

New England Plant Conservation Program
Conservation and Research Plan

Adiantum viridimontanum Paris
Green Mountain Maidenhair Fern

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SUMMARY

Green Mountain maidenhair fern, *Adiantum viridimontanum* Paris (Pteridaceae), is a delicate, small to medium-sized fern restricted to serpentine habitats in northern Vermont and southern Quebec. Propagation of the species occurs most commonly by vegetative increase, although sexual reproduction also occurs via wind-dispersed spores that can cover great distances. Green Mountain maidenhair fern occurs on steep cliffs and talus slopes in association with harebell (*Campanula rotundifolia*), field chickweed (*Cerastium arvense*), hairgrass (*Deschampsia flexuosa*), poverty grass (*Danthonia spicata*), rock sandwort (*Arenaria stricta*), and common juniper (*Juniperus communis* var. *depressa*). Based on genetic evidence, the species evidently arose as an allotetraploid cross between common woodland maidenhair (*Adiantum pedatum*) and Aleutian maidenhair (*A. aleuticum*). The species was formally described in 1991. Phenotypic plasticity and morphological similarities among members of the *Adiantum pedatum* complex can make positive field identification difficult.

This globally-rare (G2) species is currently known from seven stations in New England, all of which lie in Vermont's Mississquoi Valley. Fourteen additional sites in Quebec comprise the species' entire global distribution. In general, populations appear stable with little annual variation in size and condition. Mining, road expansion, and over-collection are the most likely threats to this species. Logging and development may also threaten Green Mountain maidenhair fern by disrupting key ecological processes that maintain the serpentine outcrop community such as groundwater movement, freeze-thaw dynamics, and light availability.

The primary conservation objectives for Green Mountain maidenhair fern are to study, protect, and maintain both the species and its associated natural community, the serpentine outcrop. Success at meeting these objectives will be measured by the fern's state rank in Vermont, which should be maintained at its current level (S2). Protection of at least five viable populations including at least 200 individuals is recommended, distributed throughout the species' range in Vermont. Specific actions necessary to achieve conservation success include long-term protection, periodic field surveys, species biology research, landowner education, spore banking, and collaboration with partners in Quebec.

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) 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

Green Mountain maidenhair fern (*Adiantum viridimontanum* Paris) is a small to medium-sized deciduous fern of the Pteridaceae (pteridophyte family). Endemic to Vermont and Quebec, it is restricted to serpentine sites where it occurs in rock clefts, on talus slopes, and in well-developed serpentine soils (Paris 1991). Green Mountain maidenhair fern's range follows the Appalachian ultramafic belt as it snakes along the spine of the Green Mountains from northern Vermont into southeastern Quebec. Prior to the early 1990s, more than half of the mapped ultramafic rock in Vermont and Quebec had not been botanized (Zika and Dann 1985). Spurred by state-listing of Green Mountain maidenhair in Vermont and by growing Canadian interest in fern conservation, inventory work has increased in recent years. Currently, populations have been described at seven Vermont sites, eight sites in southern Quebec, and six sites in Quebec's Thetford Mines region.

In Vermont, Green Mountain maidenhair fern has been given a state rank of S2 and is designated as threatened. *Flora Conservanda: New England* (Brumback and Mehrhoff et al. 1996) places the species in Division 1, for globally rare taxa that occur in New England and that possess attributes likely to make them vulnerable to extinction. Globally, it is ranked G2 (globally imperiled). In general, populations of *Adiantum viridimontanum* appear stable. However, most of the Quebec sites are in active or historic asbestos mines and are threatened by continuation of mining activities. Over-collection, incompatible forestry, and road widening may also be a concern throughout the species' range.

This Conservation Plan summarizes existing information on the ecology, taxonomy, and conservation biology of Green Mountain maidenhair fern. Included are an analysis of threats to its survival and recommended actions for study and conservation of this species in New England.

DESCRIPTION

Green Mountain maidenhair fern is a small to medium-sized, graceful fern with rather short, scaly rhizomes. Plants growing in partial shade bear circular or horseshoe-like flat fronds, whereas in full sun, leaf segments are borne in an erect posture, giving the blade a funnel-like shape. The dark and polished petiole is slender and wiry, appearing to divide into two recurving parts bearing leaflets on the outer rim. The deciduous leaves are generally arching to stiffly erect, 30 to 75 cm long, with shiny surfaces resistant to wetting. Fertile fronds differ from sterile fronds by standing more stiffly erect, overtopping the sterile fronds, and appearing more

triangular in shape. In late summer and fall, Green Mountain maidenhair fern produces round sori borne on the undersurface of dark brown, oblong, false indusia along the margins of the fertile fronds.

Two other maidenhair species occur in New England. Green Mountain maidenhair fern can generally be distinguished from the common woodland maidenhair (*Adiantum pedatum*) by a few morphological characters such as leaf posture (upright rather than horizontal), shape of the ultimate segments (long and triangular rather than oblong), indusium length and width (greater), petiole length (greater), and texture (less membranaceous). *Adiantum viridimontanum* grows more frequently in direct sunlight and almost exclusively in shallow serpentine soils, whereas *A. pedatum* favors shaded conditions and deep, enriched woodland soils. However, these morphological and ecological distinctions blur on certain individual plants growing in partial shade.

Morphological distinctions between *A. viridimontanum* and the Aleutian maidenhair (*Adiantum aleuticum*) include leaf size (larger in *A. viridimontanum*), indusium length (greater in *A. viridimontanum*) and the degree of incision between leaf segments (greater in *A. aleuticum*). *Adiantum viridimontanum* occurs most commonly on disturbed sites, whereas *A. aleuticum* is usually associated with less-disturbed sites. However, as noted above, field identification can be difficult.

TAXONOMIC RELATIONSHIPS, HISTORY, AND SYNONYMY

In eastern North America, two maidenhair fern species traditionally have been recognized: the woodland maidenhair (*Adiantum pedatum*) and a smaller maidenhair of serpentine substrates, first reported by Fernald from the Shickshock Mountains of Quebec (Fernald 1905). Fernald referred this new maidenhair to *A. pedatum* var. *aleuticum*, the common maidenhair of wet rocks and ravines from northern California and Idaho north to Alaska and south sporadically to Arizona and Chihuahua, Mexico. *Adiantum pedatum* var. *aleuticum* was subsequently located on numerous serpentine outcrops throughout southeastern Canada and New England (Jolley 1922, Mousley 1923, Zika and Dann 1985).

Cody (1983) re-evaluated the relationship of the eastern serpentine maidenhair to those of the western mountains. He removed the serpentine maidenhair from *A. pedatum* var. *aleuticum* and described a new taxon, *A. pedatum* ssp. *calderi*, comprising the maidenheads on serpentine substrates in northeastern North America, Washington, and California.

Subsequently, Paris and Windham (1988) conducted a systematic study of the *Adiantum pedatum* complex in eastern North America, recognizing three well-differentiated species: *Adiantum pedatum*, the woodland maidenhair; *A. aleuticum*, the Aleutian maidenhair, which is a disjunct member of the western lineage; and *A. viridimontanum*, an allotetraploid derived from a sterile hybrid between the Aleutian and woodland maidenheads. Restricted to

serpentine soils in northern Vermont and southeastern Quebec, Green Mountain maidenhair fern was formally described as a new species by Paris (1991).

The three members of the *Adiantum pedatum* complex are phenotypically variable, and morphological characters alone are often insufficient to distinguish *A. viridimontanum* from its diploid progenitors. Micro-site characteristics, especially light levels, exert a strong influence on morphology, and *A. viridimontanum* may resemble either *A. pedatum* or *A. aleuticum* depending on site conditions. In addition, identification is further complicated by the presence of sterile triploid hybrids in some locations where the diploids and tetraploids occur together. Morphometrics, isozyme electrophoresis, and cytology have been used in combination to distinguish the three species and their hybrids from one another (Paris 1991). The presence of primary diploid hybrids in some populations suggests the potential for repeated origins of the allotetraploid *Adiantum viridimontanum* (O'Connor 1995).

SPECIES BIOLOGY

Vegetative increase by branching is the most common means of propagation for Green Mountain maidenhair fern (Catherine Paris, University of Vermont, personal communication). Although sexual reproduction may also occur via wind-dispersed spores that can cover great distances, gene flow among distant fern populations is probably uncommon. Most spores are likely dispersed within a fairly small radius from the parent plant – several meters rather than several miles. Sexual reproduction among distant populations depends not only on transport of spores from different plants to the same location but also on appropriate environmental conditions (e.g., moist soil and high light levels) for gametophyte establishment. In a sense, ferns are “disturbance species;” recent, local disturbance associated with blow-downs or slope movement creates favorable conditions for gametophyte establishment by exposing mineral soil, removing competitors, and enhancing light availability. Green Mountain maidenhair fern also is associated with disturbance during its sporophyte generation, growing frequently in direct sunlight and almost exclusively in shallow serpentine soils. On steep serpentine sites, rock fall resulting from water movement and freeze-thaw action likely helps to maintain suitable fern habitat. In addition, most of the New England sites where the species currently occurs have a history of recent human disturbance (ex. asbestos mines, road cuts).

Use of Green Mountain maidenhair fern by herbivores has not been investigated, and its role in forest food webs is poorly understood. In general, due to high concentrations of tannins and phenolics in their tissues, ferns are less susceptible to herbivory than are many angiosperms. There are no known threats to Green Mountain maidenhair fern from predation or disease.

Populations appear to be extremely stable from year to year. Individual plants are long-lived, and recruitment rates appear to be low (Catherine Paris, personal communication).

HABITAT/ECOLOGY

Green Mountain maidenhair fern is restricted to serpentine soils in eastern North America. 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. This particular chemical environment creates challenges for many plants (Thompson and Sorenson 2000). Wherever they occur, serpentine soils are known for their extreme infertility and the peculiar nature of the vegetation they support. The 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*) dominates the shrub layer, while red spruce (*Picea rubra*) and gray birch (*Betula populifolia*) are occasionally present in the short, sparse canopy. Plant diversity is low because of the limited number of plants that can tolerate this specialized habitat.

THREATS TO TAXON

Unique and restricted habitat requirements limit the possible locations where Green Mountain maidenhair can prosper, but fortunately it prefers sites that rarely attract human interest. Farmers cannot use the unproductive serpentine soils, and foresters must work hard to find merchantable timber on the cliffs and steep talus slopes these ferns call home. Even developers find little to recommend these sites, where harsh climate, rugged terrain, and poor soils for septic systems keep population pressures low.

Mining may pose a threat to Green Mountain maidenhair. Although health concerns and tightened environmental regulations have forced the closure of most asbestos mines in New England, many of the Quebec occurrences are in active or historic mines where they are threatened by continuation or resumption of mining activities. Mines also may be used in other ways that could threaten the ferns. For example, the inactive mine that harbors Vermont's

largest Green Mountain maidenhair population was once proposed as a dump site to dispose of asbestos and local solid waste.

At least two of the Vermont sites are adjacent to roads and could be impacted by road widening. Curiously, Green Mountain maidenhair fern populations persist at several sites despite disturbance from road construction and historic mining operations. In fact, evidence suggests that human activity may have inadvertently enhanced habitat in these locations.

Collectors and horticulturists attracted by the species' rarity may pose a minor threat. As long ago as 1922, Mrs. F.L. Jolley collected a number of Green Mountain maidenhair ferns from sites in Eden, Vermont, and Mont Orford, Quebec, transplanting them successfully to her garden in Berkshire, Vermont (Jolley 1922).

Several of the key environmental characteristics found in Green Mountain maidenhair's serpentine habitat – such as steep slopes, shallow soils, and high light availability – are often associated with invasion by shrubby honeysuckles (*Lonicera* spp.), common buckthorn (*Rhamnus cathartica*), and other non-native species. Serpentine sites in Maryland and Pennsylvania have suffered invasion from grasses such as *Microstegium vimineum*, while cliffs and talus sites in Vermont and New York are often invaded by white sweet clover (*Melilotus alba*) and garlic mustard (*Alliaria petiolata*). Fortunately, no invasive plant species have yet been detected near known Green Mountain maidenhair fern populations in New England. Nonetheless, invasion by non-native species could pose a threat to this species in the future, and prevention, monitoring, and control of invasions should be a priority.

DISTRIBUTION AND STATUS

General Status

Green Mountain maidenhair fern is endemic to northern Vermont and southeastern Quebec, and it is restricted to serpentine soils. In Vermont, the fern occurs in a narrow band in the Mississquoi River Valley in Orleans and Lamoille counties. In Quebec, suitable serpentine habitat extends from the Chaudiere River through Thetford Mines to the international border in Brome County. The United States and New England distributions of Green Mountain maidenhair fern are presented in Figures 1 and 2, respectively.

In Vermont, Green Mountain maidenhair fern is a state-listed threatened species with a state rank of S2 (Table 1). It is ranked S2 in Quebec. *Flora Conservanda: New England* (Brumback and Mehrhoff et al. 1996) places the species in Division 1, for globally rare taxa occurring in New England. Green Mountain maidenhair fern is designated N2 nationally in the United States and N2 nationally in Canada. Globally, it is ranked G2 (globally imperiled).



Figure 1. Occurrences of *Adiantum viridimontanum* in North America. States and provinces (Vermont and Quebec, respectively) shaded in black have five or more confirmed, extant occurrences of the taxon.

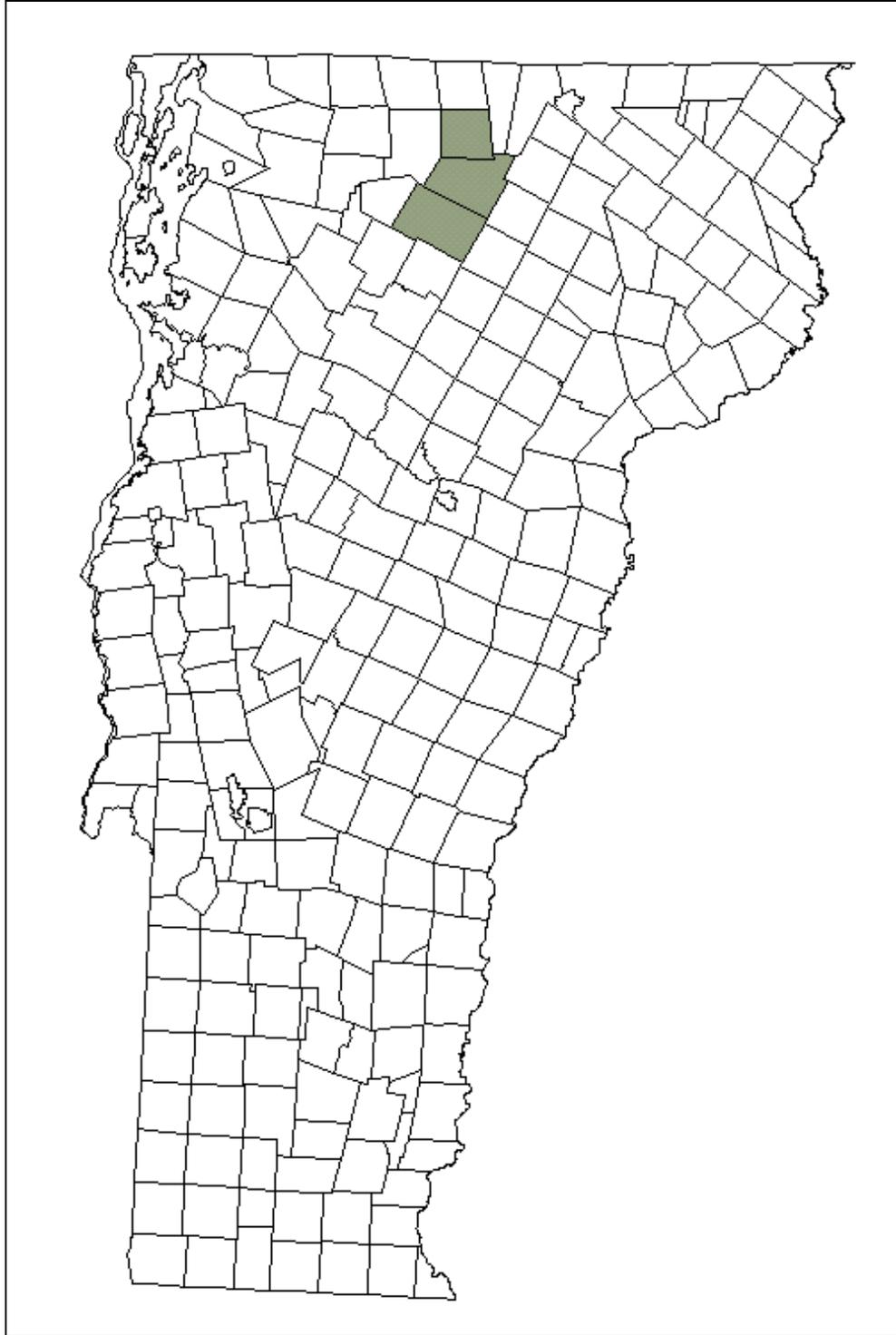


Figure 2. Occurrences of *Adiantum viridimontanum* in New England. Town boundaries for Vermont (the only state in which the taxon is recorded) are shown. Towns with shading

have 1-5 current occurrences. The taxon is not recorded as "historic" for any New England localities.

Table 1. Occurrence and status of <i>Adiantum viridimontanum</i> 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 UNVERIFIED	HISTORIC (LIKELY EXTIRPATED)
Vermont: S2;T (7 current occurrences)	n/a	n/a	n/a
Quebec: S2 (at least 14 current occurrences)			

Status of All New England Occurrences – Current and Historic

Based on literature, herbarium records, and biologist interviews, Green Mountain maidenhair fern has been identified at seven stations in New England (listed in Table 2, next page). All of these occur in Vermont.

Element occurrence (EO) ranks, which are an average of four separate ranks of quality (size and productivity), condition, viability, and defensibility, are included in the following 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.

Table 2. New England Occurrence Records for *Adiantum viridimontanum* based on data from State National Heritage Programs. Shaded occurrences are considered extant.

State	Element Occurrence Number	County	Town
VT	.001	Lamoille/Orleans	Eden/ Lowell
VT	.002	Orleans	Lowell
VT	.003	Orleans	Lowell
VT	.004	Orleans	Lowell & Westfield
VT	.005	Orleans	Westfield
VT	.006	Orleans	Westfield
VT	.007	Orleans	Lowell

II. CONSERVATION

CONSERVATION OBJECTIVES FOR THE TAXON IN NEW ENGLAND

Green Mountain maidenhair fern is a rare species in New England (Brumback and Mehrhoff et al. 1996). Its global range is restricted to Vermont's Mississquoi Valley and southern Quebec. There are fewer than 30 known occurrences globally, and this taxon is considered globally rare and imperiled. The primary conservation goals are to study and protect populations in the Mississquoi Valley. Information gathered in collaboration with Canadian botanists will provide critical information regarding the goals and strategies for rangewide conservation of this species.

The primary conservation objectives for Green Mountain maidenhair fern are to study, protect, and maintain both the species and its associated natural community, the serpentine outcrop. Success of this objective will be measured through maintenance of the current Vermont state rank (S2) and meeting the specific conservation plan objectives.

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Appendix I. An explanation of conservation ranks used by The Nature Conservancy and the Association for Biodiversity Information

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 been made for more than 20 years. An X rank is utilized for sites that are known to be extirpated. Not all EOs have received such ranks in all states, and ranks are not necessarily consistent among states as yet.