7. County distribution map of *Viburnum opulus* var. *americanum* in South Dakota. The green star in Lawrence County is based on locations of known populations from herbartium specimens at the University of Wyoming Herbarium (2005). The yellow stars in Butte and Pennington counties are based on the map from the USDA Natural Resources Conservation Service PLANTS Database (2005). The blue stars are additional reports from recent USDA Forest Service Region 2 searches (USDA Forest Service 2005c). The red star in Roberts County is based on the report by Stephens (1973).

the Northern Great Plains considers *V. opulus* var. *americanum* with potential but undetermined presence within Wind Cave National Park, South Dakota.

Viburnum opulus var. *americanum* is part of the Wyoming flora (Nelson and Hartman 1997), and Dorn (1977) has reported it from Crook County (**Figure 8**). It has never been listed as a component of the flora of Yellowstone National Park (McDougall and Baggley 1936, Shaw 1981). Crook County is similarly the only county indicated by NatureServe (2005). *Viburnum opulus* var. *americanum* is uncommon to rare in Wyoming with only a few occurrences and is considered disjunct (i.e., all of the Black Hills sites from both South Dakota and Wyoming) from its main distribution across the eastern and central United States and southern Canada. Based on readily available published sources, Crook County is the primary county of occurrence in Wyoming, although the Wyoming Natural Diversity Database (2005, report by Fertig 2000) reports three extant occurrences spread over three counties, Niobrara, Sheridan, and Crook counties (**Figure 8**). This source stated that these three occurrences were last surveyed in 1989. A fourth occurrence was previously only known from a historical record of 1895, and it was thought to be a cultivated site; however, it was confirmed to be a wild population in 1981 (Wyoming Natural Diversity Database 2005). The population in Dugout Gulch in Crook County was considered "very small" (no figures were supplied from this source). A population also occurs in the Sand Creek Late Successional Landscape of the Black Hills National Forest (USDA Forest Service 2002). The distribution map supplied by the University of Wyoming Herbarium (2005) differs from the Wyoming Natural Diversity Database (2005, report by Fertig 2000) in that it shows *V. opulus* var. *americanum* occurring only in Crook County, and not in Niobrara or Sheridan counties. This discrepancy may be due to the fact that the University of Wyoming Herbarium map is two years older than the report by Fertig. The University of Wyoming map shows four separate occurrences located in Crook County although some of these are very close to each other in the same general area. Specimens currently on file at the University of Wyoming Herbarium (2005) for *V. opulus* var. *americanum* support the mapping of only

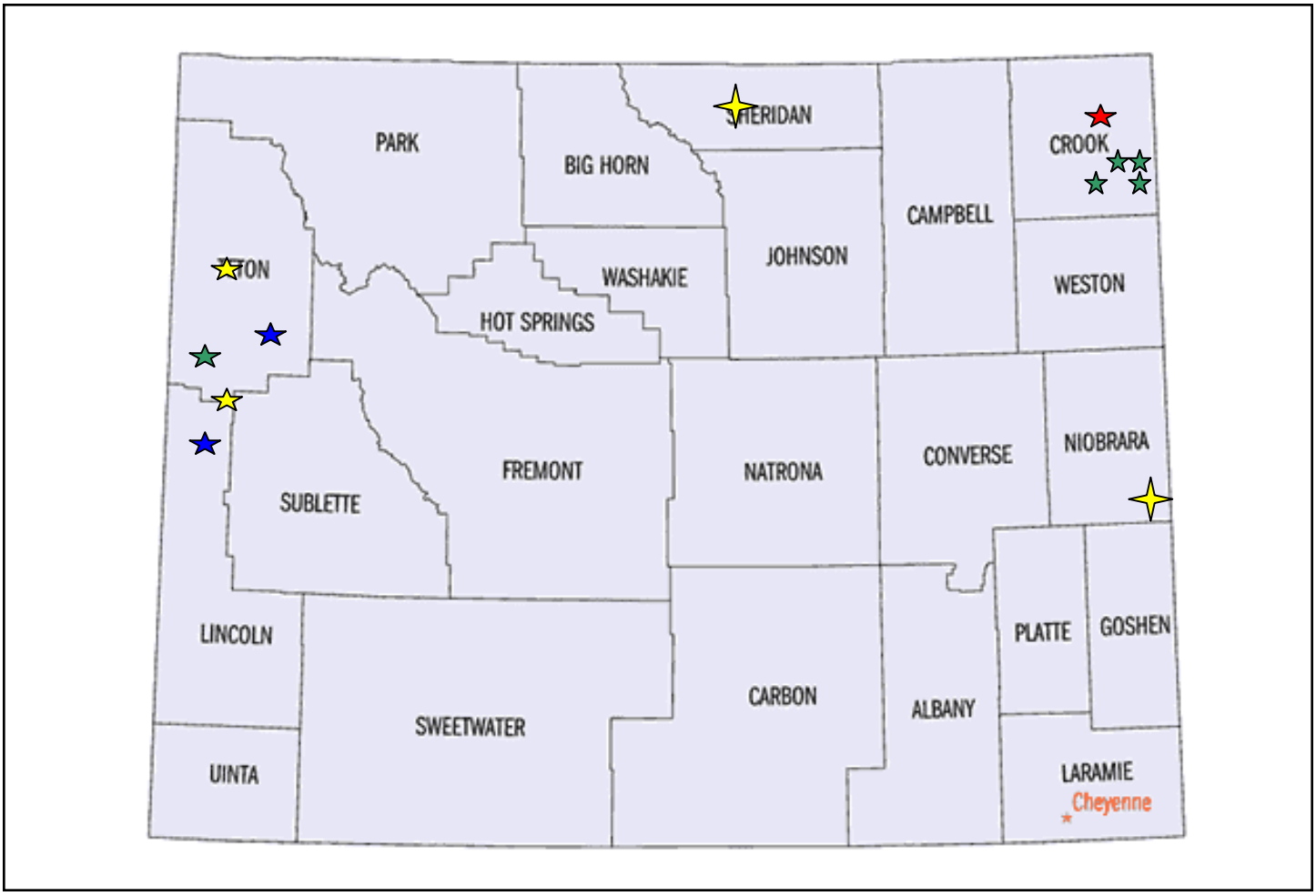

Figure 8. Distribution map of *Viburnum opulus* var. *americanum* in Wyoming. Green stars indicate approximate locations of known populations based on herbarium specimens (1998 to current). Yellow stars are additional sites mapped on the report by Walter Fertig in 2000 (Wyoming Natural Diversity Database 2005). Source: University of Wyoming Herbarium 2005.

Table 2. Specimen records of *Viburnum opulus* var. *americanum* in Wyoming (as labeled, or labeled as just *V. opulus*) at the University of Wyoming Herbarium.

County	Year of collection	Location	Elevation (ft.)	Notes on Habitat and Plant Community
Crook	1990	Black Hills, Sand Creek Crossing, about 9 miles south of Beulah, T51N, R60W, NE¼ Sec. 18	5,000	Sand Creek, birch-hazelnut woods west of creek
Crook	1990	Black Hills, Sand Creek drainage, about 2 miles above confluence with a side drainage, T51N, R60W, SE¼ NW¼ Sec. 20	5,500	Upper Sand Creek drainage, in bottom of side drainage, on mossy, rocky, north-facing lower slope with *Dryopteris felix-mas*, *Corylus cornuta*, *Rubus parviflorus*, and *Picea glauca*
Crook	1989	Black Hills, Corral Creek, west-south-west of Sand Creek Crossing, about 9 miles south of Beulah, T51N, R60W, NW¼ NW¼ Sec. 18	4,950	Corral Creek, with birch and hazelnut in bottom of draw
Crook	1982	Black Hills National Forest, vicinity of Cranberry Spring, T51N, R61W, SE¼ Sec. 11	4,500	In ravine
Crook	1983	Black Hills, Dugout Gulch, about 5.5 miles south of Beulah, T52N, R60W, W½ Sec. 30	4,300	Dugout Gulch, deciduous thickets at meadow edge
Crook	1981	Dugout Gulch, T52N, R60W, NW¼ Sec. 30	4,200	Dugout Gulch, birch-hazelnut with *Sambucus* and *Mahonia*
Crook	1895	Sundance, T51N, R63W, Sec. 13	4,800	Not given

Crook County (**Table 2**). There are seven specimens from what appear to be four or five distinctly different locations or watersheds extending from 1895 to 1990. Currently, there are no registered specimens from Sheridan or Niobrara counties. Surveys conducted by USFS Region 2 botanists to date have now identified up to nine occurrences in Crook County (USDA Forest Service 2005c). Whether some of the newest reported occurrences are confluent with existing occurrences has yet to be determined (Heidel personal communication 2006). Estimated population sizes (i.e., again reported as number of stem clusters) ranged from a low of only one plant to a high of 64 plants. Most sites had fewer than 20 plants (USDA Forest Service 2005c).

Specimens of *Viburnum opulus* var. *americanum* on file at the University of Wyoming Herbarium (2005) also support the occurrence of the species in several other watersheds on the South Dakota side of the Black Hills National Forest (Lawrence County; **Table 3**). At this time, these herbarium data do not support the USDA-NRCS (2005) mapping of Butte and Pennington counties or the reports for Meade and Custer counties. Perhaps herbarium data supporting these counties are not yet fully registered or perhaps are located only in South Dakota herbaria (not obtained for this report). Additional specimens on file at the University of Wyoming Herbarium (2005) lend support to the distribution of *V. opulus* var. *americanum* to areas outside of Region 2 (**Table 4**).

Population trend

No published scientific information on the population trend for *Viburnum opulus* var. *americanum* in Region 2, or anywhere else was found. There are some demographic recruitment studies (to be discussed in other sections), but some of these are on the European variety and were not done for the purposes of assessing the long-term trend of the species as a rare plant. Although there are numerous reports on the biology of this plant that will be covered elsewhere in this report, there are very few plant population ecologists studying particular populations or sets of populations from which one can make any clear, scientifically-based conclusions on the trend of this species.

Clements and Schwartz (1914) described *Viburnum opulus* var. *americanum* as being rare in the Rocky Mountain Region in the early 1900's. Based on the information summarized in the previous section, one could arrive at the same conclusion today. It has apparently never been reported as part of the natural flora of Colorado. There are no verifiable reports that it has been extirpated from anywhere except for the one county in which it occurred in the northern tip of Idaho (Idaho Fish and Game Conservation Data Center 2005). Within Region 2, its stronghold was the Black Hills 100 years ago and remains as such today. In other words, on a qualitative level, it is not apparent whether *V. opulus* var. *americanum* is substantially decreasing or increasing in Region 2.

Table 3. Specimen records of *Viburnum opulus* var. *americanum* in South Dakota (as labeled or labeled as just *V. opulus*) at the University of Wyoming Herbarium.

County	Year of collection	Location	Elevation (ft.)	Notes on Habitat and Plant Community
Lawrence	1989	Black Hills, Bear Gulch, about 0.5 miles below Knight Spring and about 8 miles west-south-west of Spearfish, T6N, R1E, NW¼ NE¼ Sec. 30	4,400	Bear Gulch, below Knight Spring, birch-hazelnut woods near creek
Lawrence	1983	Black Hills, vicinity of Roughlock Falls, about 13 miles southwest of Spearfish, T5N, R1E, SW¼ Sec. 36	5,300	Vicinity of Roughlock Falls
Lawrence	1953	Roughlock Falls, T5N, R1E	Not given	Along stream at Roughlock Falls
Lawrence	1928	Black Hills, Roosevelt Mt. road	Not given	Not given
Lawrence	1928	Roosevelt Mt. road	Not given	Gulch
Lawrence	1926	Tinton, locally common	Not given	On shaded slope

Table 4. Specimen records of *Viburnum opulus* var. *americanum* in States or Provinces Outside of USFS Region 2, from about the Mississippi River westward (labeled, annotated, or filed under *V. opulus* or its synonyms) at the University of Wyoming Herbarium.

State/Province	Year of collection	Location	Notes on Habitat and Plant Community
Minnesota	1978	Beltrami County, about 17 miles northwest of the Waskish Airport	On a conifer island dominated by larch and black spruce, Ovoid Islands Area
Minnesota	1947	Itasca County, 12 miles south of Grand Rapids	At edge of swamp
Minnesota	1900	Red Lake River	Woods
North Dakota	1912	Ft. Totten	Woods on lake shore
North Dakota	1910	Turtle Mountains, Rolette County	Not given
North Dakota	1905	Turtle Mountains, Bottineau County	Woods
North Dakota	1902	Walhalla	Not given
Manitoba	1933	Brandon	Not given
Manitoba	1933	Brandon	Not given
Saskatchewan	1973	Greenwater Lake Provincial Park, 26 miles north of Kelvington	Aspen dominated woods above Green Water Lake
Saskatchewan	1972	Mile 16 on Highway 155, 16 miles north of Green Lake	Wooded slopes above river shoreline with *Populus balsamifera* and *Salix* spp.
Saskatchewan	1964	Cypress Hills, T11, R20, Sec. 4	Under aspen-balsam poplar, moist
Saskatchewan	1964	Vicinity of Cumberland House, along Saskatchewan River	Mixed upland forest on levee of the Saskatchewan River, in woods with *Populus balsamifera*, *Picea glauca*, and *Betula papyrifera*
Saskatchewan	1947	Cypress Hills, Birch Creek Ranger Station, common	Rich aspen woods

Based on all of the accumulated information to date, it would appear that the distribution and abundance of *Viburnum opulus* var. *americanum* are quite stable, at least minimally within its core area of distribution encompassing the northeastern to central parts of the United States and southern Canada. It is apparently less secure or stable on the periphery of its range (e.g., the states of Ohio and Indiana where it has been listed as threatened or endangered).

Habitat

The USFWS has classified numerous species across the United States for their tendency to be wetland plants, and *Viburnum opulus* var. *americanum* is classified as a wetland plant across its entire range (U.S. Fish and Wildlife Service 1988, 1996). This plant is classified as either 1) a facultative (FAC) plant, meaning that it has a similar likelihood of occurring (33 to 67 percent chance) in both wetlands and non-wetlands, or 2) a facultative-wetland (FACW) plant, meaning that it usually occurs (between 67 and 99 percent frequency) within wetlands, but it sometimes (1 to 33 percent frequency) occurs in non-wetlands. Given this classification and the numerous accounts of its occurrence in wetland and riparian settings, *V. opulus* var. *americanum* minimally requires moist to damp soil, but it can be found in well-drained soil. This species is usually found adjacent to or in the vicinity of a reliable water source, but it is not restricted to wetland habitats.

Macrohabitat: general

Wetlands as they are defined by the U.S. Fish and Wildlife Service (USFWS) and used for inventory and mapping purposes for the National Wetlands Inventory are as follows (Cowardin et al. 1979):

- lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water;

- lands with one or more of the following three attributes:
  1) at least periodically support predominantly hydrophytes
  2) a substrate that is predominantly un-drained, hydric soil

3) a substrate that is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year.

This is probably the most applicable definition useful towards circumscribing the generalized wetland macrohabitat features for many of the potential habitats for *Viburnum opulus* var. *americanum*.

Wetlands have also been defined in regulatory terms (Wetland Training Institute 2001). Wetlands are lowland areas that are inundated or saturated with water for a sufficient time to allow a prevalence of hydrophytic vegetation to develop. Jurisdictional wetlands, those protected from unauthorized dredge-and-fill activities under Section 404 of the Clean Water Act and implemented by the USACE, have three essential characteristics:

1) dominance by hydrophytic vegetation, which requires inundated or saturated soils

2) hydric soils (i.e., soils that are ponded or flooded for a sufficient time during the growing season to develop anaerobic conditions)

3) wetland hydrology, or the availability of surface water or groundwater to create a wetland environment; how wetlands primarily receive their water (e.g., precipitation, surface flow, underground seepage) is important to their functioning and species composition.

While these regulatory definitions generally reflect those of the USFWS, they are narrower in scope than those of the USFWS.

Within Region 2, which contains central prairies and plains to the east and Rocky Mountain forests and alpine vegetation to the west, the term wetland can encompass bogs, fens, bottomlands, floodplains, marshes, playas, potholes, swamps, wet meadows, and wet prairies (Barbour and Billings 2000). Bottomlands appear to be a typical habitat in the Black Hills National Forest (Zacharkevics personal communication 2006).

Macrohabitat: Viburnum opulus var. *americanum*

In the eastern to central parts of its range, *Viburnum opulus* var. *americanum* is described as occurring in moist woods (Gleason and Cronquist 1963), wet thickets and shores (Seymour 1969), woods and low places (Petrides 1972), and moist, swampy sites, along roads and on alluvial plains (Dwelley 1980). The European variety is described as planted and escaped and could appear in peat bogs where it is also known to occur in Poland (Kepczynski and Peplinska 1998). In New England states, *V. opulus* var. *americanum* occurs in low cool woods, along water courses, thickets, hedgerows, and roadsides (Hyland and Steinmetz 1944, Pease 1964, Harris 1975). In Pennsylvania and West Virginia, *V. opulus* var. *americanum* occurs in swamps, fens, along streams, and in wet woods (Strausbaugh and Core 1970-77, Rhoads and Klein 1993).

In Ohio, *Viburnum opulus* var. *americanum* occurs in fens, marshes, moist woods, and thickets, and it is found in both filtered and full sun settings (Ohio Department of Natural Resources 2005). In Indiana, it occurs in low woods and the borders of lakes and streams (Deam 1940). *Viburnum opulus* was identified as a component of the vegetation along Juday Creek in northern Indiana where stream restoration was being conducted to mitigate for golf course impacts to the watershed (Moerke et al. 2004). In Illinois, it occurs in low, moist, and rich woods (Tehon 1942, Jones and Fuller 1955, Mohlenbrock 1986). In Michigan, it grows on low grounds (Billington 1949), around swamps, borders of woods, wet roadsides, along rivers, and edges of fens (Voss 1996). *Viburnum opulus* var. *americanum* was reported to occur in wetland forest zone I (the river corridor zone) along several river study sites in Michigan (Inman et al. 2002). In Minnesota, it is described as occurring in swamps and low ground (Clements et al. 1912). In Ontario, Canada, it occurs in damp soil around swamps, bogs, streams, and in low cool open woods and thickets (Soper and Heimburger 1982). In a similar fashion, *V. opulus* var. *opulus* occurs in shadier and moister conditions and generally occurs on soils that are wet some part of the year, and it can be found in peaty and waterlogged soils as well (Kollmann and Grubb 2002).

In the Great Plains region, *Viburnum opulus* var. *americanum* is described as occurring on moist, wooded hillsides or in low woodlands (Great Plains Flora Association 1986). In the northern Great Plains, it is also described as occurring in aspen and poplar groves and parkland, along river valleys and low places (Vance et al. 1984). In South Dakota, it is described as occurring in rich wooded ravines (Van Bruggen 1985). Across both South Dakota and North Dakota, it is described as occurring along wooded lakeshores and low wet woods, in moist, springy substrates, or even on rocky and brushy hillsides that are moist (Stephens 1973). Within

these two states *V. opulus* var. *americanum* would be expected to occur along permanent streams, on rich alluvial soils, and around lakes and other wet areas. The Turtle and Pembina mountains (low mountains or hills) of North Dakota do contain many lakes and bogs (Stephens 1973) and a mix of northern coniferous forest and eastern deciduous forest. The occurrence of *V. opulus* var. *americanum* along drainages in North Dakota is part of a finger-like westward spread of similar plant communities from farther to the east (Stephens 1973). Eastern deciduous forest would likewise finger its way up drainages across these states from east to west. The Black Hills occurrences could be considered disjunct populations. The Black Hills are a part of the Rocky Mountain cordilleran system that is completely surrounded by prairie; they contain a mix of Rocky Mountain cordilleran forest, northern conifer forest, and eastern deciduous forest. *Viburnum opulus* var. *americanum* is apparently equally associated with eastern deciduous forest habitats as it is with northern conifer or boreal forests and its associated aspen forests. It appears from much of the habitat descriptions across North America for this taxon that it is much more closely tied to riparian, lakeshore, wetland, and damp woods habitat characteristics (i.e., hydrological conditions) than it is to any particular kind of forest overstory cover.

In Wyoming, *Viburnum opulus* var. *americanum* is described as occurring in moist woods and thickets in low woodlands or on hillsides if moist (Dorn 1977, Wyoming Natural Diversity Database 2005). Across North Dakota, Manitoba and Saskatchewan, Canada, *V. opulus* var. *americanum* was identified as an important component of the habitat characterizing sites containing the native American hops (*Humulus lupulus* var. *lupuloides*) (Hampton et al. 2001). These were well-drained terraces of river and stream basins and included one site along the White Earth River in North Dakota, several sites along the Souris River from Minot, North Dakota, northwest into Saskatchewan, and other sites along the Qu'Appelle River in Saskatchewan, and the Assiniboine River in Manitoba. In Montana, *V. opulus* var. *americanum* occurs along stream banks (Lackschewitz 1991). In Idaho, the species' natural habitat is described as moist woods (Idaho Fish and Game Conservation Data Center 2005). In Alberta, Canada, it occurs along rivers and in moist woods (Moss and Packer 1983), and in poplar groves, river valleys, open moist woods, with scattered occurrences in aspen parkland and boreal forest (Wilkinson 1990). In British Columbia, Canada, it occurs in damp woods (Clark 1973). For the Pacific Northwest, in general, it was described as occurring in moist woods (Hitchcock and Cronquist 1973). From this discussion, it can be seen that the Native American Ojibwa (Chippewa) had the name of this plant pegged perfectly centuries ago by naming it Pembina, "born by a river."

Finally, **Table 2** presents habitat notes for herbarium specimens at the University of Wyoming Rocky Mountain Herbarium (2005) collected from Crook County, Wyoming. The specimens come from ravines, gulches, draws, and thickets near streams. This is similarly the case for specimens from Lawrence County, South Dakota (**Table 3**). USFS Region 2 surveys generally report habitat conditions as mesic bottomlands, which can be saturated at times, while some sites are lower to mid-mesic slopes (USDA Forest Service 2005c). All of these observations represent habitats within the Black Hills populations.

Vegetation associations and plant community

Based on herbarium records from the University of Wyoming Rocky Mountain Herbarium from jurisdictions outside of Region 2 (**Table 4**), plants associated with *Viburnum opulus* var. *americanum* include *Picea mariana* (black spruce), *Larix laricina* (larch or tamarack), *Populus tremuloides* (quaking aspen), *Populus balsamifera* (balsam poplar), *Salix* spp. (willows), and *Betula papyrifera* (paper birch) (**Table 4**). For Black Hills populations in Wyoming and South Dakota, associates have been identified as *Betula* spp. (birch), *Corylus* spp. (hazlenut), *Sambucus* spp. (elderberry), *Mahonia* spp. (barberry), *Rubus parviflorus* (thimbleberry), *Picea glauca* (white spruce), and *Dryopteris felix-mas* (male fern) (**Table 2**, **Table 3**). Using such information, USFS Region 2 has summarized its community associates for the Black Hills as occurring in ravines and deciduous thickets of birch-hazelnut communities at 4200 to 4950 feet in elevation (USDA Forest Service 2002).

Viburnum opulus var. *americanum* is reported to be a species component of the *Populus tremuloides* forest alliance (U.S. Geological Survey and National Park Service 2005). This alliance, which is a subcomponent of montane or boreal cold-deciduous forest, has an extensive distribution across the western United States, northern Great Plains, into the western Great Lakes area. It can be found at elevations ranging from 900 to 3350 m. It is limited to soils that are usually deep, well-drained, and loamy and that have moisture levels adequate to meet the evapotranspiration needs of the vegetation. *Viburnum opulus* var. *americanum* tends to be more associated with this alliance as it occurs in the Midwestern United States (e.g., Minnesota and Iowa),

south-central Canada, and the northern Great Plains. In the northern Great Plains, the Turtle Mountains and Pembina Hills of North Dakota are good examples for the occurrence of this forest alliance. In addition to *P. tremuloides*, tree associates in this alliance include *P. balsamifera*, *Betula papyrifera*, *Quercus macrocarpa* (bur oak), *Q. ellipsoidalis* (northern pin oak), *Fraxinus pennsylvanica* (green ash), *Tilia americana* (American basswood), and *Ulmus americana* (American elm). Shrub associates may be *Corylus americana* (American hazelnut), *C. cornuta* (beaked hazelnut), *Prunus virginiana* (chokecherry), *Symphoricarpos occidentalis* (western snowberry), *Amelanchier alnifolia* (Saskatoon serviceberry), and *Rubus* spp. (blackberry), with *Cornus* spp. (hazelnut) and *Salix* spp. (willow) in wetter sites. Herbaceous species associates may be *Aralia nudicaulis* (wild sasparilla), *Carex pensylvanica* (Pennsylvania sedge), *Maianthemum canadense* (Canada mayflower), *M. stellatum* (starry false lily of the valley), *Sanicula marilandica* (Maryland sanicle), *Oryzopsis asperifolia* (roughleaf ricegrass), *Schizachne purpurascens* (false melic), *Viola* spp. (violet), and *Thalictrum dioicum* (early meadow-rue) (U.S. Geological Survey and National Park Service 2005). The *Populus tremuloides* forest alliance is likely maintained by stand-replacing forest fires. Disease, windthrow, and tree cutting by beaver (and humans) can also be disturbances influencing this alliance. Where this alliance occurs in Wyoming and the Dakotas, it can persist as a stable habitat for dozens of years, but farther to the east this alliance is more likely to make a successional change to other community types (U.S. Geological Survey and National Park Service 2005). Plant community associates reported from USFS Region 2 surveys include most of those identified above as well as *Picea glauca*, *V. lentago* (nannyberry), *Ostrya virginiana* (hophornbeam), and *Pinus ponderosa* (ponderosa pine) (USDA Forest Service 2005c).

Viburnum opulus var. *opulus* in Poland has been associated with over 20 different plant communities and subcommunities (mostly forested communities) (Czekalski 1984). It appears to be less associated with a particular overstory composition and more determined by generally moist or mesic abiotic habitat conditions as they may be modified by the associated vegetation. This trend is indicative elsewhere across Europe (Kollmann and Grubb 2002) and similar to that of the American variety.

Reproductive biology and autecology

Viburnum opulus var. *americanum* plants flower from May to July, depending on the local environmental conditions, and the fruit ripen in August to October. Although it is a shade tolerant species, flowering and subsequent fruiting are better under conditions of greater light (USDA Natural Resources Conservation Service 2005). This means that populations in canopy gaps will likely have higher reproductive potential. *Viburnum opulus* var. *americanum* is considered to be dependent on insect visitation for seed set (Thaler and Plowright 1980). Through a flower bagging experiment to exclude insect pollinators, they determined that bagging significantly reduced seed set. In Michigan, syrphid flies (Family Syrphidae) of the genus *Temnostoma* are known to be attracted to the flowers of *V. opulus* var. *americanum* (Waldbauer 1984) and may be involved in pollination. *Viburnum opulus* var. *opulus* planted in Ontario, Canada was studied for insect pollinators, and 49 different species of insects were observed visiting the flowers (Krannitz and Maun 1991a). Because of such a large variety of insect pollinators *V. opulus* is considered to have a generalist pollination system. Insect visitors in the Krannitz and Maun (1991a) study included syrphid flies, solitary bees (families Andrenidae and Halictidae), and even plant pests such as the tarnished plant bug (*Lygus lineolaris*) and the seed-corn maggot (*Delia platura*); solitary bees were the most effective pollinators. Day-flying Lepidoptera have been reported on *V. dentatum* and *V. prunifolium* in central Illinois (Tooker et al. 2002), and although visitation to *V. opulus* var. *americanum* was not mentioned in this study, it might be an over-looked consideration. *Cetonia* sp. beetles (family Scarabaeidae) have been reported as important pollinators of *V. opulus* var. *opulus* in Sweden (Englund 1993a). Beetles demonstrated fidelity to individual cranberrybush plants, and they also showed strong constancy through their preference for cranberrybush over other species of plants by making frequent inter-plant flights. Beetles flew more than four times the nearest plant neighbor distance and were considered important mechanisms for pollen dispersal and gene flow. Digger wasps (genus *Crossocerus*) in Germany are reported to feed on the nectaries of *V. opulus* var. *opulus* (Haeseler 1987). Whether they may have any impact on pollination is not known.

Dispersal of seed from *Viburnum opulus* var. *americanum* will occur from fall through late spring, and birds such as cedar waxwings (*Bombycilla cedrorum*) are the primary dispersal vectors. Plants may begin bearing seed at eight years of age and bear seeds each year thereafter (summarized in Young and Young 1992). There are approximately 30 seeds per g. The seeds may be stored dry at low temperatures for several years and remain viable. The seeds of both *V. opulus* var. *americanum* and *V. opulus* var. *opulus* have

a type of embryo dormancy called deep simple epicotyl morphophysiological dormancy ("epicotyl dormancy" for short) as do six other species in the genus *Viburnum* (Young and Young 1992, Baskin and Baskin 2001). The morphological (or physical) component of the dormancy pertains to the hard seed coats. The seeds naturally require two years after-ripening before they will fully germinate; about 50 percent will germinate in the first season, the rest remaining to the second season in a two-cycle germination sequence. However, one cycle of alternating 20 ºC (for one week) and 2 ºC (for one week) can shorten the total germination time to 4½ months (Fedec and Knowles 1973b). Some reports indicate that the European variety will germinate more readily in the first year (Lee et al. 1991). The seed coat was reported to contain an unidentified water soluble inhibitor to germination (Fedec and Knowles 1973a). The radicle (root tip) will emerge the first autumn, then the epicotyl (shoot tip) will emerge the following spring, the epicotyls requiring the cold treatment (the radicle has non-deep dormancy and requires warm temperatures for growth activation) (Baskin and Baskin 2001). Contrastingly, the USDA Natural Resources Conservation Service (2005) contradicts this summarization by Baskin and Baskin (2001) by stating that no cold stratification is needed. The required cold treatment ranges from 60 to 90 days. Gibberellic acid can overcome epicotyl dormancy (Fedec and Knowles 1973b). The biochemical source of the inhibition is located in the cotyledons (seed leaves), because if these are removed, epicotyl dormancy breaks. Seeds will germinate in Petri dishes on a paper towel substrate with additional layers placed above the seeds, or they may be placed on top of a sand/soil substrate in Petri dishes. They require eight hours of light and a 20 ºC night/30 ºC day temperature regime. As described above, seeds may be placed in a nursery bed planting in spring, will remain and overwinter, and then germinate the following spring (Young and Young 1992). The seedlings may require shade. The plant can be propagated from cuttings and will resprout when cut. Germination success of *V. opulus* from seeds regurgitated by robins (*Turdus migratorius*) was 50 percent (Jones and Wheelwright 1987).

Viburnum opulus var. *opulus* allocates 61 percent of the total nitrogen in fruits to the seeds and 35 percent to the outer flesh component of the fruit (Lee et al. 1991). Grubb et al. (1996) studied the effects of light level and soil nutrient supply to seedlings of several species of tall shrubs of Europe, including *V. opulus* var. *opulus*. Tall shrub species such as *V. opulus* var. *opulus* can be important components along forest edges and in gaps; they contribute to succession and are often not easily established in mature forest. Most do not produce long-lasting seed banks. *Viburnum opulus* var. *opulus* was one of the species demonstrating low mortality (1 to 7 percent) under deep shade (0.3 to 1.6 percent full sunlight). This species is moderately responsive to increased light levels by demonstrating increased growth, mainly in the transition from 1.6 to 11 percent light, when seedlings can show a 300 percent increase in growth. It did not demonstrate much additional growth when comparing conditions of 11 percent light to 63 percent light. *Viburnum opulus* var. *opulus* did not respond to increased nutrient levels in the soil until it reached at least 11 percent light, when it showed a 75 percent growth increase in response to increased soil nutrient level (Grubb et al. 1996). Specific leaf area (cm^2 of leaf per gram of leaf) of *V. opulus* var. *opulus* decreased with increasing light, but the total number of leaves and total leaf area increased until moderate light levels were attained at which these parameters reached their maximum. These data support general observations that *V. opulus* var. *opulus* is a late successional species found in shadier settings. Due to the close relationship between the American and European varieties, similar environmental responses may be expected for *V. opulus* var. *americanum*.

Sack and Grubb (2002) studied the effects of drought on the growth and biomass allocation of several species of woody plant seedlings, including *Viburnum opulus* var. *opulus*. The study was conducted in Great Britain on first-season shade tolerant seedlings under both low light and high light conditions. Low light conditions were 3 to 4 percent of full daylight, and high light conditions were 30 to 40 percent of full daylight. The well-watered treatment was watered every three to four days while the drought treatment received water only five times during the entire 8-week experiment. The drought condition resulted in soil water matrix potentials ranging from -0.03 to -2 MPa (MPa = megaPascal; 1 atmosphere (atm) = 1.01 bars = 760 mm Hg = 0.1013 MPa). Shading alone (at the 3 to 4 percent rate) reduced dry mass relative growth rates by 56 to 73 percent. The drought treatment also significantly reduced the relative growth rate for *V. opulus* var. *opulus* by 26 percent, but it did not significantly alter biomass allocation patterns for the seedlings (Sack and Grubb 2002). Shading and drought acted independently in their effects on the seedlings. *Viburnum opulus* var. *opulus* maintained a better relative growth rate under shade, indicating its shade tolerance, but it was much more sensitive to drought than other species tested. Hence niche differentiation was observed among the species studied; *V. opulus* is more shade tolerant but less drought tolerant, thus requiring a more consistently moist habitat.

Viburnum opulus is known to contain leucoanthocyanin pigments (Gibbs 1974), some of which are cyanidin-3-glucoside and cyanidin-3-arabinosylsambubioside in the American variety and cyanidin-3-arabinoglucoside in the European variety (Wang and Francis 1972, Du et al. 1974). These pigments give the fruits their bright red color. This species is also reported to contain the semi-toxic to toxic class of compounds called saponins (Makovicka et al. 1990), arbutin, iridoid glycosides in its foliage, and catechin in its bark (Bock et al. 1978, Ivanov et al. 1984, Miura et al. 1985). Fruits of *V. opulus* contain water soluble acidic polysaccharides (similar to pectins) (Ovodova et al. 2000) along with chlorogenic acid, betasitosterol, ursolic acid, valeric acid, and oxalate crystals when unripe (Jones and Wheelwright 1987, Foster and Duke 1990, Kollmann and Grubb 2002), making for possible mild toxicity and the bitter taste. Fruit pH ranges from 2.8 to 3.0, is quite acidic and is much lower than some other species of *Viburnum* (e.g. *V. dentatum* at pH 5.1) (Jones and Wheelwright 1987). *Viburnum opulus* var. *americanum* is also reported to contain the alkaloid viburnine (USDA-Natural Resources Conservation Service 2005), and the lipid (fats and oils) content of its seed endosperm is 34 percent on an oven dry-weight basis (Fedec and Knowles 1973b).

Ostrom (1983) has developed estimates for standing biomass of trees and shrubs on commercial forest stands in Michigan for various classes of forest composition. The potential ecological productivity of *Viburnum opulus* var. *americanum* within plant communities could be inferred in relationship to various forest cover types. **Table 5** shows fresh standing biomass figures for species of *Viburnum* under various types of forest stands. In a similar fashion, Smith (1986) also developed biomass yields for numerous species of plants in commercial forest stands across northern Minnesota, Wisconsin, and the Upper Peninsula of Michigan (**Table 6**). The equations used were those developed by Smith and Brand (1983). In general, the biomass figures presented by Smith (1986) are considerably smaller than those presented by Ostrom (1983). There is a greater tendency for *Viburnum* species (including *V. opulus* var. *americanum*) to be associated with aspen stands in Minnesota, as opposed to sites farther east. This observation concurs with flora accounts cited earlier (such as the association of *V. opulus* var. *americanum* with aspen parklands in Alberta, Canada) that demonstrate a plant community gradient pattern extending westward into the Great Plains states.

Brand (1985) has rated numerous trees and shrubs on a generalized environmental indices scale that includes moisture, nutrients, heat, and light. *Viburnum* species (with reference to the genus as a whole) were rated at moderate conditions for all of these environmental variables. These observations were based on 356 study plots in Minnesota (of which 16 contained *Viburnum* spp.) and 3,943 study plots in Michigan (of which 408 contained *Viburnum* spp.). *Viburnum opulus* var. *americanum* was reported to have an importance value of 20 (out of a maximum of 200) in wetland forest zone I (the immediate river corridor zone) across several river study sites in Michigan (Inman et al. 2002). The importance value is the sum of relative frequency and relative density for each species in the survey area. This zone also supports the greatest number of breeding bird species. The importance value for *V. opulus* var. *americanum* dropped to 8 in zone II (the inland floodplain farther from the river).

Table 5. Biomass of species of *Viburnum* under various types of forest stands in Michigan (from Ostrom 1983).

Forest Type Based on Dominant Species	Green (live) Standing Weight of Viburnum spp. (lbs/acre)[1]
Jack pine	34
Red pine	27
Balsam fir	239
Black spruce	98
Northern white cedar	47
Tamarack	137
Oak-hickory	189
Elm-ash-maple	192
Maple-birch	21
Aspen	99
Paper birch	56

[1]Includes all species of *Viburnum*.

Table 6. Biomass of species of *Viburnum* under various types of forest stands in Michigan, Minnesota, and Wisconsin (from Smith 1986).

	Green (live) Standing Weight of Viburnum spp. (lbs/acre)[1]			
Forest Type Based on Dominant Species	**Michigan**	**Minnesota**	**Wisconsin**	**Weighted Average of all three states[2]**
Jack pine	57	0	0	15
Red pine	42	23	0	8
Balsam fir	89	0	2	39
Black spruce	96	0	2	32
Northern white cedar	21	0	0	13
Oak-hickory	0	0	7	7
Elm-ash-maple	2	1	3	3
Maple-birch	2	1	5	3
Aspen	4	45	8	12
Paper birch	0	2	2	1

[1]Includes all species of *Viburnum*.

[2]This figure is based on the quantity of plots surveyed under each respective vegetation type for each state; there were anywhere from 30 to 1000 plots per vegetation type per state.

The only reported plant or stem density figure discovered during the literature search came from a European source. *Viburnum opulus* var. *opulus* occurs on annually flooded flood plains near the Danube River in the Czech Republic at densities of 175 plants per hectare (70.8 plants per acre) (Oszlanyi 1995). *Viburnum opulus* var. *opulus* produces numerous fine roots in the upper 20 cm of soil and does send deeper roots to below 100 cm (Kollmann and Grubb 2002). The highest tolerable leaf temperature recorded for a member of the genus *Viburnum* was 43.8 ºC (Levitt 1972). Although this is near the limit for many plant species, it is probably more applicable to southern species of *Viburnum* rather than the northern *V. opulus* var. *americanum*. The USDA Natural Resources Conservation Service (2005) reports that *V. opulus* var. *americanum* falls within the following environmental conditions of tolerance:

- a soil pH of 4.5 to 6.9
- a medium drought tolerance
- a medium fire tolerance
- an intermediate shade tolerance
- a medium tolerance to anaerobic conditions (i.e., roots experiencing conditions of poor oxygen supply as in complete flooding).

It will grow in well-drained to poorly drained soils, and it may take five to 10 years for the plant to reach a full mature size (e.g., flowering and fruiting). *Viburnum opulus* var. *americanum* is hardy in zones 2 through 8 in North America (North Carolina State University 2005).

Soil temperatures may affect the survival of *Viburnum opulus* var. *americanum* seeds planted in the fall (Ball 1987). A general recommendation was made to plant them four weeks before the soil temperature in the root zone drops to 7 ºC. Nursery stock of *V. opulus* var. *americanum* is consistently rated as very cold tolerant (Wachter and Cappiello 1996), and 100 percent of nursery stock will remain undamaged at -36 ºC (Wachter and Cappiello 1997). *Viburnum opulus* can apparently tolerate warmer climates like Florida, where it has been tested for production in containerized conditions (Ingram et al. 1989). Cuttings of *V. opulus* var. *opulus* root better in a peat-amended compost substrate than they do in perlite (Chong 1999). Cuttings of *V. opulus* steeped in water release unidentified water soluble root promoting substances (Kawase 1971). Cuttings of *V. opulus* var. *opulus* stored better under low pressure storage than under traditional refrigerated storage (Eisenberg et al. 1978).

Viburnum opulus var. *americanum* has an intermediate sensitivity to herbicides used to control various weeds among field grown landscape plants (Collins et al. 2001). The herbicides used in this study were sulfentrazone, alone and in combination with Gallery (isoxaben), Treflan (trifluralin), and Pennant (S-metolachlor). Sulfentrazone belongs to the aryl triazolinone chemical class. Trifluralin is a highly

volatile herbicide that needs to be soil incorporated, or else it volatilizes into the ambient air. For example, it has been reported that 90 percent of trifluralin applied to moist soil volatilized into the air within two to seven days after application (Glotfelty et al. 1984). Nellessen and Fletcher (1990), using data compiled in a computer database, predicted that herbicide drift and volatilization from herbicides such as trifluralin could have unintended impacts to native non-target sensitive plant species. Nitrous oxide (NO) and nitrogen dioxide (NO_2) air pollutants, which are emitted by automobiles, have been reported to cause an increase in foliar organic nitrogen content and total amino acids in phloem sap in *V. opulus* var. *opulus* (Bolsinger and Fluckiger 1987). This study indicates that air pollution has a physiological impact to the species. *Viburnum opulus* var. *americanum* could be similarly affected.

Ozone air pollution injury has also been observed for *Viburnum opulus* var. *opulus* (Novak et al. 2003). In Switzerland several species, including *V. opulus*, were studied to determine potential impacts of the amount of ozone exposure accumulated over a threshold of 40 ppb, the current European standard to protect forest vegetation. Of those species studied, *V. opulus* was rated at an intermediate sensitivity, and *V. lantana* was sensitive. Peak hourly ozone concentrations of 110 ppb to 139 ppb were recorded. Symptoms of ozone injury include upper leaf surface stippling, leaf discoloration such as reddening, yellowing, or bronzing (Novak et al. 2003). The genus *Viburnum* is rated as one of the more sensitive across Europe (Skelly et al. 1999). Given the close relationship between the American and European cranberrybushes, the native American variety could similarly be sensitive to ozone, which is one of the most common and prevalent air pollutants across the continent. The precursors to ozone air pollution can be transported long distances to form ozone over rural areas, so that they are not necessarily free from the possible impacts of air pollution.

Viburnum opulus var. *americanum* was rated as a sensitive species to chronic exposures to gamma irradiation (Dugle and Mayoh 1984). At the Field Irradiator Gamma research site at the Whiteshell Nuclear Research Establishment, in Manitoba, Canada, naturally growing shrubs were exposed to gamma irradiation ranging from the background level 0.1 µGy per hr up to 62 mGy per hr over a 6-year period (10 mGy = 1 rad). *Viburnum opulus* var. *americanum* was placed in the sensitive group with an LD_{50} (lethal dose that kills 50 percent of the population) of 4 mGy per hr. Vegetative mutations were observed in several other species of shrubs, but in *V. opulus* var. *americanum* increased levels of anthocyanin pigments were observed in the tissues (Dugle and Mayoh 1984).

Based on the information presented, as a woody perennial plant of semi-mature to mature forest ecosystems (late successional, but not necessarily climax), *Viburnum opulus* var. *americanum* would probably be best classified as a "K" species, a species with a relatively slower growth rate, lower reproductive rate, longer-lived species of stable to semi-stable habitats (Grime 1979). It will resprout when cut, indicating that it has some resilience to disturbances of the aboveground stems. Damage to roots and the soil substrate in general would probably be highly detrimental. Alterations to the natural hydrologic regime would likely also be highly detrimental. At the same time, the species may have some ability to recolonize disturbed and open niches in riparian and wetland habitats (Ohio Department of Natural Resources 2005), indicating that restoration of populations is potentially possible.

Demography

There are very few studies in the literature discussing the demographic life history characteristics of *Viburnum opulus*, and most of those are on the European variety. However, the studies on *V. opulus* var. *opulus* can be useful in understanding the potential demographics of the American variety. There are no individual studies that examine the full demographic picture from seed to seedling to mature plant and back to seed; the studies available cover various subcomponents of the life history. A simple lifecycle diagram can be found in **Figure 9**. This model was created using information on *V. opulus* autecology and reproductive characteristics reported on in the previous section, as well as information from this section and the next on Community ecology.

The diploid chromosome number for both American and European cranberrybush is 2n = 18 (Egolf 1962, Bassett and Crompton 1970, Moss and Packer 1983, Kollmann and Grubb 2002). *Viburnum opulus* var. *opulus* is reported to produce 9 seeds per m^2 per year (Kollmann and Grubb 2002). The number of fruits per flower cluster generally ranges from 10 to 30. In a long-term garden experiment, researchers reported an approximate density of 0.5 seedlings per m^2 in and around the experimental stand of plants (Kollmann and Grubb 2002). Soil seed banks in wetland habitats are low in viable seed (reviewed in Kollmann and Grubb 2002).

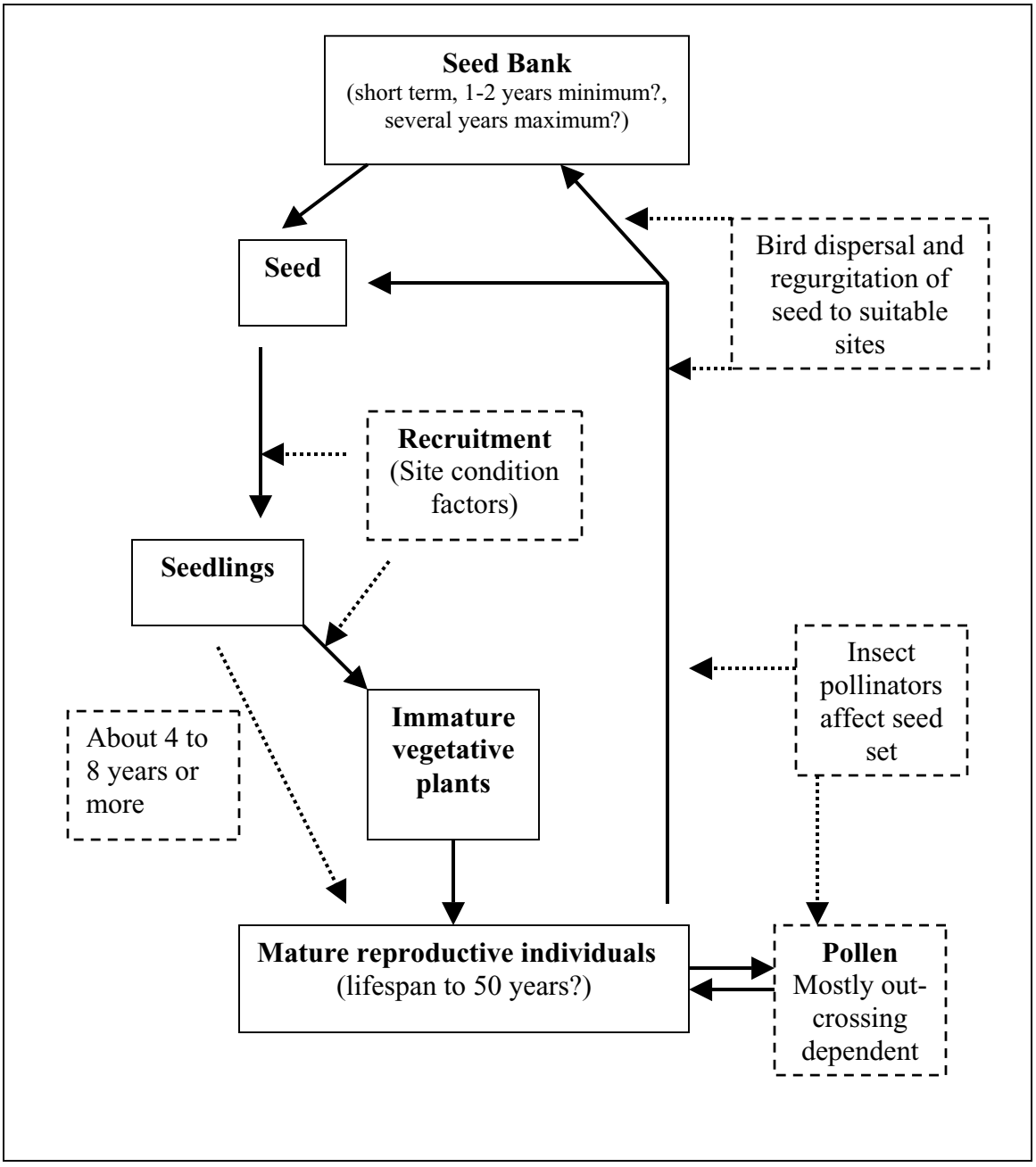

Figure 9. Lifecycle diagram for *Viburnum opulus* var. *americanum*.

Thaler and Plowright (1980) demonstrated through flower-bagging experiments, which excluded insect pollinators, that the fecundity of *Viburnum opulus* var. *americanum*, measured as mature fruits per flower cluster, was significantly reduced from a mean of 7.0 fruits in unbagged plants to 4.6 fruits in bagged plants. This study was conducted in New Brunswick, Canada. From about 1952 to the time of this study, aerial insecticide spraying of fenitrothion was being conducted to control for outbreaks of the eastern spruce budworm. Destruction of beneficial insect pollinators was an item of concern. Thaler and Plowright (1980) also demonstrated that the fecundity of *V. opulus* var. *americanum* was significantly reduced by aerial applications of this insecticide. Mean fecundity in fenitrothion-treated areas was 4.1 fruits per flower cluster and 17.3 fruits per flower in unsprayed areas. Fenitrothion is no longer in use, but this study shows that certain insecticides can negatively impact the reproductive ability of *V. opulus* var. *americanum*, and ultimately the ability to recruit new plants into existing populations.

Studies on the reproductive success of both *Viburnum opulus* var. *americanum* and *V. opulus* var. *opulus* were carried out by Krannitz and Maun (1991b) in Ontario, Canada. Wild *V. opulus* var. *americanum* experienced only 0.5 percent fruit initiation when flowers were bagged to exclude pollinators while unbagged flowers initiated fruit at the rate of 18.5 percent. A very similar result was recorded for *V. opulus* var. *opulus*. When European variety plants were deliberately cross-pollinated, fruit set at a rate of 83.9 percent. Although some limited self-pollination can occur, both varieties are essentially self-incompatible with an obligate outcrossing breeding system. The native American variety does, however, have a slightly better tendency to self pollinate than the European variety. There is a large variation in the number of flowers per cluster in both forms. The quantity of the small, fertile flowers in the American variety ranged from a low of 29 to a high of 535 flowers per cluster (mean of 220.9) (Krannitz and Maun 1991b). The number of large sterile flowers ranged from two to 20 (mean of 11.4). Larger clusters of plants tended to set more fruit (i.e., a greater percentage of fruit) than smaller clusters of plants even when the number of flowers was factored in. This means that larger clusters of plants have a better chance of getting pollinated and setting a greater percentage of fruits, which should ultimately lead to a better chance of recruiting new individuals into the population. This study should lead one to conclude that small populations have a better chance of going extinct if some environmental variable affects the species' reproductive or recruitment capability.

Eriksson and Ehrlen (1992) attempted to determine seed and microsite limitation factors for the recruitment of new individuals into the population for several species of woodland plant species in Sweden, including *Viburnum opulus* var. *opulus*. Seeds were planted in the vicinity of adult plants under either undisturbed vegetation conditions or in a disturbance area where the aboveground vegetation was purposely removed. The results could not effectively determine what the limitations for *V. opulus* var. *opulus* might be. No seedlings of *V. opulus* were observed germinating. The availability of seed and the properties of the seed itself were not considered as limiting factors, but the limiting factor was considered to be something other than disturbance-related microsites.

In Great Britain, *Viburnum opulus* var. *opulus* generally occurs as isolated individual plants although it can form thickets by layering (Kollmann and Grubb 2002). *Viburnum opulus* var. *opulus* may begin flowering at the age of four to five years and may live to 50 years of age (reviewed in Kollmann and Grubb 2002). Sapling growth rate begins to decline after about nine years of age.

Viburnum opulus var. *americanum* was among three species (including also *Prunus pensylvanica* [pin cherry] and *Abies balsamea* [balsam fir]) reported to experience thinning due to moose browsing in Newfoundland, Canada (Thompson et al. 1992). Browsing by moose may reduce the reproductive capability of *V. opulus* var. *americanum* by reducing stand density and the ability to recruit new individuals into the population. Contrastingly, the abundance of *V. opulus* var. *opulus* increased after five years of grazing by horses and cattle on a site in the Netherlands (DeBonte et al. 1999). Cattle and sheep grazing at a particular site in Finland were studied since the 1960's and 1970's, and it was observed that sheep had a quantitative negative impact on *V. opulus* var. *opulus* abundance (Haeggstrom 1990). Although slow growing, *V. opulus* var. *opulus* resprouts readily from rabbit browsing (Grubb et al. 1999). This ability to resprout from damage was classified as a resilient response to this type of stressor.

Population viability analyses have not been performed on *Viburnum opulus* var. *americanum*. Estimating minimum viable population sizes can become a risky extrapolation when the concrete field studies relating specifically to the taxon in question (and its site-specific conditions) have not been performed. Extrapolating between species of different life forms (e.g., herbaceous plants to woody plants) may not be completely appropriate. Several authors have discussed effective, minimum, or viable population sizes in general (or broad) terms that have been extensively discussed, debated, and applied by other scientists (Franklin 1980, Soulé 1980, Lande and Barrowclough 1987, Soulé 1987, Menges 1991, Lande 1995, Nelson 1999). The general rule of thumb model from these authors has been the 50/500 rule – isolated populations will need an effective population size of 50 individuals for short-term persistence and 500 individuals for long-term survival. Some of the more recent authors listed above have increased these numbers. *Viburnum opulus* var. *americanum* is documented to have been in USFS Region 2 for at least 100 years (Clements and Schwartz 1914, University of Wyoming Rocky Mountain Herbarium 2005). It was considered rare at that time and remains rare in Region 2 today. Nevertheless, based on the population viability models discussed by the above-listed authors, some or all of the

small populations located in within Region 2 may be subject to stochastic pollinator and other environmental variables and events.

Community ecology

This section is essentially an expansion of some of the discussion under sections entitled Habitat, Reproductive biology and autecology, and Demography that have to some extent overlapped into topics of greater community ecology. The fruits of *Viburnum opulus* var. *americanum* are consumed by various species of wildlife, especially birds including ruffed grouse (*Bonasa umbellus*), sharp-tailed grouse (*Tympanuchus phasianellus*), ring-necked pheasant (*Phasianus colchicus*), and songbirds (Petrides 1972). Other animals consuming fruits may be foxes, raccoons, mice, chipmunks, squirrels, skunks, and rabbits. Twigs may be consumed by deer, moose, and beaver (USDA Natural Resources Conservation Service 2005).

Several studies have examined the fruit consumption and seed dispersal by birds; some allude to an evolved mutualistic relationship with certain species of birds. As stated earlier, fruits of *Viburnum opulus* generally remain on the plant through much of the winter, some remaining till spring. In New York, Jones and Wheelwright (1987) observed fruits of *V. opulus* (apparently the European variety) remaining largely untouched by birds in the fall, but by January 15 all fruits were removed. Although not directly observed, this fruit disappearance coincided with a flock of pine grosbeaks (*Pinicola enucleator*) in the study area. Jones and Wheelwright (1987) also studied fruit dispersal from the ground. Fruits placed purposely on the ground are believed to have been removed by mice such as *Peromyscus* spp. and chipmunks such as *Tamias* spp. Also in New York, the fruits of *V. opulus* (probably mostly the European variety, but there may have been some of the native American variety) comprised the principal part of the diet of cedar waxwings in April; cedar waxwings were considered the principal dispersers, with a few robins as occasional contributors (Witmer 2001). In feeding trials with American robins, however, robins consumed few *V. opulus* fruits and preferred those of *V. dentatum* (Jones and Wheelwright 1987). Bohemian waxwings (*Bombycilla garrulus*) will also consume the fruit of *V. opulus* (Elder 2002). Thrushes, robins, and cedar waxwings in New York state are similarly instrumental in removing the fruit pulp from the related *V. dentatum* and thus facilitate the germination of those seeds (Meyer and Witmer 1998).

In Europe, thrushes, blackbirds, and waxwings are considered the most important birds consuming fruits and dispersing seeds of *Viburnum opulus* (Englund 1993b). These bird species consume the whole fruit and cause little damage to the seeds, which are either regurgitated or defecated. Bullfinches are considered seed predators as they reject the fruit and consume only the seeds. In a study in Sweden, 95 percent of the fruits of *V. opulus* were destroyed by bullfinches (Englund 1993b). It was concluded that due to the high seed predation by bullfinches, seedling recruitment was very low, and this may have had something to do with why mature plants were often separated by hundreds of meters across apparently suitable habitats.

Cedar waxwings actually preferred early season (fall) fruits to late season (spring fruits (Witmer 2001). Fall fruits have a greater water content and a lower sugar concentration, but the total amount of sugar remains the same from fall to spring. Under natural wild feeding conditions cedar waxwings also consume *Populus deltoides* (eastern cottonwood) catkins as an additional food source while they are consuming cranberrybush fruits. In feeding experiments, birds lost weight when fed either just cranberrybush fruits or just poplar catkins, but they maintained their body weight when fed both simultaneously (Witmer 2001). Poplar catkins are rich in protein. Fruits of cranberrybush contain secondary chemical compounds that make the fruits very acidic; the fruits also have a low nitrogen to carbohydrate ratio. Consuming poplar catkins helps the birds to maintain their required nitrogen and protein levels and also enables them to manage metabolically the high acidity of the cranberrybush fruits. The secondary compounds and acidic fruits function to protect the seeds of cranberrybush from microbial attack. The conclusion from this study is that a mutualism has developed in that cranberrybush protects its seeds from microbial attack, causing birds in the fall to consume more palatable fruit from other species, then in the spring when other complimentary food sources are available (poplar catkins), cedar waxwings can utilize the cranberrybush fruits and effect a mass dispersal of the seed (Witmer 2001). Although these observations were made on the introduced and naturalized European variety, they are believed to occur and function similarly on the native American variety.

The following paragraphs review studies about parasites, diseases, and additional symbiotic and mutualistic interactions of *Viburnum opulus* var. *americanum* and/or its close European relative.

Viburnum opulus was tested for vesicular arbuscular mycorrhizal (VAM) fungal inoculation and colonization potential under nursery growing conditions (Morrison et al. 1993). Neither the VAM fungi *Glomus intraradices* nor *G. fasiculatum* significantly colonized the roots of *V. opulus*. *Viburnum opulus* var. *opulus* do have VAM fungi associated with the roots (Harley and Harley 1987).

Aphid (*Aphis fabae*) populations increase on *Viburnum opulus* var. *opulus* exposed to ambient air pollution containing NO and NO_2 emissions from automobiles (Bolsinger and Fluckiger 1987, 1989). The increased aphid populations on plants exposed to these air pollutants are presumed to be due to the increase in foliar organic nitrogen content and total amino acids in phloem sap in exposed plants. These air pollutants are apparently altering the nutrient quality of the plants, making them more favorable for aphids. The ambient air pollution did not cause increased levels of sugars, but it did cause increased levels of amino acids. Whether the increased available amino acid content is due to uptake of nitrogen compounds from the polluted air or due to a breakdown of existing plant proteins under the stress of air pollution was not determined (Bolsinger and Fluckiger 1989). Regardless of the mechanism, these studies indicate that air pollution has a physiological impact on the species, with secondary beneficial effects to plant-feeding aphids. *Viburnum opulus* var. *americanum* could possibly be affected in a similar manner. Increased aphid populations could result in weakening of the plant, thus increasing its susceptibility to other environmental parameters. Increased aphid feeding could also result in an increased risk of plants picking up diseases such as viruses, further weakening *V. opulus* var. *americanum*.

There are several diseases reported and known from the genus *Viburnum* (Horst 1979). *Pseudomonas viburni* is a bacterial leaf spot of *Viburnum* that is widespread and causes circular, water-soaked spots on the leaves, as well as sunken, brown cankers on young stems. The bacteria winter in stems and buds of the host plant. *Micropeltis viburni* is a leaf blight fungus belonging to the ascomycetes (sac fungi). *Plasmopara viburni* is a downy mildew fungus found on the foliage of the plant. *Cristulariella pyramidalis* is another fungus that causes leaf spots on numerous plant species including *Viburnum*. There is a wide variety of other diseases including bacterial crown gall, stem cankers, powdery mildews, several other leaf spotting organisms, nematodes, root rot (*Phytophthora cinnamomi* [Zentmyer 1980]), leaf rusts, and wilts (Horst 1979). The leaf rust fungus *Puccinia linkii* is known to occur in Idaho and Montana. Members of the genus *Viburnum* may serve as alternate hosts for the leaf rust fungus, *Coleosporium viburni*, once only known from stages II and III on *Viburnum*, but now known from stages O and I on jack pine (*Pinus banksiana*) (Hepting 1971). The powdery mildew *Microsphaera shinanoensis* has been reported on *V. opulus* var. *calvescens* in Japan (Tanda 1994). Cuttings of *V. opulus* var. *americanum* during horticultural propagation may be subject to infection from the fungi *Rhizoctonia*, *Phytophthora*, and *Pythium* (Smith and Neely 1981). Alfalfa mosaic virus is reported on *V. opulus* and *V. tinus* (Schwenk et al. 1971, Cooper 1979). It causes yellow mottling or variegated leaf coloring, including light green and white, and has been referred to as the "Viburnum Calico" (Williams et al. 1971). It is transmitted by sap, with aphids being a natural transmission agent.

The web-spinning sawfly (*Pamphilius ochreipes*) is known to lay eggs on the underside of foliage of *Viburnum opulus* in Ontario, Canada (Lindquist and Harnden 1970). Larvae roll the leaves into shelters and then feed upon the foliage. The predatory spider mite (*Neoseiulus fallacis*) may have some important biological control ability for the pest mite (*Tetranychus urticae*) on *V. opulus* (Pratt and Croft 2000). The viburnum leaf beetle (*Pyrrhalta viburni*) feeds on the foliage of *V. opulus* (both American and European varieties). This beetle, native to Europe and Asia, was introduced into North America in 1947, but breeding populations were not discovered until 1978 in Ontario, Canada (Becker 1979, USDA Natural Resources Conservation Service 2005). As its name indicates, this beetle is selective to the genus *Viburnum*, and while it has been reported on other *Viburnum* species, *V. opulus* is the preferred host (Weston and Desurmont 2002). The beetle feeds on the tissues between the midrib and the lesser veins, "skeletonizing" the leaves. It is not necessarily considered a severe pest, but two to three years of consecutive defoliation can lead to death of the plants. At the current time, this insect is only known in the eastern United States, but small insects have been known to undergo sudden, great dispersal distances, so one cannot necessarily assume populations of *V. opulus* var. *americanum* in central and western North America will stay free of this insect herbivore. Several foliar and systemic insecticides have demonstrated control ability (Weston et al. 2002). Extracts from species of pepper tree (*Piper* spp.) have also demonstrated some ability to control the viburnum leaf beetle (Scott et al. 2004).

Despite all of these potential diseases and pests, *Viburnum opulus* var. *americanum* is generally considered to be relatively free of serious pests (USDA

Natural Resources Conservation Service 2005). Bacterial leaf spot, powdery mildew, shoot blight, tarnished plant bugs, stem borers, thrips, and the viburnum leaf beetle are generally considered to be the biggest pest problems.

Figure 10 outlines the envirogram for *Viburnum opulus* var. *americanum*. An envirogram is a graphic presentation of the various principal environmental components that influence a species' ability to reproduce and survive in the environment. Envirograms have traditionally been designed for animals (Andrewartha and Birch 1984), but they may be applied to plants. Components that directly affect *V. opulus* var. *americanum* are part of the centrum, and components that have indirect effects are part of the web. Although much information concerning this species is lacking, there was enough to construct a functional envirogram.

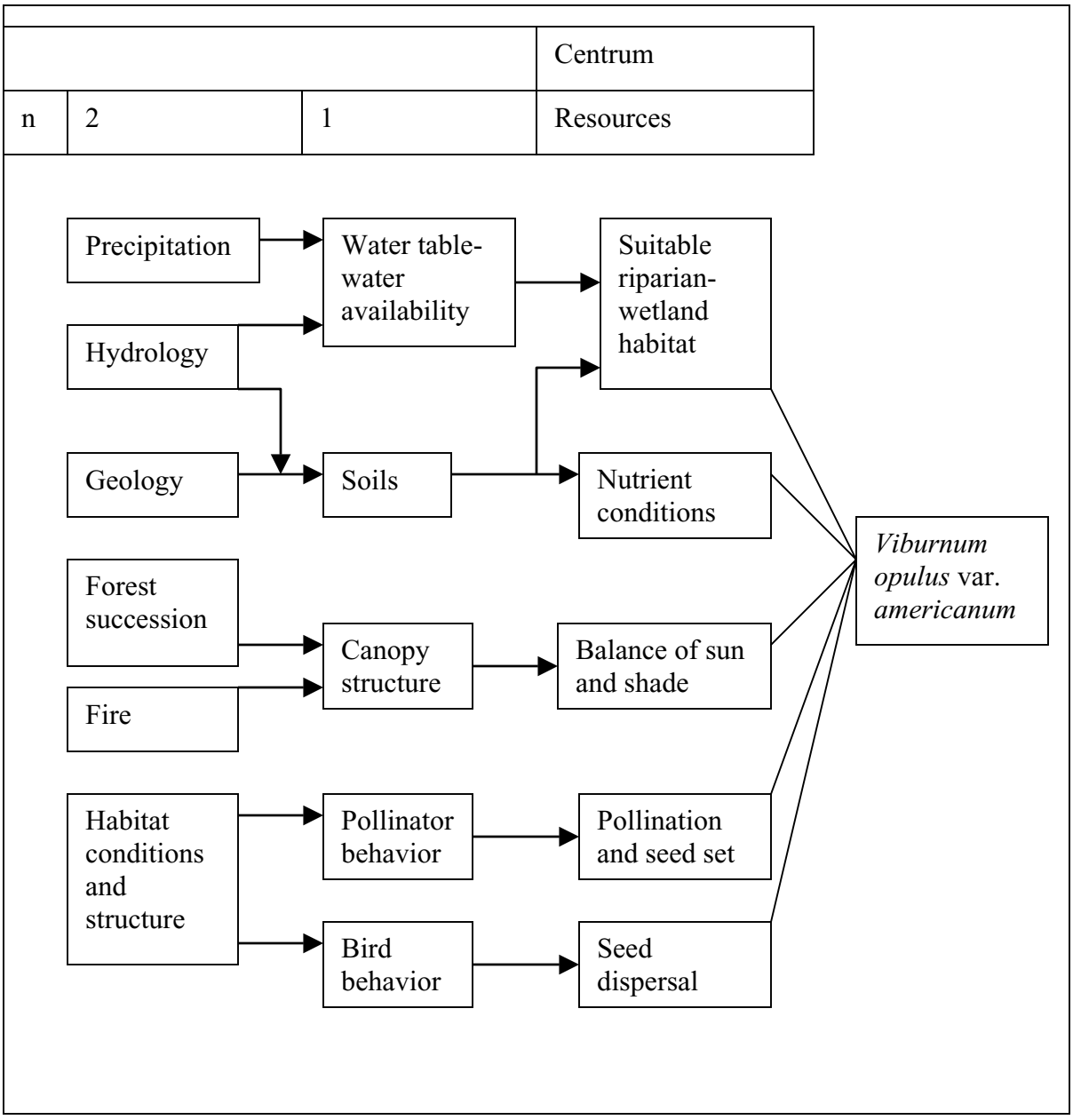

Figure 10. Envirogram outlining the resources of *Viburnum opulus* var. *americanum*.

CONSERVATION

Threats

This section attempts to address threats or potential threats to populations of *Viburnum opulus* var. *americanum* derived from the variety of sources described above. Where appropriate the discussion of these threats has been expanded upon from the author's general environmental and ecological experience and knowledge.

Habitat loss

Under current laws and regulations in the United States and Canada, there do not appear to be any substantial rangewide threats to *Viburnum opulus* var. *americanum*. A threat that may apply at individual sites across its entire range would be habitat loss of wetland and riparian habitats. More than 50 percent of all wetlands have been lost in the conterminous United States from the time of European settlement to recent times (Barbour and Billings 2000, Dahl 2000). Of the estimated original 221 million acres of wetland, only 106 million remained in 1997. The annual loss rate was 450,000 acres from 1950 to 1970; it then declined to 290,000 acres from 1975 to 1985; and then it declined again to 58,000 acres from 1986 to 1997 (Dahl 2000). Most of this loss has been to inland freshwater wetlands, which is the typical habitat of *V. opulus* var. *americanum*. Dahl (2000) categorized wetland loss resulting from anthropogenic influence as follows: 30 percent to urban development, 26 percent to agriculture, 23 percent to silviculture, and 21 percent to rural development.

Habitat loss also needs to be discussed in context with *Viburnum opulus* var. *americanum* distribution and occurrences within Region 2. The species is peripheral in Region 2 and would have to be considered disjunct in Region 2 due to the wide geographic distance of the Great Plains separating confirmed Region 2 sites from the known western edge of the main body (Minnesota and northeastern North Dakota) of its eastern distribution. In addition to being disjunct, the species also has a fragmented (discontinuous) distribution in Region 2, due to its general limitation to mesic riparian corridors. This is a natural expectation in Region 2 for a species requiring mesic sites. Fragmentation (referring to geographic or physical separation) and connectivity (referring to ecological linkages) of populations and occurrences of a species are also relative, based on geographic and temporal scales, and based on the life history (life cycle) characteristics of the species. So, although *V. opulus* var. *americanum* may have a naturally fragmented distribution in Region 2 (occurring in widely separated drainages), fragmentation may also occur on a local scale, within individual riparian corridors. Fragmentation on this local scale could be a potential threat by reducing connectivity of necessary insect pollinator activity and reducing subsequent seed set, already reported at relatively low percentage rates (see Reproductive biology autecology section). Contrastingly, since birds are important consumers of fruit and distributors of seed, and birds travel much greater distances than most insects, *V. opulus* var. *americanum* populations and occurrences that have poor connectivity at the pollinator level and fragmented or discontinuous distributions at the geographic level, may very well be connected at the seed distribution level.

Alterations to hydrology

Alterations to the hydrology of wetland habitats have been identified as a threat to populations of *Viburnum opulus* var. *americanum* in Ohio (Ohio Department of Natural Resources 2005). Similarly, for the Black Hills populations of South Dakota and Wyoming, disturbances to the riparian community and hydrologic system have been identified as areas of concern (USDA Forest Service 2003a). These populations have also been considered potentially vulnerable due to their low population sizes and the limited amount of suitable habitat available (Wyoming Natural Diversity Database 2005). *Viburnum opulus* var. *americanum* is classified as a wetland plant, and while it is not restricted to such settings, it still requires a moist substrate. In the arid western United States these habitats are less abundant, and consequently, they are at a premium in the West.

Fire

Fire may pose a threat to *Viburnum opulus* var. *americanum* populations and occurrences, but there are no data specifically concerning the effects of fire to this species. Fire is a less frequent occurrence in the more mesic, deciduous forests in the East than in the drier habitats within Region 2; consequently fire may be of greater concern in managing *V. opulus* var. *americanum* in Region 2 than in some eastern portions of the species' overall range. The species also occurs in boreal forests across the eastern and central portions of North America. Fire has been considered a major factor affecting vegetation patterns, species composition, and community stability in the boreal forest region (Heinselman 1981, Duchesne 1994). Since *V. opulus* var. *americanum* is known to resprout

when the stems are cut, it could be extrapolated that the species could survive and recover from moderate burns where litter and duff are charred, but mineral soil is not altered. Whether *V. opulus* var. *americanum* plants could recover from a severe burn where mineral soil is altered is unknown. Severe burns have been reported to affect water quality characteristics and sediment loads (Driscoll et al. 2004), and these consequences may affect *V. opulus* var. *americanum* sites. In general terms, the interaction of plant seed banks, vegetative propagation abilities, and fire interval and intensity are all important components to consider in management (Whittle et al. 1997). Although *V. opulus* var. *americanum* seeds will store for several years dry in the lab, their longevity in the soil seed bank in the field has not been reported. Even several years in the lab is not considered a long time; consequently, given that mature adult plants may survive to 50 years or more, frequent fire return intervals, perhaps Group I and II (0 to 35 year interval range), may not be desirable for maintaining healthy populations of this species.

Non-native species

Introduced *Viburnum opulus* var. *opulus* is a known threat to the native variety, *V. opulus* var. *americanum*. The European variety is a naturalized component of the flora from the east coast to the Midwest and is cultivated nationwide. The sterile form of the European variety (*V. opulus* var. *opulus* cv. 'Roseum') does not reproduce and cannot hybridize. However, the fertile European variety *V. opulus* var. *opulus* may hybridize with variety *americanum*, diluting the native gene pool through introgression. Fertile variety *opulus* could also be involved in directly replacing variety *americanum* in the field (i.e., if its seed gets distributed to a suitable site, and its seedlings survive to out-compete the native form). In Pennsylvania and Ohio, *V. opulus* var. *opulus* is specifically identified as a threat to *V. opulus* var. *americanum* (i.e., *V. trilobum*) due to its replacement in the wild from competition and hybridization (Ohio Department of Natural Resources 2005, Pennsylvania Department of Conservation and Natural Resources 2005). The USDA Natural Resources Conservation Service (2005) indicates that *V. opulus* var. *opulus* is listed as one of the species in the Wisconsin Manual of Control Recommendations for Ecologically Invasive Plants. In other midwestern places at this time (e.g., Michigan), there may not be that many escaped European cranberrybushes. Voss (1996) states that most observed wild plants in Michigan fit the characteristics of the native cranberrybush. From sources reviewed in this document, it is known that *V. opulus* var. *opulus* has been artificially planted in New Mexico and Utah. Weber and Wittmann (2001a) also make a point that *V. edule* is somewhat similar to cultivated *V. opulus*, further indicating that *V. opulus* is cultivated in Colorado; whether this is cultivated *V. opulus* var. *opulus* or *V. opulus* var. *americanum* is another question. How common the cultivated European variety (*V. opulus* var. *opulus*) is in Region 2 is unknown. In summary, the European variety is present in the West, meaning its gene pool could become intermingled with the American variety, and it could possibly replace the American variety as it reportedly has in some places in the eastern United States.

Concerning invasions of exotic species and taxa other than *Viburnum opulus* var. *opulus*, nothing is known or reported specifically in the published literature for impacts to *V. opulus* var. *americanum*. It is not unreasonable to speculate that invasive, non-native woody species may impact *V. opulus* var. *americanum* and its habitat, species such as Russian olive (*Elaeagnus angustifolia*), salt cedar (*Tamarix* spp.), Siberian elm (*Ulmus pumila*), tree-of-heaven, (*Ailanthus altissima*), and European buckthorn (*Rhamnus cathartica*). If allowed entrance through site disturbances, such species could compete directly with mature and immature *V. opulus* var. *americanum* and possibly replace them in the habitat. Invasive non-native herbaceous plants that frequent riparian and wetland habitats, especially in the western United States include musk thistle (*Carduus nutans*), bull thistle (*Cirsium vulgare*), teasel (*Dipsacus fullonum*), poison hemlock (*Conium maculatum*), perennial pepperweed (*Lepidium latifolium*), hoary cress (*Cardaria draba*), and purple loosestrife (*Lythrum salicaria*) to name a few. Although not competing directly per se with sapling or mature *V. opulus* var. *americanum*, such species could have very substantial impacts to seedling recruitment by filling niche spaces that would otherwise be needed for seedlings. Currently, potentially invasive species reported to be at or nearby (but offsite) *V. opulus* var. *americanum* sites on the Black Hills National Forest include: musk thistle, hound's tongue (*Cynoglossum officinale*), Canada thistle (*Cirsium arvense*), bull thistle, and common tansy (*Tanacetum vulgare*) (USDA Forest Service 2005c). Trampling disturbances by cattle combined with the introduction of invasive species could have a synergistic effect on the ability of *V. opulus* var. *americanum* to recruit new individuals into the population.

Herbivores

Both native herbivores (mostly large, grazing ungulates) and introduced livestock may have impacts

through direct consumption and through trampling of seedlings. Direct browsing by animals (e.g., moose, sheep) that prefer woody materials may negatively impact *Viburnum opulus* var. *americanum*. Deer are also known to browse woody materials and could have an impact if their populations were over-abundant. Grazers such as elk are expected to have little direct effect. Similarly, cattle generally avoid woody materials, and it appears from the studies presented in this report, two of which involve cattle, that they would not substantially impact the species through direct plant consumption. Cattle can impact the species, however, through trampling of plants and riparian and wetland substrates, and this has been identified as an item of concern in Region 2 (Wyoming Natural Diversity Database 2005). Compared to native wildlife, livestock, especially cattle, may spend an inordinate amount of time around a water source; this can result in more trampling impacts than might occur otherwise. Trampling and associated soil erosion, topsoil loss, and nutrient loss could have a detrimental impact on the local environmental conditions required by seedlings of *V. opulus* var. *americanum*. *Viburnum opulus* var. *opulus* cover and frequency decreased by 50 percent from 1977 to 1997 in an area of Belgium intensively managed for livestock (Lameire et al. 2000).

Pesticides

Thaler and Plowright (1980) have demonstrated that the use of insecticides that indiscriminately kill useful insects, such as pollinators, can have a statistically significant negative impact on the ability of *Viburnum opulus* var. *americanum* to reproduce (i.e., set seed). The use of any insecticide in or near populations of *V. opulus* var. *americanum* needs to be carefully examined for its potential to harm insects required for pollination.

Because *Viburnum opulus* var. *americanum* has been reported to have an intermediate sensitivity to some herbicides used to control weeds among field grown landscape plants (Collins et al. 2001), the use of herbicides in and around wild populations should be considered a potential threat. Other stressors or factors in the environment could either increase or decrease its sensitivity to herbicides.

Diseases

Although *Viburnum opulus* var. *americanum* is relatively free of major diseases and pests, small populations could always become adversely affected by the disease and pest organisms discussed earlier. Threats from diseases and pests would likely only be important if plants were being subject to multiple stresses (i.e., concurrently being subject to drought and habitat alterations) that would cumulatively weaken individuals or entire small populations. The fungus that causes "sudden oak death" (*Phytophthora ramorum*) in the eastern and central United States is known to make use of multiple hosts, including species of *Viburnum* (Pennsylvania Department of Conservation and Natural Resources 2005). Fungal attack of seedlings and the viburnum leaf beetle may be considered some of the worst threats. Some signs of insect feeding and leaf fungi have been observed on Black Hills National Forest populations, but these have not been considered substantial influences at this time (USDA Forest Service 2005c).

Air pollution

Exposure to common air pollutants emitted by automobiles (e.g., NO and NO_2) appears to cause an increase in aphid populations that could affect plant vigor and susceptibility to other biotic and abiotic environmental conditions. Although most populations in Region 2 are probably not adjacent to busy roads with a high enough traffic volume to generate enough localized NO and NO_2 to impact vegetation, individual known sites could be evaluated for such conditions. Ozone (O_3) air pollution is also reported to cause injury to *Viburnum opulus*. Unlike the other pollutants, ozone precursors can be generated one place (e.g., a large urban area), transported hundreds of miles, and under the proper atmospheric conditions, generate ozone concentrations potentially injurious to native flora. For example, air pollution from the Los Angeles, California area is known to be transported to the Grand Canyon area of Arizona, where it causes "smog" or haze, substantially reducing visibility, in what otherwise is considered a remote and pristine area. Although the Black Hills is not necessarily an area impacted or potentially impacted by ozone air pollution, an investigation into this situation is still advisable. The large urban centers of Denver, Colorado, and Salt Lake City, Utah, could possibly be sources for ozone exposure in the Black Hills, especially during periods when winds are coming from the southwest.

Harvest

However noble the traditional, historical, or current use of native plants for food, medicinal, or health reasons may be, for rare and uncommon plants, such use must be considered a potential threat to their existence. Both the American and European cranberrybush

varieties represent a case in point, with numerous reported uses for health and food. Consequently, a brief summary of known and reported uses of *Viburnum opulus* var. *americanum* will be discussed.

Viburnum opulus var. *americanum* is also known by the common name crampbark because of its reported abilities to treat various cramps and ailments. Among these uses are the treatment of asthma, cold, fever, nervousness, water retention problems, cough, cramps and stomachache, menstrual cramps, uterine infections, blood pressure, infertility, and use as a uterine sedative and an astringent (Millspaugh 1892, Foster and Duke 1990, Duke et al. 2002). A tea made from the bark is the medium for some of these treatments. The fruits are juicy, tart with an acid taste, but edible (Petrides 1972, Newcomb 1977, Peterson 1977). The fruits have been historically used by Native Americans in making pemmican; the bark has been used for a diuretic, a sedative, and for septic poisoning in childbirth (Wilkinson 1990). The fruits have been eaten fresh or preserved by Assiniboin, Iroquois, Ojibwa, Algonquin, Micmac, Malecite, Shuswap, and Kootenay (Kuhnlein and Turner 1991). From the past (Clements et al. 1912, Graves 1952) to the current times, the fruits are popular as cooked fruits, or for making jams, jellies, and beverages, but it has never developed into a commercial fruit crop (USDA Natural Resources Conservation Service 2005). However, an interest in commercial production and preservation of this native fruit remains current (St. Pierre 1992) at the Native Fruit Development Program at the University of Saskatchewan, Canada. The fruits are high in vitamin C (Peterson 1977). The fruits of the European variety are supposed to be more bitter than those of its American counterpart (McAtee 1956). *Viburnum opulus* var. *opulus* continues to be evaluated for its medicinal and pharmacological properties (Zuzuk et al. 1995) and has been evaluated for its potential properties to treat cancer, malaria, and the human immunodeficiency virus (HIV) (Grzybek et al. 1997).

Climate change

On a theoretical level, population trends as affected by global climate change may be considered. Global climate change research over the past decade or so has demonstrated slight (1 to 2 ºC) warming trends (reviewed in Weltzin et al. 2003). Within Region 2 over the past 100 years, average temperatures have increased. For example, at Pierre, South Dakota temperatures have increased 1.6 ºF (0.9 ºC) (U.S. Environmental Protection Agency 1998). Although climate warming has been a controversial subject and difficult to determine, measure, and predict, most researchers have predicted warmer and drier conditions for much of central North America. Primack (2000) used existing riparian vegetation data, three different global climate models, and stream discharge models to predict the possible effects of global warming on riparian vegetation in the Pere Marquete watershed in west-central Michigan. Of the several vegetation cover types analyzed, one of them was an open-viburnum association classified as a hydric-mesic habitat. Although the *Viburnum* species in question was *V. lentago* (nannyberry), it occurs in riparian settings as does *V. opulus* and is rated a facultative plant (FAC) that can occur in wetlands, similar to *V. opulus*, which is rated FAC to facultative wetland plant (FACW). Three of the four open-viburnum study plots fell within the 1 to 5 percent inundation zone (i.e., flooded 1 to 5 percent of the time) while one plot fell within the 5 to 40 percent inundation zone. Climate models were projected to the year 2050 when the carbon dioxide levels are predicted to be doubled (Primack 2000). Output temperature and precipitation data were used as input to the stream discharge model to predict changes in river flow. Due to reduced water discharge, the result was a predicted decrease in the frequency of open-viburnum plots of 7 to 14 percent under the least reduced discharge rate to a reduction of 20 to 27 percent under the most reduced discharge rates. In summary, this report is inferring that riparian vegetation will be negatively impacted by a climate warming trend. In the arid western states, such a trend may result in potentially greater impacts to riparian vegetation. On a contrasting note, precipitation across most of South Dakota has increased by 20 percent over the past 100 years; whether this trend will continue is unknown (U.S. Environmental Protection Agency 1998).

Miscellaneous

Road construction has been identified as a localized threat to some occurrences of *Viburnum opulus* var. *americanum* in the Black Hills (Wyoming Natural Diversity Database 2005). Studies presented in this report have shown that *V. opulus* seedlings require a moist, partially shaded, nutrient-rich microhabitat and are sensitive to drought. The western United States is often subject to periods of drought. Any combination of the environmental variables and threats reviewed in this report may potentially compound the ability of small populations in locations like the Black Hills to recruit new individuals into the population and to maintain their population sizes. Finally, at this time, over-utilization for commercial, recreational, scientific, or educational purposes does not appear to be a factor

threatening the presence of *V. opulus* var. *americanum* in Region 2.

An envirogram outlining the threats (malentities) to *Viburnum opulus* var. *americanum* is included in **Figure 11**. The **Figure 11** diagram is similar to the one in **Figure 10**, but it focuses on the threats that may affect or influence the environmental resources important to *V. opulus* var. *americanum*. These threats are based on the limited number of scientific reports contained within the literature and infer pathways of potential impact to the species. The potential degree (severity) of impact along these various pathways remains an uncertainty and must be taken into consideration when making management decisions.

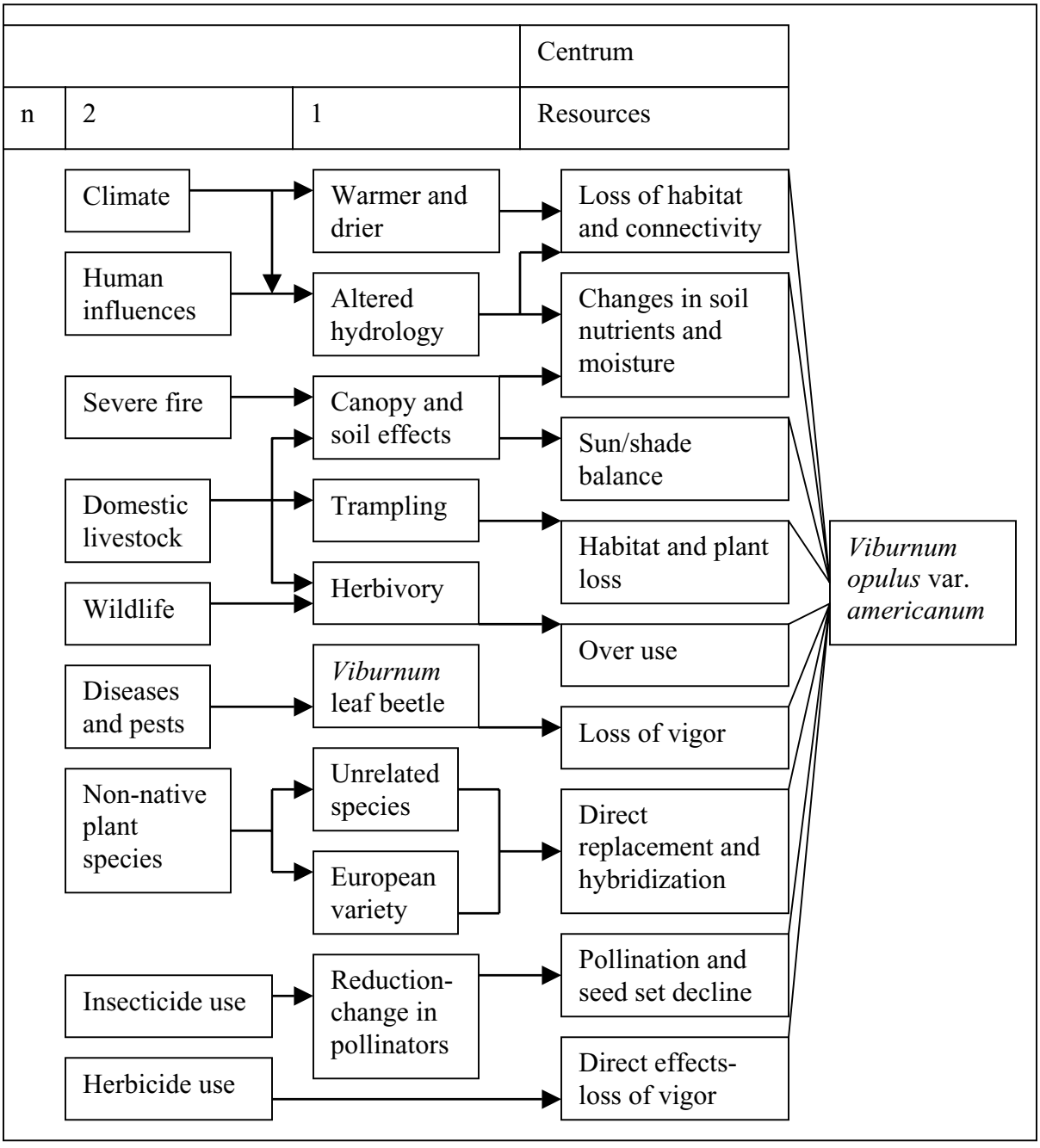

Figure 11. Envirogram outlining the malentities and threats to *Viburnum opulus* var. *americanum*.

Conservation Status of Viburnum opulus var. *americanum* in Region 2

The USFS Region 2 has assigned *Viburnum opulus* var. *americanum* a sensitive species status. Within USFS Region 2, the only state, agency, or organization that ranks the species is the Wyoming Natural Heritage Program, which ranks it as S1 (critically imperiled) with a medium conservation priority (Wyoming Natural Diversity Database 2005). *Viburnum opulus* var. *americanum* is considered a peripheral species in Wyoming, but it is given a high Wyoming flora contribution rank because it contributes substantially to the overall distribution of the species. Disjunct populations, such as those in the Black Hills of Wyoming and South Dakota contribute unique components to the flora of the region and special distributional occurrences to the species overall.

Under USFS Region 2 management, some of the occurrences of *Viburnum opulus* var. *americanum* have additional levels of conservation and protection, beyond its sensitive species status. On the Black Hills National Forest in Wyoming, the Dugout Gulch and Upper Sand Creek populations have been included in the Dugout Gulch and Upper Sand Creek Botanical Management Areas. In designated botanical areas, management emphasis is to protect or enhance the area and, where appropriate, to develop and interpret the area for the general public so that they may be educated to its unusual botanical characteristics. The management of fire, livestock grazing, recreational use, and timber and minerals extraction are all factored into the management plans and can be tailored to the particular biological and ecological requirements of a botanical area.

Within the South Dakota portion of the Black Hills National Forest there is one Research Natural Area (RNA) containing a population of *Viburnum opulus* var. *americanum*, Upper Pine Creek (1190 acres), that has been in existence since 1932 (USDA Forest Service 2005b). This area protects plants from grazing impacts and is one of the largest roadless areas on the Black Hills National Forest. RNAs are permanently protected areas maintained in their natural state for the purposes of conserving biological diversity, conducting research in a non-manipulative manner, and fostering education (USDA Forest Service 2004a). These areas become removed from the suitable timber base and generally make fuel reduction treatments inappropriate (depending on the ecological requirements necessary to maintain a particular plant community) (USDA Forest Service 2004a). Hunting and recreation are usually allowed (unless detrimental effects are noted), and such sites are carefully evaluated for the appropriateness of livestock grazing. Another area that receives some special management status, although not to the degree of Botanical Areas or RNAs, is the Sand Creek Late Successional Area (Fertig and Oblad 2000). Finally, several other sites with populations of *V. opulus* var. *americanum* in the Black Hills National Forest encompassing both South Dakota and Wyoming have been proposed for either Botanical Area status or RNA status: Cranberry Springs (including Upper Sand Creek), Bear/Beaver Gulches, and Little Spearfish Creek (USDA Forest Service 2004a).

There does not appear to be any conservation status applied to the other potential sites in Region 2, in Niobrara and Sheridan counties in Wyoming (**Figure 3**; Wyoming Natural Diversity Database 2005) and in the northeast corner of South Dakota (Roberts County; Stephens 1973). Supposedly *Viburnum opulus* var. *americanum* also occurs in Nebraska (likely the northeast corner near the Missouri River), but in the time allotted to complete this report, this location has not been determined.

Despite all of the information presented herein, there is insufficient information concerning those populations in Region 2 to state, with any high level of certainty, whether the abundance of *Viburnum opulus* var. *americanum* is declining, increasing, or remaining stable across its range within Region 2. Some concerted and organized searches have been conducted (Heidel personal communication 2006, Zacharkevics personal communication 2006), but these are considered baseline data collection stages at this point (Burkhart personal communication 2006) (see Species and habitat inventory section below). On a qualitative basis, Clements and Schwartz (1914) described the species as being rare in the Rocky Mountain region nearly 100 years ago. The species remains rare today, if nothing else, indicating that the populations have been relatively stable over this time period (except for the extirpation from the lone county in northern Idaho). It does appear that the Black Hills National Forest populations are the primary populations within USFS Region 2. They should be considered as disjunct populations. Those populations that may occur in far eastern South Dakota and Nebraska would not be considered as disjunct sites, but as fingered extensions following drainages from the main eastern body of the species distribution. The populations in the Black Hills are considered "small," and based on current available information, they do indeed appear to be small, ranging in size from one

to 122 individuals, with most sites having less than 50 individuals (USDA Forest Service 2005c). Small populations have the potential to completely disappear due to stochastic variables and fluctuations in the environment and plant community. On the other hand, because the species is bird dispersed, it has the potential to become established at new (previously undocumented) sites through long-distance dispersal. The report from Ohio may indicate that the species can colonize wetland sites with open niches (Ohio Department of Natural Resources 2005). Such changes in small, localized populations would be referred to as stochastic changes or those subject to stochastic risk. Biologists have tried to deal with the concept of a minimum viable population (reviewed in Nelson 1999). Since *V. opulus* is a relatively longer lived woody perennial, perhaps to 50 years or more, this characteristic of the species alone will help maintain a viable population. Despite this, the species needs to reproduce and recruit new individuals into the population; otherwise, existing populations will age, become decadent, and eventually disappear. Data presented in this report indicate that seed production and seedling site conditions will be critical to populations maintaining themselves, but it remains unclear what a minimum viable population size would be. Because this is a tall shrub, with showy flowers, it is not likely there are any other undiscovered populations within the region. Perhaps there could be newer, more recently established populations in little-visited drainages. There is probably a greater potential for new sites containing the species to be discovered on private lands or other lands not under the jurisdiction of the USFS, lands that probably have not been accessible to most botanists and plant ecologists.

Forested and woodland riparian habitats with perennial water could potentially support this species. Open, non-forested, non-woodland riparian habitats would not be considered suitable habitats to support the needs of this species. The life history characteristics of *Viburnum opulus* var. *americanum* vary in their tendencies to make the species vulnerable or safe. Its longevity and ability to resprout are a plus to its stability. Its potential dispersal through birds is a plus enabling it to reach new sites. Which species of birds reach the fruits first, waxwings that effect dispersal, or finches that act as seed predators, can affect its reproductive ability. The various environmental variables discussed in this report may negatively affect seed production and seedling establishment and will be important factors determining its ability to reproduce.

Management of Viburnum opulus var. *americanum in Region 2*

Where applicable and appropriate, one of the considerations that will be useful towards managing sites with *Viburnum opulus* var. *americanum* in Region 2 will involve the regulatory mechanisms under Section 404 of the Clean Water Act implemented by the USACE (Wetland Training Institute 2001). In addition, the USFS at various administrative levels has policy, guidelines, and management plans for wetlands. For example, within the Medicine Bow National Forest Revised Resources Management Plan, provisions to protect wet meadows, fens, bogs, and peatlands include:

- Prohibiting concentrated livestock use.
- Actively discouraging illegal motorized use.
- Prohibiting peat or bog iron mining.
- Prohibiting road construction (USDA Forest Service 2003b).

Such policies and guidelines on wetlands, in combination with the listing of *V. opulus* var. *americanum* as a sensitive species in Region 2, add layers of protection onto existing federal CWA Section 404 regulations.

Furthermore, the Black Hills National Forest itself has taken additional steps to protect and conserve some of *Viburnum opulus* var. *americanum* sites within its jurisdiction. As previously stated, one RNA site has been designated in South Dakota, and two Botanical Management Areas and one Late Successional Landscape site have been designated in the Wyoming portion of the Black Hills. Several other sites are currently proposed for Botanical Management Areas or RNAs. The following two sections will discuss and synthesize the known information about *V. opulus* var. *americanum* into a set of management elements, tools, and practices.

Implications and potential conservation elements

The combination of existing management activities protecting wetlands under: 1) applicable and appropriate use of Section 404 of the CWA and 2) implementation of USFS policies and guidelines to conserve wetlands will continue to be important conservation elements

for populations of *Viburnum opulus* var. *americanum*. Approaching wetland management with a "no net loss" (U.S. Army Corps of Engineers 2005) consideration is important. On December 26, 2002, a multi-agency task force issued the National Wetlands Mitigation Action Plan (2005). The USDA, of which the USFS is a part, was a signatory to this plan. The USACE and U.S. Environmental Protection Agency have been issuing guidance for use of on-site versus off-site and in-kind versus out-of-kind compensatory mitigation, the use of vegetated buffers, the implementation of preservation, compensation within a watershed, mitigating impacts to streams, the use of biological indicators, and functional assessments towards protecting and mitigating impacts to wetlands. Protecting (conserving) wetlands and mitigating impacts to wetlands (and riparian areas) will be important conservation elements.

Wetlands should not necessarily be viewed as static environments, but rather as environments subject to a certain amount of disturbance from which they may easily recover and regenerate (Middleton 1999). Changing water levels and flood regimes can be important factors in wetland ecosystem dynamics, especially those of riverine and riparian systems. Flood events may be expected as a more important feature of wetland habitats in arid western lands. Alterations to the hydrology of a riparian habitat that would cause a long-term drying of the habitat would be detrimental to the populations. *Viburnum opulus* var. *americanum*, although not restricted to wetland soils, requires a moist substrate on which to grow. Seedlings are subject to drought stress, more so when they do not receive adequate shade. The species is relatively shade tolerant, and although the seedlings respond positively to increased light levels, they also appear to require moderate shade. The soil substrate should be nutrient rich. Some of the studies indicate that seedling establishment is difficult. Seeds generally require two years before they will fully germinate and begin to grow. Livestock may trample seedlings and saplings. Sheep, moose, and perhaps deer will consume the plants, limiting their ability to reach maturity and reproduce. Cattle are less likely to actually consume the plants, but they would be factors contributing to trampling of the plants and their habitat. All of these factors need to be taken into consideration when managing *V. opulus* var. *americanum* populations.

The disjunct peripheral distribution of *Viburnum opulus* var. *americanum* within Region 2 presents additional discussion concerning conservation of the species within Region 2. Since the species has a secure ranking rangewide across North America, land managers may need to carefully evaluate the use and implementation of various conservation strategies and elements. The priorities and value of conserving peripheral species have been debated (Lesica and Allendorf 1995, Peterson 2001, Bunnell et al. 2004), and special listings and protections for some species may not be warranted. However, it is generally agreed upon that conservation of disjunct peripherals to preserve potential genetic diversity and uniqueness is ecologically desirable. The genetic uniqueness or divergence of *V. opulus* var. *americanum* in Region 2 from eastern populations is not known, but the presence of the species in Region 2 has been considered to be of special botanical interest (Wyoming Natural Diversity Database 2005).

Populations of *Viburnum opulus* var. *americanum* in the Black Hills are small and therefore at greater risk to adverse impacts. Because small sites are influenced and modified by the greater matrix of habitats (including upland habitats) surrounding them, protecting a localized site all by itself may not be enough. Protecting the greater habitat matrix surrounding a particular site may be just as important as protecting the site itself (reviewed in Nelson 1999). Protecting an entire drainage will be more beneficial to the species than protecting just the localized site on which the plants reside. Although the species will grow in thickets or clumps, plants also occur as scattered individuals. The thickets themselves are often widely scattered. The continued existence of an ecologically dynamic set of sub-populations or meta-populations will depend on the plants being cross-pollinated (it is an obligate out-crosser) and to found new populations on suitable sites through bird dispersal of the seeds. Concerning the life history characteristics of *V. opulus* var. *americanum*, sub-populations would be physically separated by some distance yet close enough to be cross-pollinated by most of their insect pollinators. For *V. opulus* var. *americanum*, meta-populations would be those that are separated by greater distances (i.e., distances great enough that most insect pollinators would not traverse) but are still connected by the ability of birds to disperse seeds between the populations. These factors will be important for the populations to maintain an actively exchangeable gene pool that will probably keep the small populations viable. Preventing fragmentation of existing populations at a local watershed scale in order to maintain pollinator connectivity may be an important consideration for this species.

There is probably enough information about the species *Viburnum opulus* to make an inference as to whether it is a matrix-habitat species or gap-phase

species. Matrix habitats are those that form extensive and contiguous cover (Corner et al. 2003). Gap-phase species are those that respond to gaps or localized transitional zones in a larger habitat matrix. Although *V. opulus* var. *americanum* is associated with vegetation types that form extensive cover (e.g., eastern deciduous forest, northern and western conifer forest, and aspen parkland), it is generally associated with the riparian and wetland subcomponents within these vegetation types. Wetlands and riparian areas in the Great Plains and the Rocky Mountains would generally not be considered matrix habitats. The species does not contribute substantial amounts to cover and standing biomass, and although it may be frequent or common in localized areas, it is not highly abundant anywhere. Consequently, it can be concluded that *V. opulus* var. *americanum* is not a matrix species. From the ecological knowledge of the species at this time, it does appear to have some tendencies to respond to localized transitional zones in existing habitats. Although shade-tolerant, mature plants will grow well and flower more profusely in full sunlight. Apparently it grows readily along roadsides (essentially openings in the canopy), and can recolonize wetland areas with open available niches. However, *V. opulus* var. *americanum* is slow growing. The species is probably not classifiable as a full gap-phase species, but it does have some tendencies that way and would best be described as a late successional species (pre-climax) that can take advantage of occasional gaps in the matrix vegetation. Concerning fire management, sites with *V. opulus* var. *americanum* are probably best managed under conditions of low intensity with longer-term fire return cycles.

Excluding livestock from just a few *Viburnum opulus* var. *americanum* sites may not be sufficient to protect the species in the Black Hills area. Sites separated by many miles across different drainages could still be part of a meta-population and connected genetically by bird dispersal of seed. The ability of the plant to disperse from drainage to drainage, and the concomitant requirements of a suitable seed bed for seedling establishment and ultimate recruitment, may be necessary to maintain the greater population dynamics, and ability of the species to survive and maintain itself in the Black Hills. Riparian vegetation covers only about 1 percent of the Black Hills region, including both public and private land (USDA Forest Service 2004b). Historical local information and photographs indicate that riparian vegetation, including the woody shrub component, has decreased over time. Livestock grazing has been implicated as one of the reasons for the degradation of riparian habitat. Some effort has gone into restricting livestock, reducing siltation from roads, and re-establishing woody shrubs through planting (USDA Forest Service 2004b). Based on the biological and ecological information available concerning *V. opulus* var. *americanum*, such efforts are a continued consideration.

Indiscriminant use of insecticides that kill beneficial insects required in the pollination of *Viburnum opulus* var. *americanum* is detrimental to the reproductive capability of the species. Such management practices could affect the species' long-term survival, especially of small populations, such as those in the Black Hills. Several insect pests are known from forested areas in Region 2: mountain pine beetle (*Dendroctonus ponderosae*), Douglas fir beetle (*D. pseudotsugae*), spruce beetle (*D. rufipennis*), pine engraver beetle (*Ips pini*), western spruce budworm (*Choristoneura occidentalis*), and the European gypsy moth (*Lymantria dispar*) (USDA Forest Service 2004b). The mountain pine beetle has been expanding in the Black Hills, killing 5,219 trees in 1997 and 36,202 trees in 2000 (USDA Forest Service 2004b). Any use of insecticides to control or manage insects in habitat containing *V. opulus* var. *americanum* is an important consideration to be carefully examined.

Viburnum opulus var. *americanum* has also shown an intermediate sensitivity to certain herbicides. With the growing concern over non-native invasive plant species across the United States, herbicide usage to control such invasive species has been growing. Although herbicide use may have certain economical factors favoring its use in native landscapes towards managing invasive species, its unintended impacts to non-target native vegetation, especially rare plants such as *V. opulus* var. *americanum* need to be considered. If herbicide use is necessary in the vicinity of populations of *V. opulus* var. *americanum*, slope, aspect, and prevailing wind directions should be considered. Appropriate buffers need to be selected. Herbicide volatilization and drift are items of concern (Glotfelty et al. 1984, Glotfelty et al. 1989, Nellessen and Fletcher 1990). Distances of at least 50 to 100 m may be necessary, depending on the mode of application. In riparian areas, directional runoff also needs to be considered (i.e., how far downstream are *V. opulus* var. *americanum* populations from herbicide treated areas?).

Finally, just as its European counterpart, *Viburnum opulus* var. *americanum* is a frequently cultivated species. Due to its showy display of flowers, it is popular among horticulturalists. Because it is readily available, restoration can also be considered as part of an overall conservation strategy for the species. It would

be preferable to obtain seed or plants from western or midwestern sources, but it may be even better to begin a propagation program from local Region 2 sources. At this time, it is not known if populations in USFS Region 2 differ genetically from populations in the Midwest or East. Because Region 2 populations are disjunct, they may be genetically different, but if so, the degree of difference would be another unknown. Consequently, although restoration is a good idea, its implementation should probably focus first on identifying a good local seed source and developing a local nursery. Once this has been done, restoration could be considered as another valid component in the overall conservation approach for *V. opulus* var. *americanum*.

Tools and practices

Inventory and monitoring protocol

There is nothing particular about the biology, life history, distribution, or ecology of *Viburnum opulus* var. *americanum* that would necessarily place any constraints on monitoring known sites containing it, at least not any constraints that would be different from monitoring many other plant species. One consideration that will place certain constraints on monitoring of this species, as with all woody long-lived species, is that a study of population demographics would be a major long-term effort. However, this should not be viewed as a deterrent. Researchers can still divide populations into size classes as a surrogate for actual age classes. Regarding flower, fruit, and seed production, as for any other plant species, the monitoring of flowering time and seed production is going to have the constraint of requiring field work at the appropriate flowering and seed set time periods.

Species and habitat inventory

As stated earlier, because *Viburnum opulus* var. *americanum* is a showy, flowering shrub, it is more readily noticeable to most professional and amateur botanists, perhaps even to the general public. This may mean that a majority of sites in Region 2 have already been discovered. The greatest chances of finding new sites would be by exploring riparian areas that are little visited. Attempts to seek out new populations could focus on sites distant from all roads and existing trails. Riparian corridors in these un-roaded, un-trailed areas could be the prime targets for field botanists attempting to add new sites to the existing inventory. In drainages with perennial to intermittent flows that are already known to contain populations of *V. opulus* var. *americanum*, the entire length of the drainage could be explored. Topographic maps, soils maps, wetland maps, and aerial photographs can all be employed to focus on potentially suitable habitats. Organized search efforts have been implemented in some areas, such as the Black Hills National Forest of South Dakota (Zacharkevics personal communication 2006). Geographic information tools that project the sun's path to help locate shadier and moister sites have been used. Search efforts have been greater over the past five years than in previous periods (Heidel personal communication 2006, Zacharkevics personal communication 2006). The taxon does seem to be mostly associated with bottom habitats (Zacharkevics personal communication 2006). Although observations on plant vigor and habitat conditions are made when a new occurrence is recorded, search efforts are still in a baseline data collection mode (Burkhart personal communication 2006). When new occurrences (i.e., new populations or individuals) are discovered, at least one voucher specimen must be collected and submitted to a university or museum herbarium; this is an important step in documenting and verifying an occurrence.

These search efforts could continue to be focused first in the Black Hills National Forest. Secondarily, efforts could be focused in other national forest units across northern Wyoming (e.g., Bighorn and Shoshone national forests). If *Viburnum opulus* var. *americanum* has not yet been discovered in Yellowstone National Park (and based on available data it has not), then this potentially reduces the chances of finding it on the Shoshone National Forest. Systematic searches in USFS lands south of these units should probably be given lowest priority at this time as there may be less likelihood of finding the species farther to the south. Likewise, the likelihood of finding the species in any USFS unit in Kansas, Nebraska, or east of the Black Hills in South Dakota is also low. Although the species is reported from far eastern South Dakota, and is expected for far eastern Nebraska, these occurrences would not be on USFS units. In other words, it is possible that historical populations do not exist in southern Wyoming, all of Colorado, all of Kansas, most of Nebraska, and most of South Dakota, but this does not mean that new populations could not establish themselves in any of these areas, either from chance long-distance dispersal of wild populations or from chance dispersal of cultivated plants existing throughout the region. Searching for such random occurrences is probably best left to chance discovery.

Finally, monitoring of *Viburnum opulus* var. *americanum* occurrences and populations will be aided if forest managers and field investigators are

cognizant of the fact that introduced *V. opulus* var. *opulus* has the potential to invade and hybridize with the American variety. Urban areas such as Rapid City, South Dakota, could contain the European variety. This would represent a potential source of introduction into the wild. As a popular cultivated species, its presence would also not be limited to urban areas; it could exist on farm and ranch sites. Although such use is outside the realm of USFS management, this knowledge will be important in monitoring existing populations of *V. opulus* var. *americanum*.

Population monitoring

The following monitoring techniques can be used at known sites with *Viburnum opulus* var. *americanum*. First determine the approximate full extent of area currently occupied by the species at a site. Then determine the extent of potential habitat, including portions of the riparian corridor or wetland that do not appear to contain the species currently. If these areas coincide fairly closely, that is fine. The objective of this exercise, before laying out transects or quadrats, is to make sure one is not biasing the sample by purposely placing a quadrat or belt transect over a clump of *V. opulus* var. *americanum*. In essence, there is some bias because the investigator is intentionally sampling for this particular species, but the objective is to sample its entire suitable habitat. Most of the time, this will be linear to semi-linear corridors along streams. The species can also occur on moist slopes, so this must be kept in mind. Once the full potential habitat area is determined, this will be the sample area. Depending on the overall size of the area, it can be divided up into gridded sections. Once grids are established, then they can be selected at random for sampling. Grids do not have to be used. Transects can be spaced at regular intervals across the habitat without the use of grids.

There are numerous sampling methods used in field plant ecology (Bonham 1989, Barbour et al. 1980, Magurran 1988, Smith 1996, Scheiner and Gurevitch 2001). Probably the simplest method would be presence and absence. Is the species in the sample grid or not? These counts can then be tallied up to determine the frequency or percent of all grids sampled. The quadrat method is another approach. General cover categories such as the Daubenmire method or the Braun-Blanquet method can be employed. These use cover class ranges (e.g., ranges are 1 to 5 percent or 5 to 25 percent). For woody plants, quadrat sizes of 100 m^2 are typical. Within a quadrat, simply record presence/absence, use cover classes, estimate cover without using classes, or determine density.

Quadrats may be placed along transects. For woody plants like *Viburnum opulus* var. *americanum*, belt transects are often preferred. Belt width can be determined by the width of the riparian corridor. For example, the belt could encompass the entire riparian corridor, or separate belts could be placed on opposite shores of the stream. The point intercept method may be used in smaller quadrats for seedlings and saplings. This method is quick and very robust (Mitchell et al. 1994). Frequency refers to the number of samples in which the species appeared (whether sampling is conducted via quadrats, point or line intercept, etc.). An Importance Value (IV) can be derived from a combination of the relative covers, densities, and frequencies, or any combination of just two of these parameters. *Viburnum opulus* var. *americanum* is a multi-stemmed shrub. The number of stems per clump can be determined. Stem diameters-at-breast height (dbh) can be made with calipers. Measuring species productivity of woody plants is more problematic without destroying the entire aboveground portion of a plant. Sub-sampling of foliage on a small plant could be accomplished to estimate annual productivity of leaves and shoots. This should be done in mid-summer on mature foliage. Both fresh weight and air dry weight can be measured. Biomass productivity is probably not needed for assessing general population change, as it will be a function of cover and density. For monitoring population changes in *V. opulus* var. *americanum*, cover and density will probably be the best indictors that will not require extensive amounts of field time. These methods only need to be employed once per year, but for a long-lived woody species as this, they could be done every two to three years and still function to monitor for trends.

Deriving an understanding of demographic patterns and cycles at a particular site would entail much more detailed sampling. Determining flowering time, collecting and harvesting fruit and seed for productivity, making observations for quantity of seed on the ground, watching and marking seedlings with toothpicks or other markers for seedling recruitment and survival, and carefully marking both young and old stems for survival and longevity would all be part of such a monitoring program. All plants within a population can be divided into appropriate age classes (using size class as a surrogate). Flower pollination can be observed. What species of insects frequent the flowers? Fruit persistence on the plants can be studied and observed. The plants can be observed for birds feeding on the fruits. What species are involved? What time of year do they consume the fruits? Are the species true dispersers (consuming the entire fruit, eventually passing the seeds intact and undamaged), or are they

seed predators (either rejecting the fruit and consuming only the seeds or consuming both fruit and seeds and the seeds become damaged or digested)?

NatureServe (2005) has identified a possible technique to delineate population occurrence. This method is called the "Habitat-based plant element occurrence delimitation guidance" and is a model to help determine whether particular occurrences or populations of a plant are part of the same feature or a new and separate feature. The model is a flow chart that examines distances between occurrences and evaluates suitable or unsuitable habitat in relation to distances between occurrences. It is a general model that may have some functionality in evaluating trends in existing habitat areas. The habitat evaluation features of the model appear to be based on a 25-year period, which could be considered a questionably short time period for longer-lived woody plants such as *Viburnum opulus* var. *americanum*. Nevertheless, this model may have some utility in monitoring population trends in a general manner. It could not, however, be considered a substitute for actual stem counts, stem density counts, cover determinations, age-class determinations, seedling and sapling recruitment, and floral and seed production, all of which would be integral to determining true population trends.

Monitoring the overall habitat will be important as well. Regularly recording the plant associates of *Viburnum opulus* var. *americanum* would be a part of such a program. When doing cover or density counts of *V. opulus* var. *americanum*, cover and density of other species could be estimated simultaneously. Monitoring in this manner will help to determine whether the cover relationships are changing and whether the status of *V. opulus* var. *americanum* in the community is remaining stable or changing. Making note of new species appearing in the habitat could be important. Photo point monitoring is valuable habitat monitoring technique, but it often works best for general landscape monitoring. What is needed for *V. opulus* var. *americanum* within Region 2 is solid quantitative ecological data, not qualitative information.

Beneficial management actions and approaches

Beneficial management actions and approaches are direct corollaries to many of the conservation elements discussed above. The following list of beneficial management actions is not in a prioritized order. Land managers are encouraged to carefully evaluate the situation at each *Viburnum opulus* var. *americanum* site and make their own determination on which approaches and actions are most appropriate for a particular site at a particular point in time.

1) Protect and preserve wetlands; mitigate impacts to wetlands according to existing USFS Region 2 policy and guidance; apply USACE regulations and mitigation guidance where applicable and appropriate; consider whether the definition of wetlands by the USFWS can be used to improve upon existing policies and guidelines.

2) Protect the greater habitat matrix, including upland habitat in the same watershed surrounding the riparian areas and other small wetland and mesic sites containing *Viburnum opulus* var. *americanum*; this may be just as important as protecting the local site.

3) Prevent livestock from trampling suitable and potentially suitable habitat, including seedlings and saplings, and the soil surface, which may lead to erosion, topsoil loss, and the loss of soil nutrients.

4) Minimize grazing impacts, or prevent or exclude livestock from riparian areas that contain either populations of *Viburnum opulus* var. *americanum* or suitable habitat for the species.

5) Manage suitable habitat in a manner that would prevent alterations or changes in the balance of sun and shade; such changes may have consequences on the species' ability to recruit new individuals into the population.

6) Avoid actions that would impact bird and small mammal activity in areas that contain *Viburnum opulus* var. *americanum*.

7) Avoid or minimize the indiscriminant use of insecticides that could kill beneficial insects that are required to pollinate the species.

8) Avoid or minimize the indiscriminant use of herbicides that could have unintended, negative side effects on populations of *Viburnum opulus* var. *americanum*; consider wind directional effects and buffer zones of at least 50 to 100 meters from populations when herbicides must be applied.

9) Monitor for the potential invasion of *Viburnum opulus* var. *opulus* into wild habitats.

10) Minimize and avoid activities that could result in the introduction of invasive, non-native species into riparian corridors.

11) Collect information from the U.S. Environmental Protection Agency or local Air Pollution Control agencies on the status of air pollution where populations of *Viburnum opulus* var. *americanum* occur, such as the Black Hills.

12) Make a record of unusual damage to existing populations of the species (i.e., possible collection and use of plant materials by persons seeking natural and alternative medicinal purposes).

13) Attempt to maintain the integrity of multiple riparian systems, wetlands, and watersheds in the Black Hills area through appropriate management practices; this will reduce the stochastic effects that may occur to small populations.

14) Begin a propagation program from local Region 2 sources; while *Viburnum opulus* var. *americanum* is a frequently cultivated species, and the plant material should be available for restoration activities, seed and plants from western and midwestern sources will probably be better than from eastern sources.

Other tools and beneficial management actions within direct control and responsibility of the USFS include:

1) List or continue to list *Viburnum opulus* var. *americanum* as an Region 2 sensitive species.

2) Regulate occupancy and use of National Forest System units, including ditches and water diversions, recreation, and livestock.

3) Implement standards and guidelines in Land Resource Management Plans.

4) Change management area allocation, such as to one with more protection).

5) Implement other management directions, such as watershed conservation practices.

6) Identify the potential for land exchanges or purchases.

7) Propose land exchanges or purchases with willing partners.

8) Provide opportunities to collect and store seed or other propagules.

9) Provide opportunities to establish off-site populations for conservation purposes.

10) File for water rights on wetlands that support rare species.

11) Designate limited operating periods or areas (buffers) as part of project planning and implementation.

Seed banking

Concerning seed banks and germplasm conservation for *Viburnum opulus* var. *americanum*, there are at least six accessions of plant material according to the Germplasm Resources Information Network (GRIN) at the National Germplasm Resources Laboratory in Beltsville, Maryland (USDA Agricultural Research Service 2005). Since this is a commonly cultivated species, there are likely numerous other sources of stored seeds and facilities that store and propagate stem cuttings. However, locally adapted genomes from Region 2 are probably not currently part of such germplasm banks. *Viburnum opulus* is also being studied for its micropropagation ability with tissue cultures (Ibanez et al. 2003). The Native Fruit Development Program at the University of Saskatchewan, Canada, has included *V. opulus* var. *americanum* in its program for conserving diversity in native fruit plants (St. Pierre 1992).

Information Needs

Although there is a fair amount of information on the species *Viburnum opulus*, much of it specifically concerns the European variety. Considering how closely related the two varieties are in both appearance and habitat preferences, much of the information on the European variety has been deemed applicable or potentially applicable to the American variety. In addition, research conducted on the American variety

is almost entirely from eastern North American sources. The taxonomic status of *V. opulus* var. *americanum* appears relatively stable, so there does not appear to be much additional work needed in this area. What is probably needed most for this species, especially for the western populations, is more plant ecologists (e.g., plant population ecologists, plant physiological ecologists) studying existing populations to develop a much better understanding of the biology and ecology of the taxon, specifically as it pertains to populations in western habitats. The Black Hills National Forest populations would serve as good study sites. Ornithologists could be employed to assist plant ecologists by studying the bird species that consume the fruit and distribute the seed in these western populations. Are the bird species visiting this plant the same species seen in the eastern part of the continent, the same guild of bird, or are there different players in these western habitats?

Ultimately, what is primarily needed is more site-specific research on the community ecology, population ecology, physiological ecology, and reproductive ecology of the taxon in western North America. The collection of such ecological information will enhance what is already known about its life history characteristics, its response to fine and broad scale changes in natural disturbance, and the importance of meta-population dynamics. There are numerous reliable methods to monitor population trends at existing sites.

Reproductive methods of the species are understood, but its basic reproductive capability and seedling recruitment capabilities in western habitat settings would enhance what is already known about eastern populations. Such information will help plant biologists and land managers to predict whether *Viburnum opulus* var. *americanum* will persist at a site.

Reliable restoration methods are likewise available. Wetland and riparian restoration has advanced considerably over the past several decades. Some of the particular local habitat and environmental requirements in western settings may not be understood, but plant material from this readily available, highly prized species in horticultural circles is available to conduct restoration activities.

Research priorities in Region 2 are best focused on the following order of initiatives:

1) geo-reference all known occurrences in Region 2

2) review and annotate all *Viburnum opulus* vouchers in herbaria from Region 2 states

3) initiate systematic field searches for additional occurrences of *Viburnum opulus* var. *americanum* on USFS lands, perhaps beginning with remote localities in the Black Hills, the Bighorn Mountains, and the Shoshone National Forest

4) conduct studies into the site-specific ecology of the species at existing sites in the Black Hills of South Dakota and in Wyoming; these studies can include standard ecological monitoring methodologies useful in tracking multi-year population trends

5) examine populations for evidence of introgression from the European variety.

At this time, there is probably not much potentially useful additional research and data that were not incorporated in this report. There was not time to include specimen records from all herbaria in the region. Many herbaria do not have on-line Internet systems through which to conduct a search. Nebraska has been identified as a potential state containing *Viburnum opulus* var. *americanum*, but its location was not determined; it is likely found in far eastern Nebraska, near the Missouri River, and is unassociated with any USFS unit. Similarly, the species is reported for the northeastern corner of South Dakota (apparently Roberts County), but confirming this observation is recommended. Finally, there are many wetland and riparian restoration practitioners across the United States. It is very possible that some of these practitioners may have some actual field experience with *V. opulus* var. *americanum* in restoration projects that is not generally published or available.

DEFINITIONS

Diploid – having a homologous pair of chromosomes for each characteristic except sex; having one chromosome from each parent.

Disjunct – individuals or a population separated by a relatively wide geographic distance from the main body of the species distribution.

Ecotype – a population within a species that has undergone a natural selection process and become adapted to a particular set of local environmental conditions.

Frequency – how often, or how many times something is encountered in a sampling design.

Inflorescence – the structure produced by plants that bears flowers.

Introgression – the spread of genes of one species into the gene pool of another by hybridization and backcrossing.

Mesic – sites or habitats with moderate moisture regimes.

Meta-population – the combination of several smaller (or localized) populations (interbreeding on a more regular basis) that interbreed on a less regular basis.

Occurrences – sites or locations in the environment where individuals of a species are located.

pH – the hydrogen ion concentration in solution, how acidic or basic a solution is.

Population – a group of interbreeding individuals.

Synergistic – when the impact or influence of two or more factors (or variables) is more than their individual additive effects.

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