VIRGINIA SPIRAEA

(*Spiraea virginiana* Britton)

Recovery Plan

U.S. Fish and Wildlife Service, Region Five

Virginia Spiraea (*Spiraea virginiana* Britton)

Recovery Plan

Prepared by:

Douglas W. Ogle
Associate Professor of Biology
Virginia Highlands Community College
Abingdon, VA 24210

for:

U.S. Fish and Wildlife Service
Region Five
One Gateway Center
Newton Corner, MA 02158

APPROVED: Nancy M. Kaufman
Regional Director, Region Five

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EXECUTIVE SUMMARY
VIRGINIA SPIRAEA RECOVERY PLAN

Current Status: Virginia spiraea (*Spiraea virginiana*) consists of 31 stream populations in seven states from West Virginia and Ohio to Georgia, down from 39 populations in eight states. The plant is threatened by small population size, a paucity of sexual reproduction and dispersal, and manipulation of riverine habitat. The species was listed as threatened on June 15, 1990.

Habitat Requirements: *S. virginiana* typically is found in disturbed sites along rivers and streams. The species requires disturbance sufficient to inhibit arboreal competition, yet without scour that will remove most organic material or clones.

Recovery Objective: To delist the species.

Recovery Criteria: Delisting will be considered when: (1) three stable populations are permanently protected in each drainage where populations are currently known, (2) stable populations are established on protected sites in each drainage where documented vouchers have been collected, (3) potential habitat in the states with present or past collections has been searched for additional populations, and (4) representatives of each genotype are cultivated in a permanent collection.

Recovery Strategy: Protect the known populations and their habitat, and restore rangewide distribution. Understand the environmental tolerances and genetic diversity of the species to ensure long-term reproductive viability.

Actions Needed:

1. Protect existing populations and essential habitat through landowner cooperation and land acquisition.
2. Search for additional populations.
3. Conduct site-specific habitat manipulation as needed to maintain populations.
4. Distinguish between N and η individuals and identify genetically different populations.
5. Maintain cultivated sources for reproduction studies as well as conservation and reintroduction activities.
6. Study the species' environmental tolerances and habitat characteristics.
7. Re-establish populations within the historic range of the species.
8. Inform land owners and managers about the plant's recovery needs.
9. Monitor populations and evaluate effectiveness of recovery efforts.

Estimated Costs ($000):

Year	Need 1	Need 2	Need 3	Need 4	Need 5	Need 6	Need 7	Need 8	Need 9	Total
FY 1	14	5		9.5		10		5	1	44.5
FY 2	19	5	5			8	5		1	43
FY 3	23		5			7	5		1	41
FY 4-5	16.2					14			2	32.2
Total	72.2	10	10	9.5	?	39	10	5	5	160.7

The total cost for recovery of *Spiraea virginiana*, excluding the cost of maintaining a permanent collection of genotypes, is estimated at $160,700. Most expenses are for research and conservation easements (one-time expenses), monitoring, and education.

Estimated Time Frame: The time frame for full recovery is tentatively estimated at five years, pending further study of the species' requirements.

* * *

The following recovery plan delineates a practical course of action for protecting and recovering the threatened Virginia spiraea (*Spiraea virginiana*). Attainment of recovery objectives and availability of funds will be subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities.

This plan has been prepared by Douglas W. Ogle for the Northeast Region of the U.S. Fish and Wildlife Service. It does not, however, necessarily represent the views or official position of any individuals or agencies other than the U.S. Fish and Wildlife Service. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

Literature citations should read as follows:

U.S. Fish and Wildlife Service. 1992. Virginia Spiraea (*Spiraea virginiana* Britton) Recovery Plan. Newton Corner, Massachusetts. 47 pp.

Copies of this plan can be purchased from:

Fish and Wildlife Reference Service
5430 Grosvenor Lane, Suite 110
Bethesda, Maryland 20814
(301) 492-6403
or
1-800-582-3421

Fees vary according to number of pages.

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OVERVIEW

Robertson (1974) recognized two indigenous and one introduced species of Spiraea, section Calospira, in the southeastern United States. These species, the introduced S. japonica L. and the native S. betulifolia Pallas and S. virginiana Britton, are characterized by a compound corymb terminating a long shoot. The latter species has received both state and national attention (U.S. Fish and Wildlife Service 1985, 1989), and was designated a Federally threatened species on June 15, 1990 (USFWS 1990).

Spiraea virginiana is a perennial shrub that has a modular growth form. The species is clonal, with a root system and vegetative characteristics that allow it to thrive under appropriate disturbance regimes. Stutz (1989) states that perennial shrubs occupying unpredictable habitats are probably the most plastic of plants. S. virginiana survives several types of stochastic events, and its phenotypic plasticity has much to tell us about temporal adaptation.

Description of the species is complicated by its plasticity, as well as by the paucity of collections rangewide and the reliance on herbarium sheets (which tend to preserve reproductive rather than vegetative material). The wide distribution of the species and the exorbitant demands of field work have caused further difficulties. An examination of the variation found in S. virginiana reveals a closer phenotypic resemblance to S. betulifolia than early narrow circumscription would indicate. Both native species deserve a thorough taxonomic review.

The species probably reached optimal population numbers, genetic diversity, and widest distribution during late glacial times when arboreal competition was inhibited. During this period, distribution was probably achieved using sexual reproduction and seed dispersal. As the climate ameliorated, plants became limited to riverine habitats, thus isolating and probably eliminating many genetic individuals, increasing dependence on vegetative reproduction, and restricting population numbers over a wide but discontinuous range. The riverine sites in which the species now occurs have enough erosion to inhibit arboreal competition and fragment the modular colonies, combined with a deposition pattern suitable for the establishment of vegetative propagules.

Human activities have inadvertently maintained the species in several sites through periodic clearing, yet human activities are the only documented cause of extirpation. Recovery of S. virginiana will involve a program of research, habitat protection, and management of the species and its habitat.

TAXONOMY

Of the three Spiraea species in section Calospira, the introduced S. japonica is the most distinct. The dense pubescence (easily seen with a 10x lens) on its branchlets and inflorescence allow this species to be separated with confidence at any season; it is also distinctive in leaf and flower characteristics. S. japonica is sympatric with the two native species of the section, and the author has seen it in direct competition with both. This species readily escapes cultivation to become naturalized, and may be a local factor in the rarity of S. virginiana.

S. betulifolia generally is considered to have three geographic varieties: var. betulifolia in Asia, var. lucida (Dougl.) C.L. Hitchc. in northwestern North America, and var. corymbosa (Raf.)

Maxim in the eastern United States (Hess 1976, Robertson 1974, Hitchock *et al.* 1961, Ohwi 1984, Stephens 1973). The same basic taxonomic concept using subspecies with different authority is cited in Kartesz and Kartesz (1980). Some older references (e.g., Gray 1889, Britton 1889) refer to eastern material in essentially the same fashion, but most early treatments for this region cited *S. corymbosa* Raf., (e.g., Hyams 1899, Mohr 1901, Short and Griswold 1833, Chapman 1883, Shreve *et al.* 1910, and Small 1933). The oldest binomial used for the native corymbose *Spiraea* is *S. corymbosa* Raf., and several specimens of *S. virginiana* initially were determined to be *S. corymbosa*. This becomes a problem because several older publications cite *S. corymbosa* (Short 1833, Hussey 1875) from states within the range of *S. betulifolia* and *S. virginiana*. Unless a voucher exists, the only way to resolve this dilemma is field work.

Shreve *et al.* (1910) cite *S. corymbosa* from Maryland, but the ridge and valley plants found there are *S. betulifolia* (Ed Thompson, MD Natural Heritage Program, pers. comm.). Mohr (1901) cites *S. corymbosa* from Cypress Creek near Florence, Alabama. The voucher is deposited at US, and although the specimen is in poor condition, its appearance is very similar to depauperate individuals of *S. virginiana*. An effort to relocate this population was not successful. Hussey (1875) cited *S. corymbosa* and had done most of his collecting on Bear Creek and Nolin River in Edmondson County, Kentucky. Suitable habitat still exists on both streams, but the most promising sites are now flooded by a U.S. Army COE impoundment; a 1991 search revealed no populations in the area.

In his original description of *Spiraea virginiana*, Britton (1890) attributed the earliest collection of the species to G.R. Vasey. Vasey collected the material "in the mountains of North Carolina" in 1878 and identified it as *Spiraea corymbosa* Raf. Specimens are deposited at US and PH, and both have been annotated as *S. virginiana* in Britton's distinctive hand. A letter dated September 26, 1913 from C.F. Millspaugh to C.S. Sargent cites the type locality of the species "located under the over-hanging bank of the Monongahela River just outside of the Morgantown limits north of the railway station at Morgantown." Fernald (1950) cited S. corymbosa with a range from northern New Jersey, Pennsylvania, and West Virginia to Georgia and Kentucky, and S. virginiana in West Virginia, western North Carolina, and eastern Tennessee.

Clarkson (1959) reviewed the taxonomic and distributional history of S. virginiana and restated the narrow delineation of Britton (1890) and Rehder (1920, 1949). He stated that the species has "quite constant characters," referred two collections (Morgan County, Tennessee, and Walker County, Georgia) to S. corymbosa Raf., and highlighted a Dade County, Georgia collection that did not resemble the type description.

Glencoe (1961) recognized the wide latitude of phenotypic variability in the species, and broadened the description to include a wider range of character states. He added the Dade County collection and a collection from Van Buren County, Tennessee, but did not mention either of the collections referred to as S. corymbosa by Clarkson, even though they fell within the phenotypic and geographic ranges of S. virginiana. Rawinski (1988) compiled rangewide date on the species.

In further reviewing the taxonomic status of the species, the author received site-specific information from the following collections (following Holmgren et al.): A, BGSV, BKL, CM, DUKE, EKY, F, FARM, GA, GH, K, KY, LYN, MO, MSC, MU, MUHW, NCSC, NCU, NY, PH, TENN, US, VDB, VPI, WCUH, WVA, and WVW. Every known site was visited, several old populations were again located, and several new populations were found. All sites were documented by specimens and photographs, and current population information was shared with the Natural Heritage program within each state. A complete voucher series is now deposited at NY and US.

Examination of herbarium material and observations of populations in the field have allowed the construction of

Table 1. There is some overlap in almost all the characters listed. Many more specimens of S. virginiana were examined than S. betulifolia var. corymbosa. Both shrubs are quite variable, and there is no basis for separating them with stem coloration, pubescence, or sepal position at fruiting (reflexed/erect, see Krussman 1986). There are sufficient habitat and distributional differences to merit the maintenance of S. virginiana at specific rank. For clonal species, habitat and distribution are as important to species delineation as fine morphological distinctions (e.g., pubescence).

ECOLOGICAL FORM

The modular growth pattern of Spiraea virginiana may exhibit several genetically identical "forms" that are determined by age and environmental conditions. Harper (1981) emphasizes that characteristics considered taxonomically important are features of the module rather than features of the entire genet. The plastic nature of modular structures such as leaf shape has caused some identification problems with this species. The ecological forms possible for a single genet are illustrated in Figure 1.

DISTRIBUTION

The distribution of Spiraea virginiana (Figure 2 and Table 2) has been compiled from herbarium sheets, references, and field work, using the species delineation from Table 1. All localities are within the southern Blue Ridge or the Appalachian (Cumberland) plateau physiographic provinces on the headwaters, or just over the divide, of streams that flow to the Ohio drainage basin. This distribution is probably relictual from a more widespread distribution during late glacial time (Ogle 1984). As Delcourt and Delcourt (1986) state: "In the Allegheny plateau and Blue Ridge

TABLE 1. COMPARISON OF CHARACTER STATES

CHARACTER	*S. virginiana*	*S. betulifolia* var. *corymbosa*
Branching pattern	Usually profuse	Usually simple
Normal plant size	Large shrubs, 1-3 m (4 m maximum height)	Small shrubs, 0.5-1.0 m (1.5 m maximum height)
Leaf shape	Ovate to lanceolate	Oval to oblanceolate
Leaf size	3-15 cm long x 2-5 cm wide	2-8 cm x 2-6 cm
Leaf margin	Entire (near corymb or long established) to completely serrate	Rarely entire to completely serrate
Serration	Almost always single teeth occasionally curved, coarse to fine, obviously mucronate	Almost always double teeth not curved, almost always coarse, rarely mucronate
Leaf base	Acute	Usually obtuse
Leaf surface	Glaucous beneath, often darker green above	Not glaucous, often yellowish above
Corymb size	5-22 cm	2-10 cm
Flower color	Yellowish/greenish, clear pale white	Chalky white, pink
Flowering period	Late May-late July	May-October
Flower production	Rare on first-year plants, sparse unless established	Profuse, often every stem even on first-year plants
Flower morphology	Stamen twice length of sepal	Stamen three times length of sepal
Habitat	- Scoured banks of high gradient streams - Meander scrolls and point bars Natural levees Braided features of lower stream reaches - Disturbed rights-of-way	- Open to thin, often rocky woods - Dry slopes - Clearing edges
General distribution	From WV to GA (?PA, AL): WV, OH, KY, VA, TN, NC, GA	From PA to NC (?NJ): PA, MD, WV, VA, NC
Physiographic provinces	Southern Blue Ridge, Appalachian (including Cumberland) Plateau	Northern Blue Ridge, Ridge and Valley, Piedmont, and Southern Piedmont outcrops

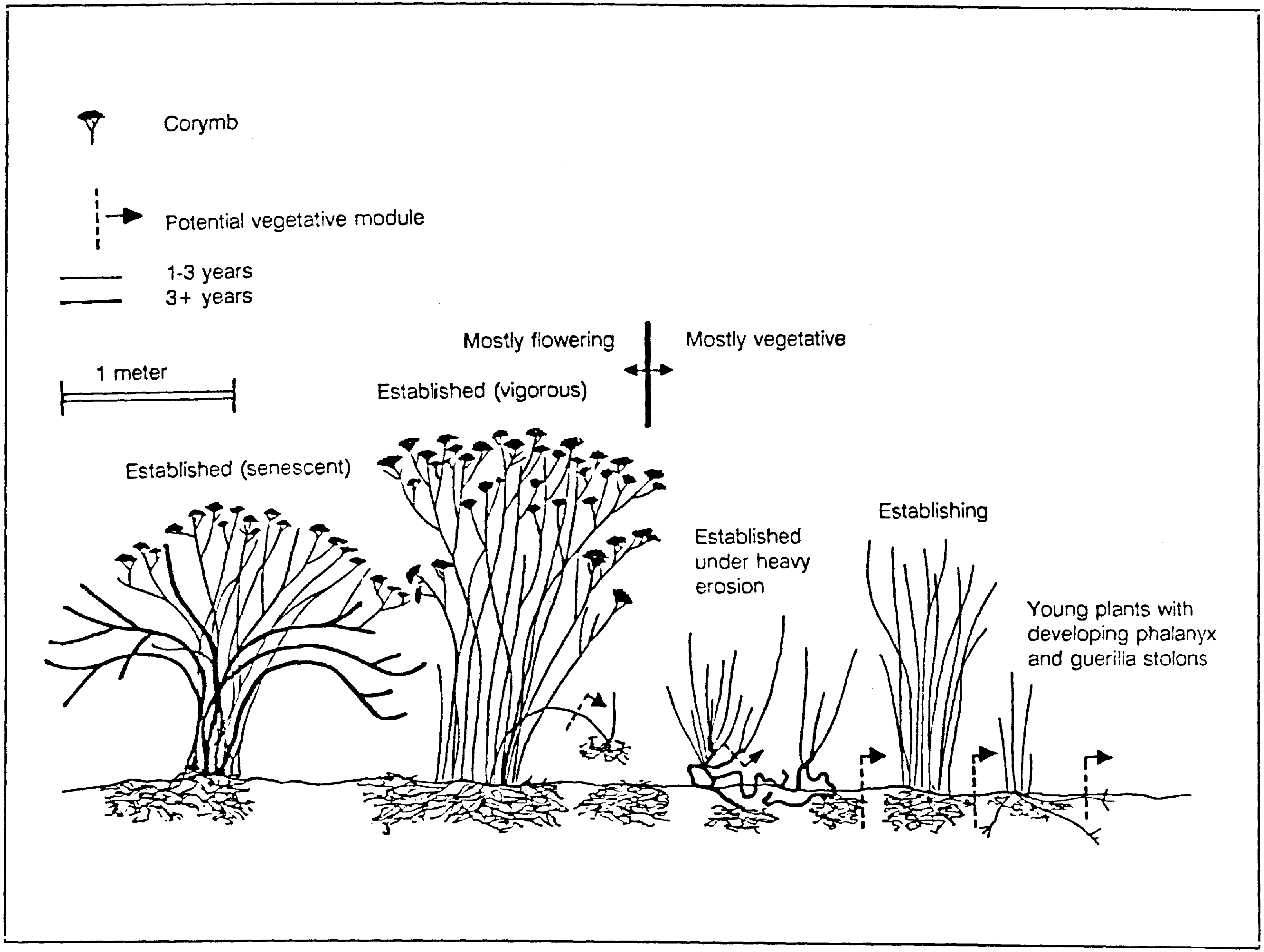

FIGURE 1. ECOLOGICAL FORM OF *SPIRAEA VIRGINIANA*

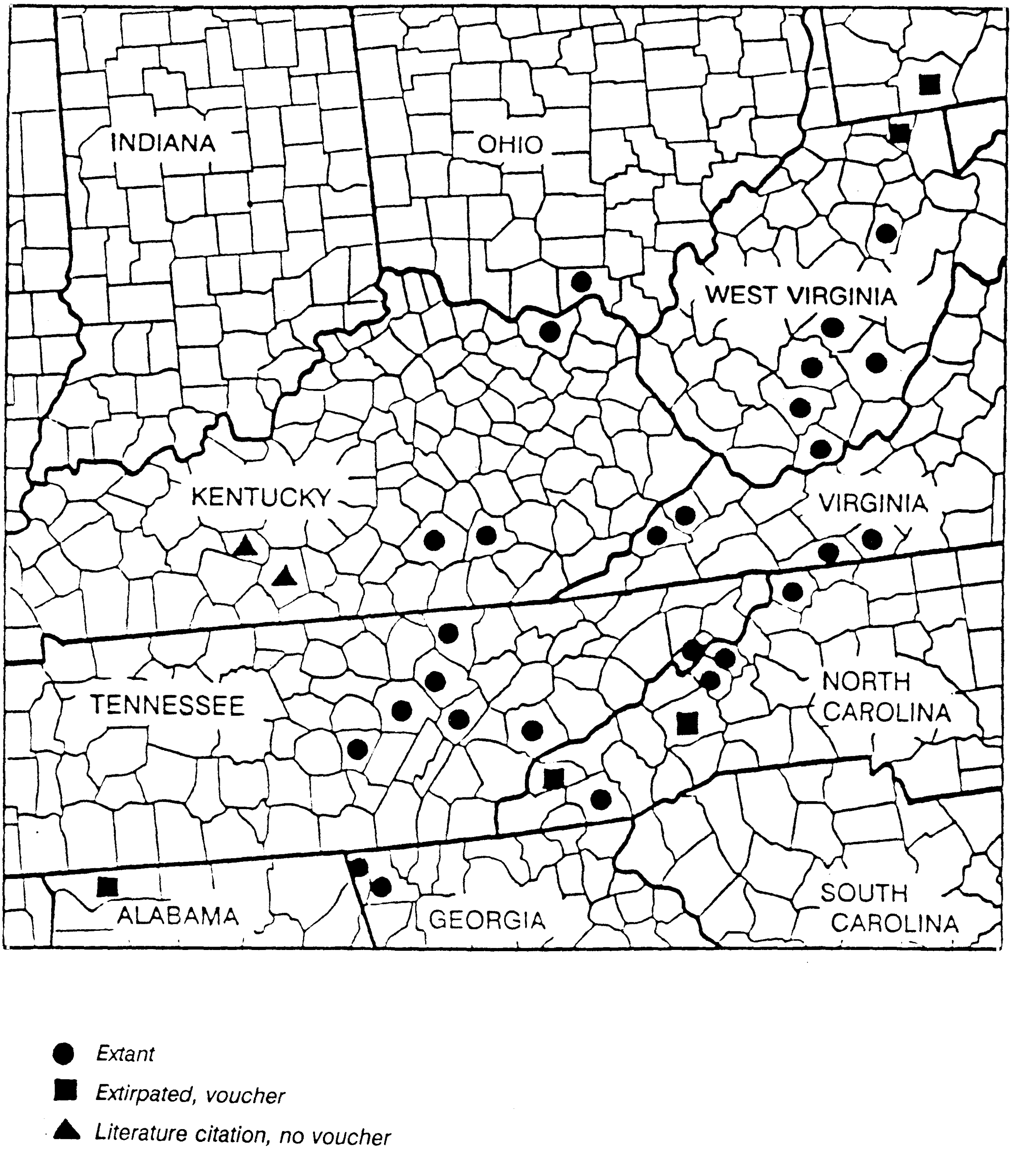

FIGURE 2. DISTRIBUTION OF *SPIRAEA VIRGINIANA*

TABLE 2. HISTORICAL AND PRESENT RECORDS OF *SPIRAEA VIRGINIANA*

STATE (with references)	COUNTY and/or DRAINAGE	VERIFICATION DATE(S)
Alabama (Mohr 1901)	Lauderdale County/Cypress Creek	189?*
Georgia (Chapman 1883, Cronquist 1949, Patrick 1988)	Dade County/Bear Creek	1948, 1987-89
	Walker County/Lula Falls, Rock Creek	1898, 1987-89**
Kentucky (Short and Griswold 1833, Hussey 1875, USFS *et al.* 1988)	Laurel County/Sinking Creek	1989**
	Pulaski County/Rockcastle River	1987-1989
	Lewis County/Kinniconick Creek	1991
North Carolina (1878) (Chapman 1883, Hymans 1899, Radford *et al.* 1968)	Ashe County/South Fork of New River	189?, 1952, 1986-87, 1992**
	Buncombe County/Hominy Creek	1904, 1919*
	Graham County/Cheoah River	1940*
	Macon County/Little Tennessee River	1919, 1961, 1988**
	Mitchell County/Nolichucky River	1988
	Yancey County (1898)/Cane River	1987**
	Nolichucky River	1987**
	South Toe River	1987**
Ohio (S. Sine, OH Dept. Nat. Res., pers. comm. 1991)	Scioto County/Scioto Brush Creek	1991**
Pennsylvania (Wherry *et al.* 1979, PA Natural Heritage Inventory 1987)	Fayette County/Youghiogheny River	1903*
Tennessee (Kearney 1894; Gattinger 1901; Svenson 1941; Shanks 1952; Caplenor 1954, 1955; Sherman 1958; White 1982)	Blount County/Abrams Creek	1979, 1989
	Little River	1891, 1893, 1896-98, 1989**
	Little Tennessee River	1896*
	Cumberland County/Daddy's Creek	1976, 1989**
	Morgan County/Clear Fork	1938, 1981, 1989
	Roane County/Clifty Creek	1983, 1989**
	Scott County/Clear Fork	1989
	White Oak Creek	1986, 1989**
	Unicoi County/ Nolichucky River	1987, 1989**
	Van Buren County/Cane Creek	1952, 1989
Virginia (Wieboldt 1986, Harvill *et al.* 1986)	Dickenson County/Pound River	1987
	Russell Fork River	1987
	Carroll and Grayson Counties/ New River	1986, 1992**
	Wise County/Guest River	1985
West Virginia (Core 1936, 1940; Tosh 1942; Clarkson 1959, Clarkson *et al.* 1981; Glencoe 1961; Grafton 1976, 1982; Rouse 1985; Bartgis 1987)	Fayette County/New River	1954, 1961*
	Fayette and Nicholas Counties/ Gauley River	1977, 1988**
	Meadow River	1985, 1988**
	Greenbrier County/Greenbrier River	1983, 1989
	Mercer County/Bluestone River	1987**
	Monongalia County/Monongahela R.	1890*
	Raleigh County/Glen Daniels	1941, 1961, 1988**
	Upshur County/Buckhannon River	1895-97, 1953, 1989**

* Probably extirpated
** Private; protection by conservation easement needed

physiographic provinces, persistence of severely cold climate and frequent disturbance by active geomorphic processes such as freeze-thaw churning of soil maintained alpine tundra and inhibited establishment of tree populations throughout the late glacial period." This is an ideal situation for a disturbance-adapted shrub, and S. virginiana probably achieved its optimal distribution during or just after this period, with sexual reproduction and the dispersal of small wind- or water-borne seeds allowing a wide range. As the climate ameliorated, S. virginia generally became restricted to areas of stream topography where arboreal competition was inhibited by erosion. During this range contraction, the sexually reproducing clones presumably shifted to vegetative propagation and from ice-disturbed to water-disturbed habitats, leading to a discontinuous range and low genetic diversity.

The single exception to the species' riverine habitat is a population growing in a wet meadow at Glen Daniels in Raleigh County, West Virginia. While it is possible that these plants were introduced there from imported roadbed fill, a more feasible hypothesis is that these plants became isolated in a "glade like" environment where disturbance was maintained by freeze-thaw actions rather than erosion.

A state-by-state description of the species' current status follows. In addition, the sites listed in Table 2 may point to other possible localities for S. virginiana.

Georgia

The first mention of this species in Georgia was by Chapman (1883), who referred to it as Spiraea corymbosa. The first collections, also identified initially as S. corymbosa, were collected by A. Ruth in Walker County, Georgia, along Rock Creek at Lula Falls in 1898. This site has been a well known picnic spot for many years. There are paintings of the site in the Tennessee State

Archives (J.A. Hoobler, Curator of the Capitol, pers. comm.), and George Barnard, the Civil War photographer, made several images of the falls and stream during 1864. All the photographs were examined for evidence of S. virginiana, but none was found within the photographed area, although some existing populations occur very close to the site. In a 1988 survey, five extant clones were found along Rock Creek.

The second Georgia site for S. virginiana was discovered by A. Cronquist in 1948 along Bear Creek in Dade County (Cronquist 1949). In 1988 there were two extant clones along this stream, both of which are within Cloudland Canyon State Park.

A summary of clones in Georgia follows:

Rock Creek	5 clones (private)
Bear Creek	2 clones (State Park)
TOTAL	7 clones

The Georgia Wildflower Preservation Act prohibits digging, removal, or sale of state-listed plants from public lands without approval of the Georgia Department of Natural Resources. Federal listing provided automatic state listing for the species.

Kentucky

The species was first discovered in Pulaski County along the Rockcastle River by J.N. Campbell in 1987; the plant was collected again in 1988 by Campbell and Kenneth Nicely. A second population was discovered on Sinking Creek (a Rockcastle tributary) in Laurel County in 1989. M. Shea located the species along Kinniconick Creek during 1992 inventories, and located additional populations on the Rockcastle River and Sinking Creek.

A summary of clones in Kentucky follows:

Kinniconick Creek	8 clones (private)
Rockcastle River	3 clones (1 National Forest, 2 private)
Sinking Creek	9 clones (National Forest)
TOTAL	20 clones

The Kentucky Nature Preserves Commission is proposing that the species be listed as a species of concern, but no official state status is given to rare species.

North Carolina

The first North Carolina collections were made by G.R. Vasey "in the mountains" in 1878. These plants, cited in Britton (1890), are recognized as the first collected specimens of the species. Hyams (1899) also cited the species; a specimen at NCSC was collected by Hyams in June 1898 at "Mica, NC."

Another North Carolina collection was made by W.W. Ashe along the "banks of the South Fork of New River, Ashe County," near covered bridge #63 (NCU). In Ashe's field notebooks, also at NCU, there is a hand-drawn map of the South Fork dated August 10, 1891. This may be the probable time of collection, and on the map there is clear evidence that Ashe travelled the current route of State Route 16 crossing the South Fork at Wagoneer. The 1992 discovery of a "new" population on the west bank of the South Fork by the North Carolina Department of Transportation may or may not be the same population recorded by Ashe. In addition, there is an extant population about one-half mile north of Wagoneer; this may be near the site of Ashe's original collection. A. Radford re-collected S. virginiana on the South Fork in July 1952 "SW of Scottsville."

In 1919, T.G. Harbison collected the species along Hominy Creek in Buncombe County and along the Little Tennessee River at Franklin in Macon County. The Franklin locality was re-collected in 1933 by Harbison and Totten, and in 1961 by J.F. Glencoe and Kenneth Nicely; it was still extant in 1988. The population at the Hominy Creek locality has evidently been extirpated, but has been preserved as a cultivated specimen at the Arnold Arboretum.

There are additional extant populations on the Cane River, the South Toe River, and the Nolichucky River in Yancey County, and the South Fork of the New River. The Town of Micaville is in Yancey County, and the South Toe populations may have been Hyams' "Mica" site.

A summary of clones for North Carolina follows:

New River (Scenic R.)	4 clones (private)
S. Toe River	2 clones (private)
Cane River	1 clone (private)
Nolichucky River	4 clones (National Forest, private)
Little Tennessee River	1 clone (private)
TOTAL	12 clones

North Carolina regulates interstate trade of state-listed plants, and provides for monitoring and management of these species. The species is listed as endangered in the state.

Ohio

During the 1991 field season, Stanley Sine discovered three clones along Scioto Brush Creek in Scioto County. A summary of clones for Ohio follows:

Scioto Brush Creek	3 clones (private)
TOTAL	3 clones

Ohio has an endangered plant law that prohibits take of plants for commercial purposes or without a permit, but does not prohibit take on private lands with landowner permission.

Tennessee

Kearney first reported the species in 1894 from the Little River in Blount County, and it was cited again in Gattinger (1901). Svenson (1941) reported S. virginiana from Clear Fork Creek in Morgan County. Shanks (1952) overlooked the Svenson specimen but re-cited Kearney's locality. Caplenor (1954, 1955) reported the species from Falls Creek Falls State Park, as did Sherman (1958). P. White, T. Patrick, and others found populations along Abrams Creek in Blount County (White 1982), while T. Patrick, E. Schell, L. Pounds, G. Wofford, and R. Kral located new populations on the Cumberland Plateau. J. Churchill located populations on the Nolichucky River in Unicoi County. A summary of clones in Tennessee follows:

Abrams Creek	4 clones (National Park)
Little River	1 clone (private)
Nolichucky River	2 clones (private)
Cane Creek	3 clones (State Park)
Falls Creek	1 clone (State Park)
Clifty Creek	3 clones (private)
White Oak Creek	2 clones (private)
Clear Fork (Scott Co.)	2 clones (National Rec. Area)
Clear Fork (Morgan Co.)	2 clones (National Rec. Area, private)
Daddy's Creek	1 (private)
TOTAL	21 clones

The species is listed as endangered on the state endangered, threatened and rare plant species list. The Tennessee Rare Plant Protection and Conservation Act prohibits taking without landowner permission, and requires that commercial activity be authorized by permit.

Virginia

A population in the Guest River Gorge in Wise County was discovered in 1985 by T.F. Wieboldt (Wieboldt 1986). F. Levy found the species in the Breaks Interstate Park along the Russel Fork River in 1986. Several other clones have been discovered along the Russell Fork and Pound Rivers in Dickenson County. One clone was discovered along the New River in Grayson County, and a single clone has recently been found in Carroll County.

A summary of clones for Virginia follows:

New River	2 clones (State Park, private)
Guest River	12 clones (National Forest, private)
Russell Fork	3 clones (State Park)
Pound River	1 clone (Corps of Engineers)
TOTAL	17 clones

The Virginia Endangered Plant and Insect Species Act provides protection from taking without permits, and provides the authority necessary to regulate the sale and movement of listed plants and establish programs for the management of listed plants. The species is listed as endangered.

West Virginia

Plants collected by C.F. Millspaugh along the Monongahela River near Morgantown were used for the original description of the species

(Britton 1890). Suitable habitat still exists in this area, but a 1990 search failed to relocate any populations.

W.M. Pollock collected the species along the Buckhannon River in Upshur County during 1895-1897. In 1989, one plant was found growing on an island in the river below Sago.

Tosh (1942) reported the anomalous "wet meadow" occurrence of the species at Glen Daniels in Raleigh County. Three populations along the highway are still extant at this site.

L.E. Hicks and F. Bartley discovered S. virginiana on the New River below Hawks Nest Dam, Fayette County, in 1954. The site was revisited by J.F. Glencoe (1961), but all recent efforts to find the population have failed and it is presumed extirpated.

W.N. Grafton was the first to discover populations of the species on the Gauley and Meadow Rivers in Fayette and Nicholas Counties. Subsequent surveys by various individuals have located six populations on the Meadow River and approximately twelve on the Gauley. The Meadow River has several miles of potential habitat.

One population found on the Greenbrier River in Greenbrier County by R. Richardson has been confirmed, and there are several miles of good potential habitat.

T.F. Wieboldt found the species along the Bluestone River in Mercer County in 1987. Subsequent surveys have confirmed a total of four populations. Suitable habitat exists both up- and downstream of these populations.

A summary of clones in West Virginia and the ownership status of the habitat follows:

Bluestone River	4 clones (2 State Park, 2 private)
Meadow River	6 clones (private)
Gauley River	ca. 12 clones (private)
Greenbrier River	1 clone (National Forest?)
Buckhannon River	1 clone (private?)
Glen Daniels	3 clone (private?)
TOTAL	26 clones

West Virginia does not have an official list of rare plants, but the State Heritage Program includes this plant on its list of sensitive species.

HABITAT

Spiraea virginiana is found along the banks of high gradient sections of second and third order streams, or on meander scrolls and point bars, natural levees, and other braided features of lower reaches (often near the stream mouth). Leopold *et al*. (1964) theorized that such areas are slow-changing, dependable aspects of the equilibrium in river systems. If this is true, the *S. virginiana* populations located there may be relatively stable; otherwise, they may be highly susceptible to extirpation.

The habitat of this species is in oft-disturbed early successional areas, and its associates are determined by availability to recolonize after disturbance. A rangewide list of associates would run to several hundred, usually disturbance-adapted, species. A list of these species compiled from a sample of element occurrence records is found in Rawinski (1988).

Competition appears to be the most important variable related to the persistence of the species in particular riverine localities. Overtopping by arboreal species or fast-growing herbaceous vegetation is tolerated for some time, but will eventually eliminate S. virginiana. Scour must be sufficient to topple the larger, heavier trees and wash out many herbs and vines, without being so extreme as to wash out the plant's fine fibrous root mass or heavy lateral rhizome. Even though a great deal of above-ground plant material may be lost during scour episodes, the below-ground portions of S. virginiana are usually capable of regenerating the clone. Senescence, observed in some older clones, may decrease the risk of a plant being washed out during flood events by decreasing the above-ground vegetative mass (Harper 1977).

Although scour is needed to control competition, the riverine sites where plants occur are not usually sites of **maximum** erosion. Rather, these sites are areas where deposition occurs after high water flows (e.g., floodplains and overwash islands). Most populations are established among driftwood jams or piles of plastic milk jugs, where eroded vegetative modules or portions of a plant fragmented as jetsam are deposited during flood events. Due to the stochastic nature of these processes, the re-colonization of any particular site is only a remote possibility.

MAINTENANCE

Some of the species' most serious competitors are plants similar to S. virginiana in vegetative and environmental tenacity, but with the added advantage of prolific sexual reproduction and dispersal (e.g., Rosa multiflora and Spiraea japonica). Competition from fast-growing alien species, such as Polygonatum cuspidatum Sieb. & Zucc., has restricted clone size at some sites. Competitors like these must be removed on a regular basis, through the actions of either nature or man, without destroying Spiraea rootstock. At several sites in Tennessee, North Carolina, and West Virginia, competition has been eliminated by right-of-way clearing for roads and railroads, and by fishermen clearing streamside sites. Spiraea populations have readily moved away from the streambank to the edge of such cleared areas, and are maintained there by arrested succession.

The demography of clonal shrubs is notoriously difficult (Harper 1977), and this is true for to S. virginiana. Harper (1981) tried to surmount this problem, for the purpose of population determination, by specifying the difference between N (the number of genets) and η (the number of modules). In any event, the "populations" of S. virginiana are most likely the growth of a single plant (i.e., genet).

The oldest rhizome examined by the author is less than 20 years old, but data suggests that the species can persist in a specific locality for many years. In a letter dated January 24, 1902, Albert Ruth spoke of his July 1898 collections (NY, US, and MO) from "Lookout Mountain, at the foot of a large waterfall. Found only one shrub of it." Re-visiting the largest falls on Lookout Mountain in June 1988, T.S. Patrick, J.D. Callahan, R.L. Hubbard, and the author found a clone of S. virginiana, ca. 4 x 9m, on a sandstone shelf within 100 m of the base of the falls. If this is not the original clone, it is very close to it, indicating that the species has existed at the site for more than 90 years.

There are three other collections from near the end of last century (one each in West Virginia, Tennessee, and North Carolina, with no specific site data), where populations of S. virginiana have been recently relocated. In these cases, the species has persisted in the general area, if not in the same spot, for about 90 years.

The growth, spread, and subsequent fragmentation of modular colonies are important processes in moving individuals within the environment. Barnes and Mann (1980) state that modular clones effectively compete for space by either sheet-like growth or vertical arborescent growth overtopping neighboring competitors.

Spiraea virginiana can do both. In terms of vertical growth, the species is capable of shading out smaller competitors with its arching stems. Some specimens in Wise County, Virginia are ca. 4 m tall, competing well with Cornus amomum Miller and Ilex verticillata (L.) Gray.

As an instance of sheet-like growth, another specimen less than 0.5 m in height produced a horizontal rhizome that exceeded the height in less than three months. Some of the species' horizontal rhizomes are over 2 m long, and one clone in Tennessee exceeds 200 m^2 in area.

These horizontal rhizomes can tap the water table, anchor and usurp unconsolidated substrate, give rise to new photo-synthetic shoots, and grow out from under arboreal competition. The horizontal rhizomes extend laterally around boulders and through unconsolidated material to give rise to new sprouts. Thus, there is a high effective value for such modular clones when they exploit territory or seasonal resources.

Barnes and Mann (1980) also state that final clone size is adjusted to available resources, just as body size is in certain animals. As a consequence of this lifestyle, asexual growth takes precedence over sexual reproduction. Sexual reproduction is delayed until the limits of vegetative growth are reached. In the often-disturbed habitat of this species, the vegetative growth limit would rarely be reached.

REPRODUCTION AND DISPERSAL

Reproduction is primarily asexual through fragmentation of clones or rhizomes, and through natural layering. The "cost" of these vegetative modules is very low. Potential vegetative modules can be a portion of a rhizome initiated in both phalanyx or guerilla strategies (Clegg 1978). Young vigorous plants often send out long lateral rhizomes, whereas slightly older plants sprout prolifically to form a dense clump. The upright branches tend to arch with normal growth, and the ends of these branches often root when they touch the substrate. One plant has been seen to root by simply hanging in flowing water (K. Langdon pers. comm.). Transplant observations by the author show that older clones show less ability to sprout and produce rhizomes than do young clones; however, well-established clones do bloom profusely and spread blooming over several weeks. Sexual fecundity varies with age, competition, and environment.

The species' flowers are visited by a host of insects, most commonly beetles. Identified insects, which are common and widespread, include flower long-horn beetles, a flower beetle, and a soldier beetle (R.L. Hoffman pers. comm.). Most flowers abort without producing follicles, particularly if the water supply is inadequate, but follicles are sporadically produced in most populations.

Seeds, however, seem to be rarely produced. The seeds are very small (> 2 mm long x ca. 0.5 mm wide) and could be dispersed by wind or water. The follicles begin to dehisce in late August-September and continue through late winter. The follicles are at the end of a long, flexible stem that would "shake out" the small seed as a result of wind or high water. The corymbs often become waterlogged, collect debris, and become heavy. As one would expect, quality of seed varies greatly among corymbs and plants. Often, only one portion of a corymb will produce seed.

Based on available information, the paucity of seed production may be due to having only one genome present at any given locality. When clones from different localities are grown together, they fruit prolifically and produce viable seed. When populations were contiguous in the past, the species may have relied more on sexual reproduction.

There may be as few as 20 different genotypes across the range of the species. Denslow (1985) stated that in frequently cut fields, important species often have relatively poor dispersal characteristics and good sprouting ability. Such a strategy is also advantageous along disturbed streambanks. Given its dependence on modular asexual reproduction to maintain itself in a specific habitat, it is not surprising that sexual reproduction is sparse for S. virginiana.

ESTABLISHMENT

R. Nicholson (pers. comm.) and the author have collected seeds from four different populations. Although the few seeds produced have dismal germination rates, preliminary observations indicate that humus retards germination and bare mineral soil with ample fresh water enhances it. The radicles, on at least some seeds, develop "prop hairs" that substantially anchor the seedling. Cook (1987) found these structures in many unrelated groups of monocots and dicots. The seeds contain no endosperm and probably do not form a long-lived seed bank. Some seeds will germinate in the fall upon dispersal, but some delay germination until spring. The cotyledons develop chlorophyll quickly but are often malformed.

The author has spent numerous hours looking in suitable sites in many locations, but has yet to see a seedling in the wild. Seedlings are readily identifiable; in sites where seedlings have been reported, they have turned out to be small vertical sprouts from a pre-existing horizontal rootstock. Establishment from seed is evidently an extremely rare event.

The most common establishment may come from the fragmentation of clones by erosion. Plants that have grown out over rock or that have accumulated large above-ground vegetative mass may be broken apart and washed downstream. If these vegetative modules are deposited in a suitable site, the plant can rapidly usurp the recently eroded area. Nevertheless, the likelihood of success is very poor, and if large pools or impoundments are downstream, it decreases to zero.

THREATS AND CONSERVATION NEEDS OR OPPORTUNITIES

The only documented cause of extirpation of Spiraea virginiana has been human activity. S. virginiana appears to be extirpated in six out of 33 watersheds. Three former sites, the Little Tennessee River, Cypress Creek in Alabama, and the Monongahela River in West Virginia, have been partially impounded.

Impoundments are a double threat to the species: clones are not only destroyed by rising water, but the impoundment may also serve as a "death trap" for propagules washed down-stream. The probability of being washed into a suitable habitat may decrease from slim to none, thus breaking any possible continuity in downstream motility.

A site on the Cheoah River in Graham County, North Carolina was probably destroyed by road-building and water release regulation (erosion control) below a dam. Areas along Hominy Creek in Buncombe County, North Carolina have been extensively developed by industries.

Cumulative and more subtle problems could occur from lack of watershed management and uncontrolled development of rivers. Bowles and Apfelbaum (1989) illustrate the effects of stochastic environmental events on another riverine species and graphically describe necessary conditions for survival. "Extinction possibility is increased by low disturbance, which favors plant succession and competition, or by high disturbance, which exceeds levels of ... population maintenance."

"Weak points" in the species' biology may be a threat to its survival. Paucity of sexual reproduction dramatically decreases the intrinsic rate of reproduction and the dispersal potential of the plant's small seeds. Genetic "fixation" of the clonal material may have adverse effects on the future breeding potential of the species, and the small number of genetically different individuals may constitute a threat.

Various insect pests have been seen on S. virginiana plants. Aphids of several types cluster at the rapidly growing shoot tips. Most of these are tended by ants, which move the aphids from place to place on the same plant, or from plant to plant. Aphids are most common on plants growing away from the water's edge. On the beneficial side, lady bug beetles are regularly seen on these same stem tips.

In another case, K. Walton (pers. comm.) identified a copper underwing moth caterpillar, a common and widespread species, that was doing damage in one population. However, for the most part, there is little evidence of anything other than local damage by insect pests.

Introduced alien plant species (e.g., Polygonatum cuspidatum, Ligustrum sinense, Spiraea japonica, and Rosa multiflora) are another, almost uncontrollable, detriment.

In a more positive sense, this species has remarkable persistence and can survive with a minimum of human intervention. It would be theoretically possible to construct an on-site barrier that would render a clone "extirpation proof" under most conditions, excluding herbicide assault. Timing of disturbances, such as right-of-way clearing or water releases, would be simple and cheap. Representative clones are being preserved by the Center for Plant Conservation, and the Arnold Arboretum already has a clone from a population now extirpated in the wild. In addition, the U.S. National Arboretum has a single representative clone. Reintroduction should always be a measure of last resort, but it is now a viable option for this species.

Although Rehder (1949) states that the species was first cultivated in 1907, horticultural use of S. virginiana merits reconsideration. It is not only a stately shrub, but it would be well suited for bank stabilization projects in residential/urban areas. The interest of this plant to the scientific community could thus be complemented by its serving a practical purpose in the future, with both measure contributing to the species' long-range viability.

RECOVERY STRATEGY

The recovery strategy for S. virginiana should be sequential: preserve, understand, extend knowledge, manage, and monitor.

Preservation issues should be addressed immediately. Known populations should receive permanent protection, and efforts should be directed toward finding new populations before they are inadvertently extirpated. Minimizing loss should be the first effort.

Distinguishing genetically different individuals should be a primary aim of research. It will not be sufficient to preserve clonal populations without knowledge of their genetic identity. DNA amplification fingerprints for populations rangewide should provide an excellent guide for genotype preservation and relationship.

Knowledge of specific environmental factors and tolerances that affect survival and reproduction will be necessary for appropriate management decisions. Initial habitat manipulation should be minimal, with the sole purpose of clonal preservation against imminent extirpation. Intensive management and re-establishment should be deferred until the species is understood as a genetic and ecological entity. A stock of cultivated material should be maintained for experimentation and for re-establishment, and crossing between native populations and re-established clones should be prevented. When recovery has been achieved, monitoring will be conducted to ascertain the species' long-term status.

PART II: RECOVERY

RECOVERY OBJECTIVE

The recovery objective for Spiraea virginiana is to delist the species by meeting the following conditions:

1. Any existing or, if possible, a minimum of three stable populations are permanently protected in each drainage system where populations are currently known.

2. A minimum of three stable populations are established or found in each drainage where, although documented vouchers have been collected, the species is not currently known. These populations must also be permanently protected.

3. Potential habitat in all states with present or past collections has been searched for other populations.

4. Representative genotypes are cultivated in permanent collections with adequate locality information.

RECOVERY TASKS

1. Protect existing populations and essential habitat. Current evidence suggests that clones persist for long periods in relatively small areas. The evidence also suggests that only one genotype is present (or at most a very limited number of genotypes are present) on a given drainage. Many populations appear to be relatively secure (both politically and environmentally), while others need immediate intervention.

1.1 Identify and monitor threats to each existing population. Populations on private lands are generally more at risk from human activities than populations in areas under public ownership (since development on public lands is more closely regulated); however, site-specific threats should be identified for all known *S. virginiana* locations.

1.2 Seek cooperation and active support of private and public landowners. Using the information packet developed in Task 8, the voluntary support of all landowners for protecting and managing known populations as well as alleviating the threats identified in Task 1.1 should be solicited.

1.3 Secure permanent protection for all known populations. Private and public conservation organizations will consider acquisition of fee title or conservation easements for populations on private property, on a willing seller basis. These efforts should allow for protection, active management, and potential reintroduction of the species. Sites and approximate cost for conservation easements are listed below by state (sites needing immediate attention are marked with an asterisk).

Georgia:	Rock Creek, 5 sites, $1200
Kentucky:	Rockcastle River, 3 sites, $1800 Kinniconick Creek, 8 sites, $1800
North Carolina:	New River, 3 sites, $1800 *South Toe River, 2 sites, $1200 *Cane River, 1 site, $600 *Little Tennessee R., 1 site, $600
Ohio:	Scioto Brush Creek, 3 sites, $1800
Tennessee:	*Little River, 1 site, $600 Nolichucky River, 2 sites, $1800 Clifty Creek, 3 sites, $1200

White Oak Creek, 2 sites, $1200
*Daddy's Creek, 1 site, $600

Virginia:	*New River, 1 site, $600
West Virginia:	*Bluestone River, 4 sites, $1200 Meadow River, 6 sites, $18,000 Gauley River, 12 sites, $18,000 *Buckhannon River, 1 site, $600 *Glen Daniels, 3 sites, $600

1.4 Comply with laws protecting the species and/or its habitat. Populations on state or Federal lands will receive regulatory protection vis-a-vis Sections 7 and 9 of the Endangered Species Act of 1973, as amended, as well as other Federal and state laws dealing with rare and endangered plants and riverine habitats. An information packet developed for distribution to private and public landowners (see Task 8) should state all applicable Federal and state regulations dealing with the species as clearly and concisely as possible.

2. Conduct rangewide searches in areas of suitable habitat for additional populations. A list of riverine systems where the species is not currently known but may potentially occur should be generated. A search image should be developed and, beginning with the highest priority sites (based on suitable habitat and range extension), these systems should be searched for populations. Any new populations found should be verified, catalogued, monitored, cultivated, and protected. In addition, appropriate habitat along drainages with fewer than three known clones should be searched until it can be clearly determined how many clones exist on a specific drainage.

3. <u>Conduct site-specific manipulation to maintain existing populations</u>. If it is determined during Task 2 that there are fewer than three clones on a given drainage, some near-term habitat manipulations should be considered to help maintain the existing clones. Techniques might include, but not be limited to, removal of arboreal competition, erosion control or modification efforts, and disturbance of soil to allow spread.

4. <u>Distinguish between N and η individuals</u>. Conservation of genetic variety across the range of the species is imperative. Determination of genetic variety and relatedness might be accomplished by DNA amplification fingerprinting or isoenzyme analysis. DNA tests on specific clones using one or more restriction enzymes would provide the least disputable information. This determination should be done in a "double blind" format to prevent bias on the part of the biochemist. Material for such work can be provided by either the Center for Plant Conservation or the author. Material provided to the biochemist should be locality coded until genetic analysis is completed, and the experiment should be designed to give rangewide comparisons after genetic analysis.

5. <u>Maintain representative material from each known genotype in permanent cultivation</u>. This material should be maintained for purposes of conservation, studies of species reproduction, and possible reintroduction efforts. These "living collections" should be propagated and distributed (with adequate locality documentation) in areas as geographically widespread as possible. Records of the origin and locations of specimens should be kept in a central facility -- the Center for Plant Conservation would be ideal for this purpose, since most clones are already represented by specimens in their collections.

Further information on species reproduction should be obtained from propagation efforts.

6. Investigate the species' environmental tolerances and habitat characteristics.

6.1 Establish baseline environmental determinants. Since *S. virginiana* occurs both below dams (where water is regulated) and in whitewater recreation areas, some cultivated material should be used to establish baseline environmental determinants for use in management decisions (e.g., how long can the clone remain submerged without serious damage?). There is some debate about the fundamental nature of riverine systems, i.e., whether or not their structural features are in relatively stable equilibrium or are determined by strictly stochastic events. Management of this species should take into account either possibility.

6.2 Monitor clonal size and distribution and compare the effects of known flow regimes in both disturbed and natural systems (e.g., Gauley River vs. Abrams Creek). Data should be collected from streams that have U.S.G.S. water level monitoring such as below Summersville Dam and on Abram's Creek (GSMNP). The elevation of the clones could then be related to seasonal water level releases, and the effects on clone size and distribution in a disturbed versus undisturbed environment could be monitored. Evidence indicates that disturbance would favor vegetative reproduction and clonal spread. The effects of isolation in undisturbed environments are unknown.

6.3 Conduct long-term demographic studies. The ultimate survival of the species as well as its successful reintroduction will depend directly on understanding the dynamics of population flux in these riverine systems. Establishment and maintenance must eventually be related to riverine dynamics, but this will be a long-term project. Baseline data has already been established for most populations.

7. As appropriate, reintroduce S. virginiana in additional drainage systems within the species' historical range. Potential reintroduction sites may include (1) areas with vouchered specimens that have been thoroughly searched to verify that extirpation has occurred (e.g., Monongalia River), and (2) other suitable sites within the historical range that have been previously searched and found not to support the species. It would be essential at this point to not "mix" cultivated with native material. Carefully planned introductions would also allow information to be gathered about establishment and sexual reproduction. As an example, if a stream with suitable habitat was verified as not supporting any native population, it would be possible to "stock" the stream with various combinations of clones and monitor reproductive success in order to determine relative importance of vegetative or sexual methods during *de novo* establishment. This would in no way adulterate or alter any native populations or normal clones.

   Vouchered sites should be replanted with material from the extant site in closest proximity. Material from the Arnold Arboretum should be used to restock the Buncombe County, North Carolina locality.

8. Develop an information packet for landowners and land managers. This packet should be used as public relations/education/conservation document related to this species specifically and rare species conservation

generally. The packet should provide an easily understood explanation of applicable Federal and state laws related to the species. It should contain information that would facilitate accurate identification reporting and appropriate management techniques. It should also include the addresses, phone numbers, and responsibilities of contact offices. The information should include some rationale for endangered species protection. The Great Smoky Mountains National Park recently published a similar information package for the Red Wolf, which might be used as a model.

9. Evaluate the effectiveness of protection and management programs and redirect efforts as necessary. As recovery activities progress, and at least every two years, population status should be monitored and evaluated. Any new data gathered should be applied to the overall recovery effort.

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PART III: IMPLEMENTATION

The following schedule indicates recovery tasks that will be initiated sometime during the next three fiscal years. It outlines responsibilities and costs, and provides a general indication of how long it will take to achieve a given task. The tasks are arranged in priority order. These priorities, shown in Column 1, have been assigned based on the following criteria:

Priority 1

An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

Priority 2

An action that must be taken to prevent a significant decline in the species population/ habitat quality or some other significant negative impact short of extinction.

Priority 3

All other actions necessary to provide for full recovery of the species.

IMPLEMENTATION SCHEDULE
Virginia Spiraea

November 1992

Priority	Plan Task	Task Number	Duration	Responsible Agency FWS	Other*	Cost Estimates, $000 FY1	FY2	FY3	Comments
1	Identify and monitor threats to each existing population.	1.1	Ongoing	R4R5	OFA SCA	4	4	4	
1	Seek support of private and public landowners.	1.2	1 year	R4R5	SCA TNC		2		
1	Enforce laws protecting the species and/or its habitat.	1.4	Ongoing	R4R5	SCA	1	1	1	
1	Distinguish between N and η individuals.	4	1 year	R4R5	PO	9.5			
2	Secure permanent protection for all known populations.	1.3	Ongoing	R4R5	SCA TNC	9	12	18	Conservation easements estimated at total of $55,200.
2	Conduct rangewide searches for additional populations.	2	2 years	R4R5	OFA SCA	5	5		
2	Conduct site-specific manipulation to maintain existing populations.	3	2 years	R4R5	OFA SCA		5	5	
2	Maintain representative material from each known genotype in permanent cultivation.	5	Ongoing	R4R5	SCA PO				Cost undetermined.
2	Establish baseline environmental determinants.	6.1	2 years	R4R5	SCA PO	3	1		
2	Monitor clonal size and distribution in a disturbed and in a natural system.	6.2	Ongoing	R4R5	OFA SCA	2	2	2	Plus 2 more years at $2,000 each.

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Priority	Recovery Task	Task Number	Duration	Responsible Agency FWS	Responsible Agency Other*	Cost Estimates, $000 FY1	FY2	FY3	Comments
3	Conduct long-term demographic studies.	6.3	Ongoing	R4R5	OFA SCA PO	5	5	5	Plus 2 more years at $5,000 each.
3	Reintroduce the species within its historical range.	7	2 years	R4R5	SCA		5	5	
3	Develop an information packet for landowners and land managers.	8	1 year	R4R5	SCA	5			
3	Evaluate the effectiveness of protection and management programs.	9	Ongoing	R4R5	SCA	1	1	1	Plus 2 more years at $1,000 each.

* **OFA** = Other Federal agencies, primarily the National Park Service (Great Smoky Mountains National Park) and the U.S. Army Corps of Engineers

SCA = State conservation agencies of participating states:
- Alabama--the Natural Heritage Program (Department of Conservation and Natural Resources)
- Georgia--the Natural Heritage Inventory (Georgia Department of Natural Resources)
- Kentucky--the Natural Heritage Program (Kentucky Nature Reserves Commission)
- North Carolina--the Plant Conservation Program (North Carolina Department of Agriculture) and the Natural Heritage Program (North Carolina Department of Natural Resources and Community Development)
- Ohio--Department of Natural Resources
- Pennsylvania: Western Pennsylvania Conservancy
- Tennessee--Department of Conservation
- Virginia--the Natural Heritage Program (Department of Conservation and Recreation)
- West Virginia--the Natural Heritage Program (Department of Commerce, Labor, and Environmental Resources)

TNC = The Nature Conservancy

PO = Private organizations and research institutions such as the Center for Plant Conservation and Virginia Highlands Community College

APPENDIX: LIST OF REVIEWERS

The following individuals and agency representatives submitted comments on the draft recovery plan during the public review period. All comments were reviewed, and appropriate changes were incorporated into the final plan. Letters of comment and specific responses are on file in the U.S. Fish and Wildlife Service's Region Five office.

Caren A. Caljouw, Stewardship Coordinator
J. Christopher Ludwig, Botanist
Virginia Division of Natural Heritage
Main Street Station, 1500 East Main Street, Suite 312
Richmond, Virginia 23219

Randall R. Pope, Superintendent
Great Smoky Mountains National Park
Gatlinburg, Tennessee 37738

Dr. Charles E. Williams, Director of Science and Stewardship
The Nature Conservancy, Virginia Chapter
1110 Rose Hill Drive, Suite 200
Charlottesville, Virginia 22903