New England Plant Conservation Program

Moehringia macrophylla (Hook.) Fenzl
Large-Leaved Sandwort

Conservation and Research Plan
for New England

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SUMMARY

Large-leaved sandwort (*Moehringia macrophylla* (Hook.) Fenzl) is a small, perennial herb in the pink family (Caryophyllaceae). The species' range includes western North America from British Columbia to New Mexico, the upper midwestern states and provinces, and eastern North America from Labrador to New England. A transcontinental species, large-leaved sandwort also occurs in Asia. In New England, large-leaved sandwort is commonly associated with serpentine habitats ranging from serpentine outcrops and ledges to well-developed serpentine soils.

Large-leaved sandwort populations in New England are at the southern end of the species' distribution in eastern North America. Sandwort has been documented at 18 New England locations. Currently, there are 17 occurrences in the region, plus one historic occurrence. Most of the occurrences are located in Vermont, with smaller numbers in Massachusetts and Connecticut, where the species is listed as Endangered. Two populations in Connecticut may be in decline, but other populations appear fairly stable, with little annual variation in size and condition. In general, large-leaved sandwort is associated with a habitat (serpentine outcrops) that receives little human disturbance. Nonetheless, development, logging, road and power line management, canopy closure, and mining may threaten large-leaved sandwort populations in New England. These activities destroy habitat or disrupt key ecological processes that maintain the serpentine outcrop community such as groundwater movement, freeze-thaw dynamics, and light availability. Invasive non-native species are a potential threat as well. In addition, global climate change may threaten large-leaved sandwort's long-term viability, especially in the southern part of its range in the region.

The primary conservation objective for large-leaved sandwort in New England is to maintain all current populations. Success will be measured through achieving and maintaining EO ranks of C or better for at least 17 populations. Specific actions necessary to achieve conservation success include long-term protection of high-quality sites, regular field surveys, seed collection and storage, landowner education, and species biology research.

PREFACE

This document is an excerpt of a New England Plant Conservation Program (NEPCoP) Conservation and Research Plan. Full plans with complete and sensitive information are made available to conservation organizations, government agencies, and individuals with responsibility for rare plant conservation. This excerpt contains general information on the species biology, ecology, and distribution of rare plant species in New England.

The New England Plant Conservation Program (NEPCoP) of the New England Wild Flower Society is a voluntary association of private organizations and government agencies in each of the six states of New England, interested in working together to protect from extirpation, and promote the recovery of the endangered flora of the region.

In 1996, NEPCoP published "*Flora Conservanda*: New England." which listed the plants in need of conservation in the region. NEPCoP regional plant Conservation Plans recommend actions that should lead to the conservation of *Flora Conservanda* species. These recommendations derive from a voluntary collaboration of planning partners, and their implementation is contingent on the commitment of federal, state, local, and private conservation organizations.

NEPCoP Conservation Plans do not necessarily represent the official position or approval of all state task forces or NEPCoP member organizations; they do, however, represent a consensus of NEPCoP's Regional Advisory Council. NEPCoP Conservation Plans are subject to modification as dictated by new findings, changes in species status, and the accomplishment of conservation actions.

Completion of the NEPCoP Conservation and Research Plans was made possible by generous funding from an anonymous source, and data were provided by state Natural Heritage Programs. NEPCoP gratefully acknowledges the permission and cooperation of many private and public landowners who granted access to their land for plant monitoring and data collection.

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I. BACKGROUND

INTRODUCTION

Large-leaved sandwort (*Moehringia macrophylla* (Hook.) Fenzl) is a small, perennial herb in the pink family (Caryophyllaceae). Dainty white flowers appear in late spring, and seed-bearing capsules mature in early fall. In addition, the species reproduces vegetatively by slender branching rhizomes that give it a clump-like appearance. In New England, the species generally is restricted to serpentine sites where it occurs in rock clefts, on talus slopes and ledges, and in well-developed serpentine soils. Exceptions include two populations in Connecticut that are associated with high-mineral soils amid outcrops of basalt. Populations in New England are at the southern edge of the species' distribution in eastern North America and disjunct from populations in the upper Midwest, Pacific Northwest, and northern Rocky Mountains (USDA, NRCS 2002).

Flora Conservanda: New England (Brumback and Mehrhoff et al. 1996) places large-leaved sandwort in Division 2, for a regionally rare taxon with fewer than 20 occurrences within New England. Sandwort populations have been discovered at 18 sites, including 13 in Vermont, three in Massachusetts, and two in Connecticut. One of these sites (in Vermont) is historic. In Vermont, large-leaved sandwort is ranked S2. The species is ranked S2 in Massachusetts and S1 in Connecticut; both of these states list large-leaved sandwort as Endangered, so it is protected under state law.

Due to the species' clonal growth habit, precise population tallies are difficult to estimate. In addition, several populations have been surveyed infrequently (e.g., only once or twice) and/or not recently (e.g., the most recent survey was more than 15 years ago), so broad conclusions about large-leaved sandwort's regional status are preliminary at this time. The two Connecticut populations appear to be in decline. Otherwise, populations of *Moehringia macrophylla* generally appear stable and their serpentine habitat has few direct threats from human activities such as agriculture, timber extraction, or development. Potential threats at one or more sites include: house construction; canopy closure or competition by perennials; logging; mining; road and power line management; invasive non-native species; and global climate change.

This Conservation Plan summarizes existing information on the ecology, taxonomy, and conservation status of large-leaved sandwort. Included are an analysis of threats to its survival and recommended actions for conservation of this species in New England.

DESCRIPTION

Large-leaved sandwort is a low, perennial herb with dainty white flowers and paired narrow leaves. The species reproduces by seeds but also grows clonally, spreading by slender branching rhizomes (Gleason 1952). Weak, slightly branching stems spread upwards or along the ground, sometimes forming mats. Plant height ranges from five to 20 centimeters (2.5 to eight inches). Due to its growth habit, the species often has a clump-like appearance. In general, these clumps have a patchy distribution.

Consistent with its name, large-leaved sandwort is distinguished from other members of the genus by the length of its leaves, which are typically two to five centimeters (one to two inches) long (Gleason and Cronquist 1991). These lance-shaped, entire-margined leaves are arranged oppositely on the stem. Five-petaled white flowers with conspicuous green sepals appear in early May and typically remain in evidence until early September. Arranged in groups of one to five, the flowers are held in terminal cymes or emerge from the axils of the middle or upper leaves. The fruit, a six-parted capsule, matures from August through early October. The capsule opens wide with three two-cleft divisions, and numerous seeds can be found inside. Seeds are small (about 1.5 mm wide), smooth, glossy, kidney-shaped, and reddish brown. Each seed has a conspicuous membranous strophiole, or appendage at the seed's point of attachment. The species has 48 chromosomes (Gleason and Cronquist 1991).

Among related species, large-leaved sandwort most closely resembles blunt-leaved sandwort (*Moehringia lateriflora*). Their ranges overlap in New England, but no shared sites are known at present. Furthermore, a few principle characters distinguish the two species. *Moehringia macrophylla* has longish (two to five centimeters, or one to two inches), lance-shaped leaves with pointed tips and sepals that exceed the petals, whereas *M. lateriflora* has shortish (one to two centimeters, or one-half to one inch), ovate leaves with blunt tips and sepals that are shorter than the petals. In addition, blunt-leaved sandwort typically occurs in woodland habitats and is not associated with serpentine soils. Another sandwort species, rock sandwort (*Arenaria stricta*), shares similar habitat with *M. macrophylla*, often growing on serpentine rock outcrops. The two species co-occur at several New England sites. (Interestingly, they do *not* co-occur in Connecticut, where rock sandwort is associated with calcium-rich rather than serpentine soils [Ken Metzler, Connecticut Natural Diversity Data Base, personal communication].) Rock sandwort can be distinguished from large-leaved sandwort by its stiff, very narrow leaves in dense clusters around the stem.

TAXONOMIC RELATIONSHIPS, HISTORY, AND SYNONYMY

Large-leaved sandwort is a member of the pink family (Caryophyllaceae). The species' original 1830 classification as *Arenaria macrophylla* was published in *Flora Boreali-Americana* by Hooker (Missouri Botanical Garden 2002). Fenzl reclassified the species as *Moehringia macrophylla*, based in part on the conspicuous membranous strophiole attached

to the seed (Gleason and Cronquist 1991). Named by Linnaeus in 1753, the genus *Moehringia* honors German botanist Paul H. G. Moehring (1710-1792). Large-leaved sandwort is one of three members of the genus currently present in North America (Missouri Botanical Garden 2002).

SPECIES BIOLOGY

Large-leaved sandwort reproduces both sexually (by seed) and vegetatively (by rhizome). Flowers are produced from May to September and fruits typically mature from August to October. At least two possible seed dispersal mechanisms have been hypothesized: wind (Schoennagel and Waller 1999) and ants (William Brumback, New England Wild Flower Society, personal communication). Evidence for the latter includes the presence of an eliasome on the seeds, but this hypothesis has not been confirmed by observation or by experiment. New shoots are produced in late summer (August to September), emerging from slender, branching rhizomes. Pollinators are unknown. Similarly, no information is available on parasites, pathogens, or herbivores that may be associated with this species. Research suggests that genetic diversity within large-leaved sandwort populations may be low (Murren and Butler 1998), due in part to the species' clonal growth habit.

Based on surveyor notes and direct observation, large-leaved sandwort populations in New England seem relatively free from disease, parasitism, and herbivory. At least one population (CT .001 [Guilford]) appears to be in decline due to a lack of flower production, but most populations produce flowers and fruits each year without much variation. Estimates for fruit set in Massachusetts range from 10 to 25% of the total population (Murren and Butler 1998).

In greenhouse experiments, germination success was greatest when seeds were dried and then sown warm without a cold treatment (Christopher Mattrick, New England Wild Flower Society, personal communication). Other treatments – dried seed sown cold, fresh seed sown cold, and fresh seed sown warm – were less successful.

HABITAT/ECOLOGY

In New England, large-leaved sandwort usually is associated with serpentine soils. It typically occurs in serpentine outcrop communities, where serpentine or other ultramafic bedrock is exposed. This unusual rock takes on several forms, including a greenish, fibrous form called serpentinite that is mined for asbestos, as well as a more common brownish form called dunite (Dann 1988).

In eastern North America, scattered outcrops of serpentine occur along the Appalachian ultramafic belt from Newfoundland to Georgia (Walker 1954). Soils derived from

weathering of ultramafic rocks are extremely rich in magnesium, iron, nickel, and chromium, minerals that are toxic to plants in high concentrations. At the same time, important plant nutrients such as calcium, potassium, sodium, and aluminum are all but absent, and nitrogen and phosphorus are often limiting as well (Thompson and Sorenson 2000). This particular chemical environment creates challenges for many plants. Wherever they occur, serpentine soils are known for their extreme infertility and the peculiar nature of the vegetation they support. Two major characteristics of serpentine vegetation are: 1) physiognomic differences from vegetation of surrounding non-serpentine soils, and 2) high numbers of rare and endemic species as well as species of disjunct distribution (Zika and Dann 1985).

Serpentine outcrops are sparsely vegetated communities, with scattered plants growing in the soil that accumulates in cracks in the rock (Thompson and Sorenson 2000). Associated grasses and herbs include harebell (*Campanula rotundifolia*), field chickweed (*Cerastium arvense*), hairgrass (*Deschampsia flexuosa*), rock sandwort (*Arenaria stricta*), and poverty grass (*Danthonia spicata*). Common juniper (*Juniperus communis* var. *depressa*) often dominates the shrub layer, while red spruce (*Picea rubra*) and gray birch (*Betula populifolia*) are present occasionally in the short, sparse canopy. Plant diversity is generally low because of the limited number of plants that can tolerate this specialized habitat.

Large-leaved sandwort typically grows in lightly shaded conditions, a result of the serpentine outcrop community's sparse canopy and low physiognomy as well as open, exposed rock surfaces. Although these sites are xeric, sandwort grows in microsites that may be more mesic, such as accumulations of soil between rocks. Most occurrences in New England are at moderate elevation, ranging from 110 to 800 meters (350 to 2400 feet). Elevation of the occurrences tends to increase with latitude in New England.

The serpentine outcrop community's disturbance regime is characterized by freeze-thaw dynamics that generate talus and expose fresh rock faces (Whittaker 1954). Water movement and rock fall are also key natural disturbance events at these sites. Several sandwort populations occur in road cuts or quarries where human activities have produced suitable habitat.

The two Connecticut sites present exceptions to the association between large-leaved sandwort and serpentine. These populations occur on outcrops and talus of basalt rock in the Holyoke and Hamden formations, where soils have high mineral content, especially magnesium, pyroxine, and calcium. Cold air drainage maintains cool temperatures and mesic conditions at one of these sites well into the summer. Magnesium may be the critical variable for large-leaved sandwort in New England (Tom Rawinski, Massachusetts Audubon Society, personal communication). High levels of this mineral — whether derived from serpentine or basalt — are a consistent feature at large-leaved sandwort sites across New England.

In New England, large-leaved sandwort is at the southern edge of its range; thus, it is possible that the species is restricted largely to serpentine soils because this inhospitable

environment minimizes competition from other plants. The species is also associated with serpentine habitats in Quebec (Labrecque and Lavoie 2002). Elsewhere in its range, large-leaved sandwort grows in less specialized habitats. In California, for example, it grows on shaded slopes between elevations of 450 and 2000 meters (1500 and 6500 feet), usually in conifer forests (Munz 1959). Soils in this part of large-leaved sandwort's range tend to be deep, well-drained, sandy loams (Schoennagel and Waller 1999). In the Pacific Northwest, it occurs in a wide variety of habitats, ranging from moist to dry, from shaded to open, and from meadowlands to montane slopes (Hitchcock and Cronquist 1973). In Saskatchewan, large-leaved sandwort is associated with open forests and tends to occur in areas with magnesium-rich or basic rocks (Harms et al. 1992). In the upper Midwest, where large-leaved sandwort occurs in only a few locations, the species is associated with basalt or granite cliffs, often on moist mineral shelves (Craig Anderson, Wisconsin Natural Heritage Inventory Program, personal communication).

Although large-leaved sandwort differs in its associated habitat type across its range, at least one study suggests that genetic differences are minor. Comparing allozymes among eight populations from Oregon, Minnesota, Massachusetts, and Connecticut, Murren and Butler (1998) found no significant differences.

Few studies of large-leaved sandwort's ecology or species biology have been conducted. One exception is Schoennagel and Waller (1999), who examined the effects of fire and artificial seeding on large-leaved sandwort in Wenatchee National Forest, Washington, where it is an important understory component of mid- and late-successional lowland white fir (*Abies grandis*) and Douglas fir (*Pseudotsuga menziesii*) forests. Under normal conditions, the species tends to occur in small, widely distributed patches. In unseeded control plots, for example, large-leaved sandwort had an average frequency of .87 and an average percent cover of 1.6%. Large-leaved sandwort and several other native species were outcompeted by artificially seeded, non-native grasses following fire.

THREATS TO TAXON

In New England, unique and restricted habitat requirements (i.e., serpentine soils) limit the possible locations where large-leaved sandwort can prosper. Fortunately, this restricted habitat provides a measure of protection to the sandwort. Due to the low productivity and rugged terrain of the serpentine outcrops where large-leaved sandwort typically grows, direct threats from human activities such as timber extraction, agriculture, and development are not common. Nonetheless, at least seven threats potentially may be a concern at one or more sandwort sites in New England.

Development

House construction or other development likely has impacted two sandwort populations already (MA .002 [Chester/Middlefield], CT .001 [Guilford]) and potentially could impact several others (VT .005 [Cavendish], VT .011 [Westfield], VT .012 [Cavendish]) that occur on small serpentine outcrops near possible house sites. Construction and associated forest clearing may disrupt light or moisture regimes, destroy habitat, and increase the risk of trampling.

Canopy Closure or Competition by Perennials

Large-leaved sandwort typically occurs on lightly shaded serpentine ledges or between outcrops that create the moderate light levels this plant favors. Currently, growth by raspberries (*Rubus* sp.), ferns, and other perennials at one site (CT .001 [Guilford]) and canopy growth in lightly wooded habitat at several others (VT .002 [Lowell], VT .005 [Cavendish], VT .006 [Dover]) may decrease light availability. This, in turn, may threaten the sandwort populations by suppressing flower and fruit production. On the other hand, fruit production appears to be more successful in moist, shady locations at some sites (MA .001 [Florida]). The influence of light availability on sandwort vigor and reproduction merits further study.

Timber Extraction

Recent logging has occurred at three sites (VT .006 [Dover], VT .009 [Lowell/Westfield], CT .001 [Guilford]). The impact of this activity is unclear. Further research is required to determine if logging benefits sandwort populations by thinning the canopy and enhancing light availability, or if it harms populations by disturbing and compacting soil, increasing woody debris, and/or killing plants directly. Presumably, the seasonal timing (winter vs. summer) and intensity of tree harvest will play a role in determining its ecological impacts.

Mining

Mining poses a potential threat to several sandwort populations. At least three sites are associated with past or current quarries. Expansion of mining operations adjacent to one population (VT .008 [Cavendish]), resumption of operations at two abandoned quarries (VT .001 [Eden], VT .007 [Roxbury]), or incompatible use of the quarries for solid waste disposal or other purposes could damage or destroy the sandwort populations associated with the serpentine habitat at these sites. Such activities have been proposed but so far have not been implemented.

Roads and Power Lines

Three of the Vermont populations (VT .004 [Newfane], VT .005 [Cavendish], VT .009 [Lowell/Westfield]) lie adjacent to roads and potentially could be impacted by road widening or right-of-way management. In addition, power lines bisect one Vermont population (VT .004 [Newfane]) and abut another (VT .009 [Lowell/Westfield]), so power line management (especially mowing or spraying) potentially could be a concern as well.

Invasive Non-native Species

Invasive non-native species do not appear to be a threat to New England's large-leaved sandwort populations at this time. Few if any non-natives currently occur in association with the species, perhaps because serpentine outcrops are generally resource-poor and resistant to invasion. Nonetheless, serpentine sites in Maryland and Pennsylvania have suffered invasion from grasses such as *Microstegium vimineum*, while non-serpentine cliffs and talus sites in Vermont and New York are often invaded by white sweet clover (*Melilotus alba*) and garlic mustard (*Alliaria petiolata*). Invasion by non-native species could pose a threat to large-leaved sandwort in the future, and prevention, monitoring, and control of invasions should be a priority.

Global Climate Change

Large-leaved sandwort populations in New England are at the southern edge of the species' distribution and are associated with drought-prone habitats (rock outcrops). These two factors make them particularly vulnerable to rising annual temperatures and other factors associated with global climate change. The two southernmost populations in the region (CT .001 [Guilford], CT .002 [Durham]) already are in decline. This issue needs further research. Protecting occurrences throughout the species' distribution, across gradients of elevation and latitude, is an important conservation strategy in order to guard against regional extirpation.

DISTRIBUTION AND STATUS

General Status

Large-leaved sandwort occurs in eastern North America from Labrador and Quebec to Vermont, Massachusetts, and Connecticut. Populations occur in several upper-Midwestern states including Michigan, Wisconsin, and Minnesota. The species also is present in the Pacific Northwest and in the northern Rocky Mountains. The North American and New England distributions of large-leaved sandwort are presented in Table 1, and Figures 1 through 3. Large-leaved sandwort also occurs in Asia (Hickman 1993).

In Vermont and Massachusetts, large-leaved sandwort is ranked S2. In Connecticut, it is ranked S1. Both Massachusetts and Connecticut include large-leaved sandwort on their state list of Endangered species. *Flora Conservanda: New England* (Brumback and Mehrhoff et al. 1996) places the species in Division 2, for a regionally rare taxon with fewer than 20 occurrences within New England. Large-leaved sandwort is designated N? in the United States and N? in Canada. Globally, it is ranked G4 (apparently secure). The species is rare throughout part of its range (New England and the upper Midwest) but appears to be more common in the Pacific Northwest and Rocky Mountains.

Table 1. Occurrence and status of *Moehringia macrophylla* in the United States and Canada based on information from Natural Heritage Programs.

OCCURS & LISTED (AS S1, S2, OR T &E)	OCCURS & NOT LISTED (AS S1, S2, OR T & E)	OCCURRENCE REPORTED OR UNVERIFIED	HISTORIC (LIKELY EXTIRPATED)
Vermont (S2): 12 extant and 1 historic occurrences	California (S?): Cuyamaca Mountains, San Diego County, Coast Ranges from Mt. Hamilton north, northern Sierra Nevada (Munz 1959)	British Columbia (SR)	n/a
Massachusetts (S2, E): 3 extant occurrences	Washington (S5): common forest understory species, particularly in eastern WA	Colorado (SR): common in spruce-fir and aspen (Weber and Wittmann 2001)	
Connecticut (S1, E): 2 extant occurrences		District of Mackenzie (Northwest Territories) (SR)	
Michigan (S1, T): 1 extant and 5 historic occurrences		Idaho (SR): widespread and common throughout much of the state	
Wisconsin (S1, E): 2 extant and 1 historic occurrences		Labrador (Newfoundland) (SR)	
Manitoba (S1S2): 1 extant and 1 historic occurrence		Montana (SR): no information	
Minnesota (S2, T): 14 extant and 4 historic occurrences		New Mexico (SR)	
Saskatchewan (S2): 15 extant occurrences		Oregon (SR): common, especially in mountainous regions	
Quebec (S2S3): at least 22 extant and 3 historic occurrences		Utah (SP [“state probable”]): no collections	

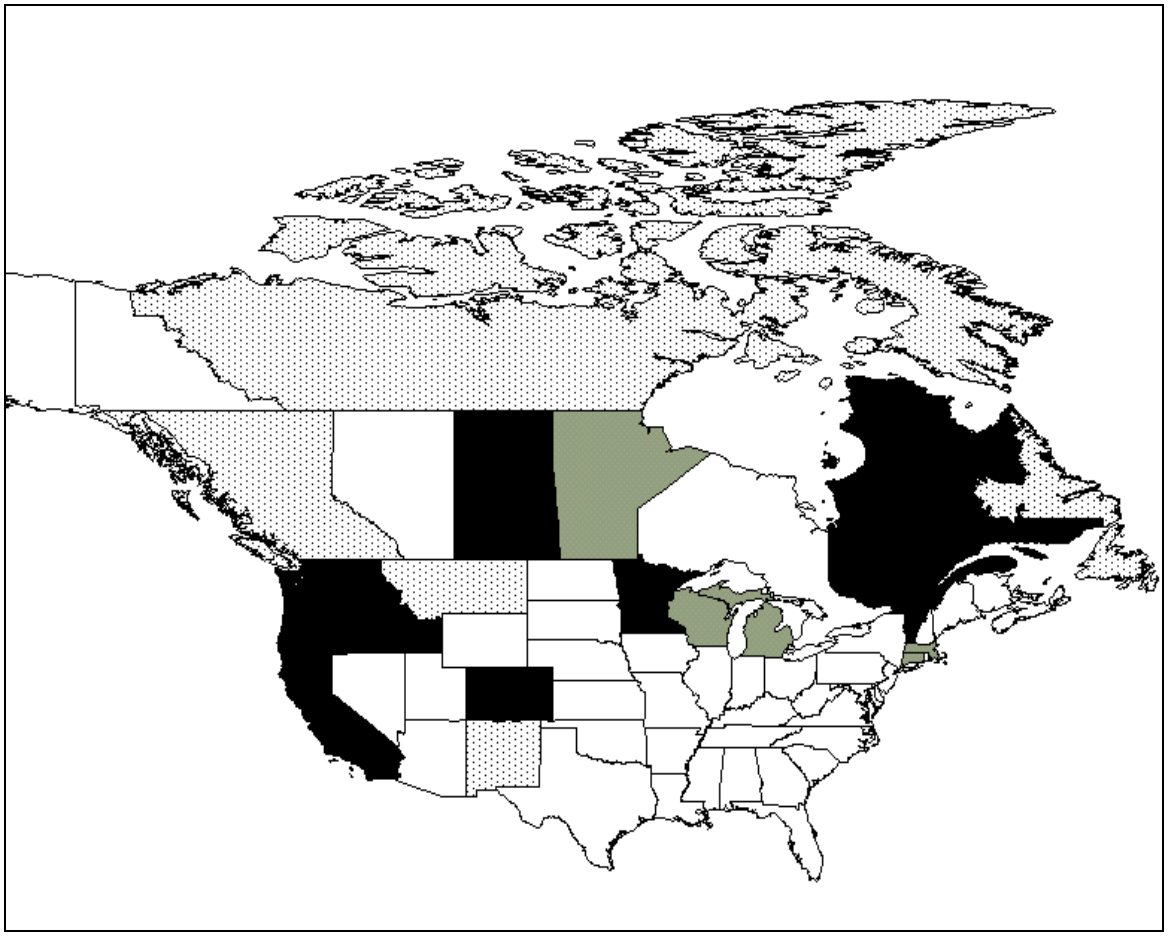

Figure 1. Occurrences of *Moehringia macrophylla* in North America. States and provinces shaded in gray have one to five (or an unspecified number of) current occurrences of the taxon. States shaded in black have more than five confirmed occurrences. States with stippling are ranked "SR" (status "reported" but not necessarily verified). See Appendix for explanation of state ranks.

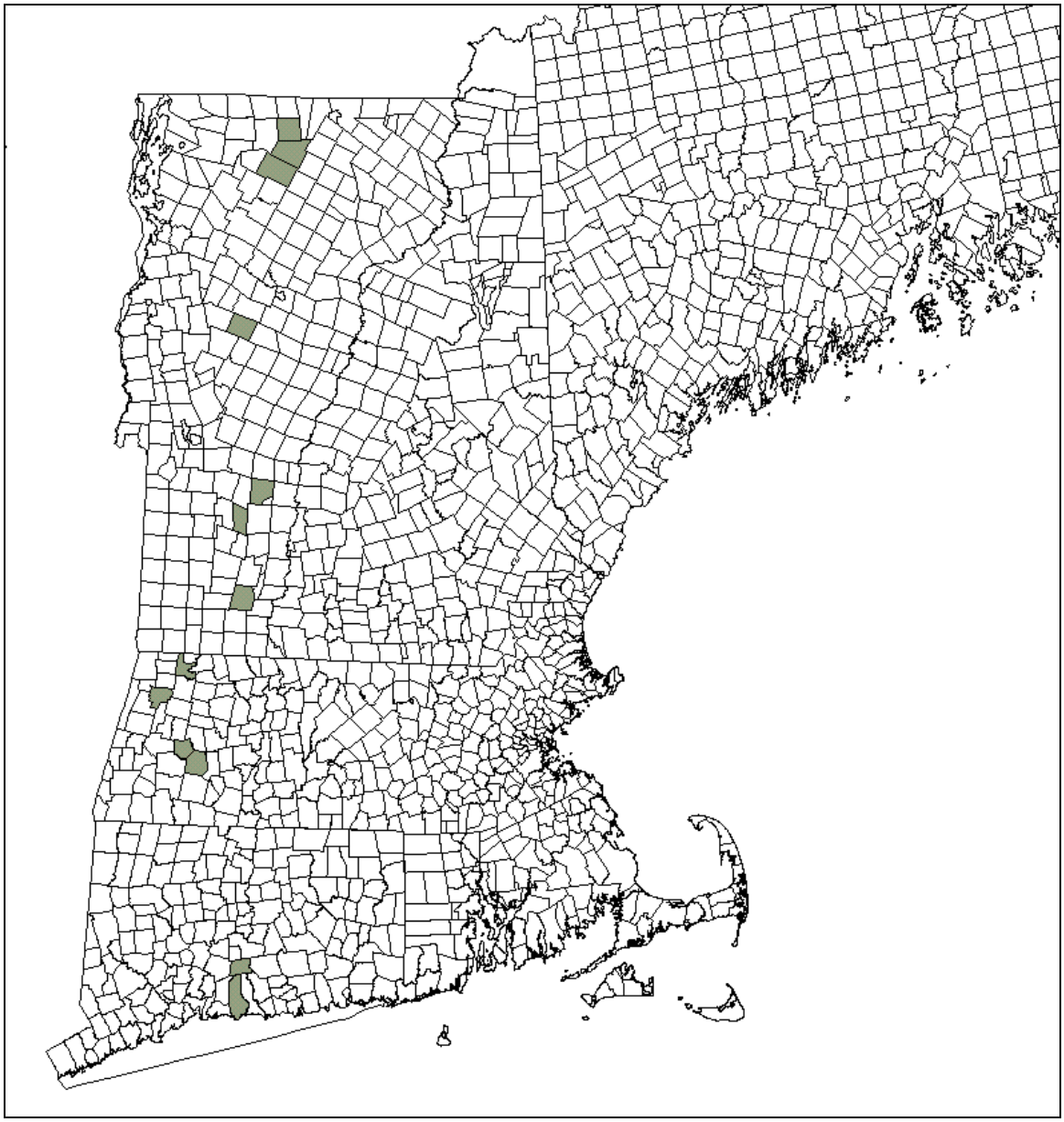

Figure 2. Extant occurrences of *Moehringia macrophylla* in New England. Town boundaries for New England states are shown. Towns shaded in gray have one to five extant occurrences of the taxon.

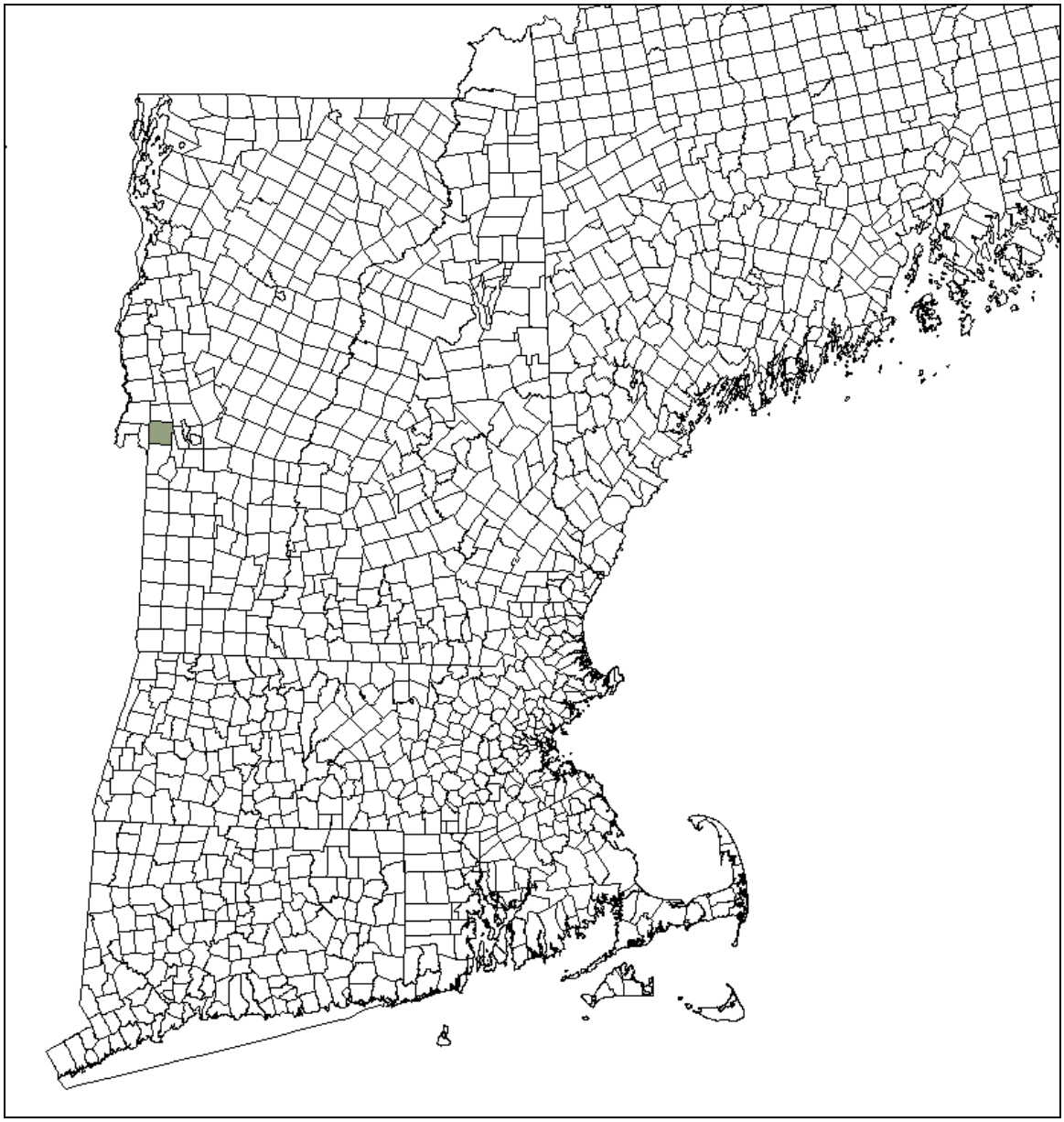

Figure 3. Historical occurrences of *Moehringia macrophylla* in New England. Towns shaded in gray have one to five historical records of the taxon.

Status of All New England Occurrences — Current and Historical

Based on literature, herbarium records, and interviews with biologists, large-leaved sandwort has been identified at 18 stations in New England (listed in Table 2). Most of these (13) occur in Vermont, with smaller numbers in Massachusetts (three) and Connecticut (two). One station (in Vermont) is historic, leaving 17 that are currently extant.

In general, sandwort sites in the two southern states have a much longer history of botanical study than sites in Vermont. Four of the five sites in Connecticut and Massachusetts have been known for roughly a century based on herbarium records. Most of the Vermont sites were not discovered until the early 1980s, when botanists Peter Zika and Kevin Dann conducted a thorough survey of serpentine habitats in the state. Dedicated searches for an endemic serpentine species – Green Mountain maidenhair fern (*Adiantum viridimontanum*) – led to the discovery of a few additional sites in the mid 1990s by botanists Cathy Paris and Kathy Reilly. Suitable sandwort habitat in the region has been fairly well inventoried – that is, for the most part, New England's serpentine sites are known and documented (Zika and Dann 1985; Paul Somers, Massachusetts Natural Heritage and Endangered Species Program, personal communication; Nancy Murray, Connecticut Natural Diversity Data Base, personal communication). Nonetheless, new sandwort populations continue to be discovered – the most recent discovery was in 2002 – so further searches may expand the list of known occurrences. In general, large-leaved sandwort appears to be a persistent and durable species. Since there is only one known historic occurrence, it seems likely that the existing populations reflect roughly what the region supported in the past.

Serpentine habitat also occurs in a few areas in Maine, but large-leaved sandwort is not known to occur there. It is likely that some serpentine sites have not been surveyed, particularly in the western mountains, and large-leaved sandwort may in fact be present in the state (Don Cameron, Maine Natural Areas Program, personal communication).

Three factors make it difficult to make broad conclusions about the status of New England's large-leaved sandwort populations. 1) Many sites lack long-term population data because they were first visited in the early 1980s and have been revisited few times or not at all since then. 2) The species' growth habit (clonal and clump-forming) hinders precise population tallies. 3) Although serpentine sites are fairly well known, not all sites have been thoroughly searched for sandwort, so individual populations may be larger than survey records indicate, especially in Vermont. With this caveat in mind, most of the populations appear relatively stable, with four exceptions. One population (VT .004 [Newfane]) appears to be increasing. On the other hand, two (CT .001 [Guilford], CT .002 [Durham]) appear to be in decline, and one (VT .010 [Castleton]) is historic.

The Vermont Nongame and Natural Heritage Program is currently in the process of revising the status of the state's large-leaved sandwort populations, based on the fact that several sites occur in close proximity to each other along the same serpentine ridge and may, in

fact, represent subpopulations of the same occurrence (Bob Popp, Vermont Nongame and Natural Heritage Program, personal communication). Some sites will be combined, revising the state's total extant occurrences from twelve to nine. *The proposed revisions are indicated below in italics.*

Table 2. New England Occurrence Records for *Moehringia macrophylla*. Shaded occurrences are considered extant.

State	EO Number	County	Town
VT	**.001**	**Lamoille**	**Eden**
VT	**.002**	**Orleans**	**Lowell**
VT	**.003**	**Orleans**	**Lowell**
VT	**.004**	**Windham**	**Newfane**
VT	**.005**	**Windsor**	**Cavendish**
VT	**.006**	**Windsor**	**Dover**
VT	**.007**	**Washington**	**Roxbury**
VT	**.008**	**Windsor**	**Cavendish**
VT	**.009**	**Orleans**	**Lowell and Westfield**
VT	.010	Rutland	Castleton
VT	**.011**	**Orleans**	**Westfield**
VT	**.012**	**Windsor**	**Cavendish**
VT	**.013**	**Orleans**	**Westfield**
MA	**.001**	**Berkshire**	**Florida**
MA	**.002**	**Hampden and Hampshire**	**Chester and Middlefield**
MA	**.003**	**Berkshire**	**Cheshire**
CT	**.001**	**New Haven**	**Guilford**
CT	**.002**	**Middlesex**	**Durham**

II. CONSERVATION

CONSERVATION OBJECTIVES FOR THE TAXON IN NEW ENGLAND

Large-leaved sandwort is a rare species in New England (Brumback and Mehrhoff et al. 1996). In New England, large-leaved sandwort is at the southern edge of its distribution in eastern North America and disjunct from populations in the Midwest and northern Rocky Mountains. Since suitable large-leaved sandwort habitat in the region has been well inventoried and there is only one known historic occurrence, it seems likely that the current occurrences reflect roughly what the region supported historically. On the other hand, one current population was not discovered until quite recently — in 2002 — so further searches may uncover additional populations in the region. In order to prevent an increase in rarity beyond levels that are natural for large-leaved sandwort, the primary conservation goal for the taxon in New England is to protect, study, and maintain the species and its associated natural community, the serpentine outcrop.

The primary conservation objective for large-leaved sandwort is to maintain all current populations. Success will be measured through achieving and maintaining EO ranks of C or better for at least 17 populations. These populations should have at least 50 stems arranged in at least 15 clumps, with evidence of some sexual reproduction (flowers and fruit) annually, located on natural and/or artificial (e.g., quarry, road cut) substrate, and sitting in a forested or semi-forested landscape. Although uniform, region-wide EO Ranking Specifications have not been developed for large-leaved sandwort to date, a possible scheme is proposed in Appendix 2. Success will also be measured through meeting the specific conservation objectives described below. *If several of the Vermont populations are combined, as proposed by the Vermont Nongame and Natural Heritage Program, the numeric goal should be revised from "at least 17 populations" to "at least 14 populations."*

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IV. APPENDICES

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1. **Proposed EO Ranking Specifications for Large-Leaved Sandwort in New England**

2. **An Explanation of Conservation Ranks Used by The Nature Conservancy and NatureServe**

1. Proposed EO Ranking Specifications for Large-Leaved Sandwort in New England

To date, no region-wide EO Ranking Specifications have been developed for large-leaved sandwort. Without a consistent ranking system, it is difficult to compare populations across the region, to analyze broad patterns, and to assess conservation success over time. Based on existing population data and the botanical literature (admittedly small) for this species, a possible scheme is proposed here.

A-Rank:
- More than 1,000 stems distributed in at least 100 clumps
- Evidence of sexual reproduction (flowers and fruits) in at least 10% of the population annually
- Natural substrate (not a quarry or road cut)
- Forested landscape, well-buffered from surrounding land use

B-Rank:
- At least 500 stems distributed in at least 30 clumps
- Evidence of some sexual reproduction
- Natural or artificial substrate
- Forested landscape, at least partially buffered from surrounding land use such as development, roads, power lines, agriculture

C-Rank:
- At least 50 stems distributed in at least 15 clumps
- Evidence of some sexual reproduction
- Natural or artificial substrate
- Forested or semi-forested landscape

D-Rank:
- Less than 50 stems distributed in less than 15 clumps
- Natural or artificial substrate

2. An Explanation of Conservation Ranks Used by The Nature Conservancy and NatureServe

The conservation rank of an element known or assumed to exist within a jurisdiction is designated by a whole number from 1 to 5, preceded by a G (Global), N (National), or S (Subnational) as appropriate. The numbers have the following meaning:

1 = critically imperiled
2 = imperiled
3 = vulnerable to extirpation or extinction
4 = apparently secure
5 = demonstrably widespread, abundant, and secure.

G1, for example, indicates critical imperilment on a range-wide basis -- that is, a great risk of extinction. S1 indicates critical imperilment within a particular state, province, or other subnational jurisdiction -- i.e., a great risk of extirpation of the element from that subnation, regardless of its status elsewhere. Species known in an area only from historical records are ranked as either H (possibly extirpated/possibly extinct) or X (presumed extirpated/presumed extinct). Certain other codes, rank variants, and qualifiers are also allowed in order to add information about the element or indicate uncertainty.

Elements that are imperiled or vulnerable everywhere they occur will have a global rank of G1, G2, or G3 and equally high or higher national and subnational ranks (the lower the number, the "higher" the rank, and therefore the conservation priority). On the other hand, it is possible for an element to be rarer or more vulnerable in a given nation or subnation than it is range-wide. In that case, it might be ranked N1, N2, or N3, or S1, S2, or S3 even though its global rank is G4 or G5. The three levels of the ranking system give a more complete picture of the conservation status of a species or community than either a range-wide or local rank by itself. They also make it easier to set appropriate conservation priorities in different places and at different geographic levels. In an effort to balance global and local conservation concerns, global as well as national and subnational (provincial or state) ranks are used to select the elements that should receive priority for research and conservation in a jurisdiction.

Use of standard ranking criteria and definitions makes Natural Heritage ranks comparable across element groups; thus, G1 has the same basic meaning whether applied to a salamander, a moss, or a forest community. Standardization also makes ranks comparable across jurisdictions, which in turn allows scientists to use the national and subnational ranks assigned by local data centers to determine and refine or reaffirm global ranks.

Ranking is a qualitative process: it takes into account several factors, including total number, range, and condition of element occurrences, population size, range extent and area of occupancy, short- and long-term trends in the foregoing factors, threats, environmental specificity, and fragility. These factors function as guidelines rather than arithmetic rules, and the relative weight given to the factors may differ among taxa. In some states, the taxon may receive a rank of SR (where the element is reported but has not yet been reviewed locally) or SRF (where a false, erroneous report exists and persists in the literature). A rank of S? denotes an uncertain or inexact numeric rank for the taxon at the state level.

Within states, individual occurrences of a taxon are sometimes assigned element occurrence ranks. Element occurrence (EO) ranks, which are an average of four separate evaluations of quality (size and productivity), condition, viability, and defensibility, are included in site descriptions to provide a general indication of site quality. Ranks range from: A (excellent) to D (poor); a rank of E is provided for element occurrences that are extant, but for which information is inadequate to provide a qualitative score. An EO rank of H is provided for sites for which no observations have made for more than 20 years. An X rank is utilized for sites that are known to be extirpated. An F rank is utilized for sites that are believed to be extirpated. Not all EOs have received such ranks in all states, and ranks are not necessarily consistent among states as yet.