New England Plant Conservation Program

Scirpus longii Fern.
Long's bulrush

Conservation and Research Plan for New England

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SUMMARY

Long's bulrush (*Scirpus longii* Fern. [Cyperaceae]) is a globally rare plant species ranging from New Jersey to Nova Scotia. It inhabits seasonally flooded peatlands and riparian marshes, primarily within the coastal plain region. Several historical populations have been destroyed by drainage, filling, and eutrophication. Many of the remaining extant populations have been seriously impacted by these environmental perturbations. At present, there are approximately 58 extant populations of the species throughout its range, and 28 of these occur in New England. About half of the New England populations are quite small, consisting of fewer than 50 individuals. In contrast, the Quaboag River site in central Massachusetts supports the world's largest population of the species. This one site contains more acres of Long's bulrush than all other New England sites combined. At least 13 of the New England populations are protected on public land or private conservation land, but even at these sites, management techniques for enhancing these populations have not yet been developed.

Long's bulrush is a long-lived perennial capable of forming large clones. Certain populations have remained in a vegetative condition for years, while other populations have shown only sporadic production of fertile culms. Fire has been shown to stimulate fertile culm production in this species, and to create ideal seedbed conditions. From an ecological perspective, Long's bulrush is regarded as a pyrophyte: that is, a plant able to withstand or achieve a competitive advantage from fire.

From 1997 to 2001, 12 new populations of Long's bulrush were discovered in Massachusetts. Botanists should continue to search for new populations, study the life history and ecology of the species, develop protection strategies for the known sites, and involve as many people as possible in this conservation effort. Government agencies, conservation organizations, volunteers, and philanthropic institutions are encouraged to coordinate their efforts to achieve the following conservation goals:

1) Develop management plans for all Long's bulrush sites occurring on public lands, private conservation lands, and utility rights-of-way.
2) Discover ten new populations of Long's bulrush.
3) Protect five unprotected privately owned sites through land acquisition or conservation easements.
4) Mitigate imminent threats from hydrologic alteration, pollution, or invasive plants at the most vulnerable sites.
5) Conduct research to better understand the ecology of the species, and to develop effective methods for enhancing population size and vigor.
6) Those involved with Long's bulrush protection or management should meet regularly to exchange information and discuss conservation issues.

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 individuals and 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

This report, commissioned by the New England Wildflower Society, provides current information on the location, status, ecology, and conservation requirements of Long's bulrush (*Scirpus longii* Fern.) populations in New England. The ultimate goal of the report is to conserve this globally rare plant species through a coordinated, prioritized, and sustained approach involving multiple conservation partners.

DESCRIPTION

Long's bulrush is a coarse, perennial member of the sedge (Cyperaceae) family. Schuyler (1963a: 283-284) described the appearance and growth habits of the wool-grass species:

> "The plants are perennial herbs with leafy culms produced from tough, fibrous, underground rhizomes. Individual culms are terminated by a much-branched inflorescence which may contain as many as one thousand spikelets. The spikelets may contain more than sixty flowers each even though the spikelets are frequently less than eight millimeters long. A single flower consists of six perianth bristles, three to no stamens, and a single pistil which contains one ovule. At maturity the perianth bristles become long and wrinkled and give the inflorescence a woolly appearance. These bristles remain attached to the base of the one-seeded fruit, which is less than one millimeter long. … Members of the *S. cyperinus* complex all form tussocks consisting of numerous, short, unconnected rhizomes. Because the culms produced by an individual tussock are extremely uniform, each tussock probably represents a clone."

Long's bulrush can be distinguished from other wool-grass species by its reddish-brown mature achenes. Furthermore, the spikelets of Long's bulrush are individually pedicelled. This character eliminates the ubiquitous *Scirpus cyperinus*, which has sessile spikelets arranged in glomerules. The blackish color of the involcels distinguishes Long's bulrush from *S. pedicellatus*. The somewhat viscid or glutinous condition of the involucre base distinguishes Long's bulrush from *Scirpus atrocinctus*.   Hybridization between *Scirpus longii* and *Scirpus cyperinus* does occur (Schuyler 1963), but it is probably a rare phenomenon, in part because of the different flowering times. I have never encountered fertile culms that seemed to be intermediate or suggestive of hybrid origin between these two species.

The rays of the Long's bulrush inflorescence are frequently longer than those found on other wool-grass species. This can create an overall longer inflorescence. Occasionally, a fertile culm will have a small lateral inflorescence arising from one of the leaf axils on the upper half of the culm. Long's bulrush flowers at least a month earlier than *Scirpus cyperinus* (late June-early July, as opposed to early August). From Massachusetts southward, Long's bulrush does not occur with its more northern congener, *Scirpus atrocinctus*.

Unlike other wool-grass species, Long's bulrush tends to have sporadic culm formation (Schuyler 1963b). Large populations have remained vegetative for many years. Fortunately, it is quite easy to recognize Long's bulrush in its vegetative condition. Hill and Johannson (1992: 142) provided the following discussion of the plant's rhizome:

> "It is essential to be able to identify the plant in its vegetative state. Rhizomes of *S. longii* are longer lived and consequently stouter (usually 1.5 –3 cm diam.) than those of *S. cyperinus* (L.) Kunth or *S. atrocinctus* (usually 1-1.5 cm diam.). In Nova Scotia, *S. longii* grows under conditions of low disturbance as large circular clones, commonly .75 to 5 m in diameter, although we have observed clones up to 50 m in diameter. In contrast, *S. cyperinus* rhizomes decay rapidly and small tussocks are formed,…usually less than 50 cm in diameter."

Rhizome width is the best field character for identifying vegetative individuals of Long's bulrush. As a rule of thumb, the Long's bulrush rhizome will be the diameter of a dime or a nickel, whereas other wool-grass species have pencil-width rhizomes. The impact of collecting a section of rhizome to make this determination is likely to be negligible.

On larger clones of Long's bulrush (> 1 m diameter) the vegetative shoots are arranged along the perimeter, and occur only sparingly in the middle region, forming a ring. The clones have been described as doughnut-shaped or bushel basket-shaped. The leaves of Long's bulrush can be confused with those of beaked sedge (*Carex utriculata*), with which it often occurs. Hill (1994: 12) provided the following helpful information:

> "Rhizome position is also useful to distinguish the plant from a co-occurring sedge, *Carex rostrata*. While the vegetation of *C. rostrata* plants resembles superficially that of *S. longii*, *C. rostrata* rhizomes are not near the surface like those of *S. longii*, but are commonly formed 25 cm or more below the peat surface."

Another character useful in distinguishing Long's bulrush from beaked sedge is leaf cross-section. Long's bulrush leaves, as those of other leafy bulrush species, are "V-shaped" in cross-section, while those of beaked sedge are somewhat pleated, resembling a "W" or an "M" in cross-section, depending on your point of view.

TAXONOMIC RELATIONSHIPS, HISTORY, AND SYNONYMY

The species status of Long's bulrush is not in dispute. The taxon was named by M. L. Fernald "for its discoverer," Bayard Long (Fernald 1911, 1950). In the year that Fernald published his description, Witmer Stone (1911: 272) wrote the following account of Long's bulrush, identifying himself as the discoverer of this plant:

> "Discovered by the writer in a Pine Barren swamp about two miles north of Speedwell July 9, 1909. Local and restricted to the Pine Barrens, usually growing in water and blooming much earlier than the closely allied *S. atrocinctus* in the Pennsylvania Alleghanies. Named for Bayard Long, who has made a critical study of the Philadelphia flora for several years past and has rendered valuable assistance in the preparation of the present volume."

Within the genus *Scirpus*, Long's bulrush is placed in the section Trichophorum, along with other leafy-stemmed species commonly referred to as wool-grasses. These closely related wool-grass species include *Scirpus cyperinus*, *S. rubricosus*, *S. pedicellatus*, and *S. atrocinctus* (Fernald 1950). Schuyler (1963a) challenged the taxonomic validity of *S. rubricosus*, and in Sorrie and Somers' checklist (1999) this taxon is regarded as conspecific with *S. cyperinus*.

SPECIES BIOLOGY

Long's bulrush is a long-lived perennial that tends to persist in a vegetative condition until something triggers the formation of fertile culms. With age, a plant develops into a circular clone. Rhizomes within the clone grow radially at the rate of about 1.45 to 2.4 cm per year (Hill 1994). Thus, large-diameter clones are judged to be older than small-diameter clones. Age class analysis of Long's bulrush clones can provide insights into the factors contributing to stand formation. Hill (1994: 12) wrote:

> "I have found charred wood 35 cm below the surface of the fen at Eighteen Mile Brook. The oldest cohort of clones at the site with diameters ranging from 5 to 6 m must have become established in the 1890's after a fire swept through the area (pers. comm. Harry Freeman); this date is very close to the estimated age of a 5.5 m dia clone (supposing circle formation was rapid, the radius of a 5.5 m dia clone would be traversed by a rhizome growing at an annual rate of 2.4 cm in 114.6 years)."

Hill and Johansson (1992) observed that the interior region of clones frequently lacked shrub growth, and hypothesized that competitive interactions were taking place between the bulrush clones and the shrub species. These authors wrote (p. 153):

> "We do not know how small clones of *Scirpus longii* exclude shrubs from their barren interior regions. Preliminary investigations reveal that the rhizomes in the interior of the clones are mostly dead but that they persist and form a fretwork which is overlain by decaying litter and moss. Shrubs may be excluded in part by the outer leafy phalanx of *S. longii* shoots because shrub roots invading the phalanx would have to establish their roots in layers of *S. longii* litter on top of the matrix of dead rhizomes. Shrub growth

may also be reduced if soil nutrients in the clone interior have been depleted by *S. longii*."

Fertile culm formation in Long's bulrush is apparently most often stimulated by stress to the plant, be it from fire, herbivory, other forms of physical damage, or prolonged flooding. If vegetative clumps of Long's bulrush are dug up in the early spring and transplanted, they usually produce fertile culms that same year (personal observation).

Schuyler and Stasz (1985) documented a phenomenal increase in fertile culm formation following fire. In addition to stimulating fertile culm formation, these authors noted that fire eliminates competing woody vegetation and creates ideal seedbeds for seedling establishment. Many of the specimens in herbaria have charred leaf bases, and many of the Long's bulrush sites are known to have burned (personal observation). The persistent dead leaves of Long's bulrush and other marsh plants form a thatch that is very easily burned when standing water is not present. As a plant adapted to withstand or achieve a competitive advantage from fire, Long's bulrush clearly fits the definition of a pyrophyte. Fire has undoubtedly played an important role in the distribution and maintenance of Long's bulrush populations. But because Long's bulrush can flower in the absence of fire, and germinate on soils exposed by other disturbance factors such as intensive grazing, the plant should not be regarded as entirely dependent on fire. I do believe, however, that fire has been the key factor explaining the occurrence and continued maintenance of Long's bulrush in New England.

Sustained conditions of unusually high water levels, or perhaps unusually low water levels may also trigger fertile culm formation. For example, unusually high water levels in 1998 apparently contributed to the production of an estimated 50,000 fertile culms at the Newburyport-West Newbury site in Massachusetts. In 1999, when water levels were lower than normal, nary a fertile culm could be found. One might surmise that the seeds produced during a high-water year would find greater opportunities for germination amid the flood-stressed vegetation once the waters recede.

Disturbance to the Long's bulrush plants caused by cattle grazing at the Newburyport-West Newbury site may have also contributed to the production of fertile culms in 1998. In 1998, no fertile culms of Long's bulrush were produced on plants occurring in the portion of the wetland fenced off from cattle. The Newburyport-West Newbury site is one of a few areas where small, young plants of Long's bulrush may be observed. These plants germinated on the exposed mucky-peaty habitats created by the bog-slogging bovines. One might surmise that the long history of grazing, perhaps coupled with fire, actually helped create and maintain this large population of Long's bulrush.

In Nova Scotia, lakeshore populations of Long's bulrush may benefit from the disturbance caused by ice scouring, and from herbivory by muskrats, which has been found to increase the incidence of fertile culm formation (Hill and Johansson 1992, Hill 1994). I, too, observed a high incidence of fertile culms on plants that were heavily grazed by muskrats in June, 2000 along the

Quaboag River. The grazed plants occurred relatively close to the river channel, and as a consequence, these were the plants most accessible to the muskrats. The fertile culms observed in 2000 were probably produced in response to muskrat herbivory on these same plants the previous year. At the Quaboag, the muskrats showed a preference for Long's bulrush, hardly touching the co-occurring marsh plants.

Sexual reproduction is accomplished via wind pollination. The flowering spikelets contain both male and female flowers. The species is probably self-compatible. Seed dispersal is primarily by wind, but seeds falling on water might move with the water. The following observation indicates that the seeds of Long's bulrush ripen quickly, and can germinate in great profusion the year they are produced. On August 3, 1988, I found a fertile culm that had been knocked over by blueberry pickers at the New Hampshire site. The culm was lying in the water, and hundreds of tiny seedlings were growing from the still-intact, wet spikelets. Because the culm probably flowered during early July, one can conclude that seed maturation and germination occurred within about a month's time. Schuyler and Stasz (1985) noted that a small percentage of the seedlings produced in 1984 at Atsion, New Jersey actually flowered that same year. It is likely that some seeds of Long's bulrush do not immediately germinate and enter the soil seed bank. We do not know how long such seeds remain viable in the soil. This may be a critical aspect of the species' ecology, with profound management implications.

Seed bugs of the genus *Cymus* were observed on many fertile culms of Long's bulrush at the Quaboag River site in 2000 (personal observation). These small insects were well-camouflaged within the inflorescences. The impact of this seed predator and its incidence at other Long's bulrush sites has not yet been determined.

HABITAT/ECOLOGY

Physiography, hydrology, and climate are key factors explaining the distribution of Long's bulrush on or near the Atlantic coastal plain. The coastal plain is characterized by low relief, low elevation, and abundant wetlands occurring on generally sandy substrates. A moderated maritime climate (i.e., mild winters, cool summers, and high humidity) affects many of the Long's bulrush sites in this region. The coastal plain region has also been prone to fire, due to low relief, dry soil conditions of the surrounding uplands, and a human population that has inhabited the area for several thousand years (Cronon 1983, Foster and Motzkin 1999).

Long's bulrush is an obligate wetland species favoring open, sunny conditions. All populations experience pronounced seasonal flooding, and all populations occur on somewhat oligotrophic mucky to peaty soils. Chemical analysis of these soils would likely show them to be acidic and nutrient-poor.

The most oligotrophic sites are essentially fens, which are treeless peatlands influenced by minerotrophic water. The fen habitats supporting Long's bulrush in New England are recognized by an abundance of *Sphagnum* moss and plants such as large cranberry (*Vaccinium macrocarpon*), leatherleaf (*Chamaedaphne calyculata*), slender woolly-fruited sedge (*Carex lasiocarpa*), beaked sedge (*Carex utriculata*), button sedge (*Carex bullata*), few-seeded sedge (*Carex oligosperma*), bog sedge (*Carex exilis*), creeping sedge (*Carex chordorhiza*), Walter's sedge (*Carex striata* var. *brevis*), twig-rush (*Cladium mariscoides*), tawny cotton-grass (*Eriophorum virginicum*), white beak-sedge (*Rhynchospora alba*), rose pogonia (*Pogonia ophioglossoides*), northern bladderwort (*Utricularia intermedia*), bog aster (*Aster nemoralis*), bog willow (*Salix pedicellaris* var. *hypoglauca*), and Virginia chain-fern (*Woodwardia virginica*). Some of these fens are associated with natural lakes and their inlet or outlet stream courses. Other fens occur in abandoned stream courses and in headwater drainages. Fens associated with lakes and rivers are seasonally flooded by the surface waters derived from these water bodies. These habitats also seem to be connected to, and influenced by, the groundwater of the regional water table. Groundwater tends to be lower in essential nutrients than surface waters, and consequently, under the influence of groundwater, the organic sediments decay more slowly and form peat. Contact with groundwater also helps maintain saturated, anaerobic conditions for longer periods of time, which also contributes to peat formation.

Long's bulrush also occurs in more enriched graminoid marshes and carrs. Here, the nutrients supplied by seasonal flooding have a more pronounced effect on the vegetation. The soils tend to be muck, as opposed to peat, and *Sphagnum* moss is usually absent or scarce. Although some of the above-mentioned fen plants may be present, species such as tussock sedge (*Carex stricta*), Canada bluejoint (*Calamagrostis canadensis*), marsh fern (*Thelypteris palustris*), swamp candles (*Lysimachia terrestris*), buttonbush (*Cephalanthus occidentalis*), woolgrass bulrush (*Scirpus cyperinus*), meadowsweet (*Spiraea alba* var. *latifolia*), steeplebush (*Spiraea tomentosa*), sweet gale (*Myrica gale*), swamp rose (*Rosa palustris*), New England rose (*Rosa nitida*), marsh cinquefoil (*Comarum palustre*), meadow willow (*Salix petiolaris*), red maple (*Acer rubrum*), sweet flag (*Acorus americanus*), northern blue flag (*Iris versicolor*), freshwater cord-grass (*Spartina pectinata*), hybrid cattail (*Typha* x *glauca*), broad-leaved cattail (*Typha latifolia*), and purple loosestrife (*Lythrum salicaria*) tend to be most abundant and characteristic. In such habitats, Long's bulrush most often occurs in the zone of vegetation just *below* the royal fern (*Osmunda regalis*) zone.

Wet power line rights-of-way support two of New England's Long's bulrush populations. These habitats provide important insights into the life history requirements of the species, and suggest management opportunities. The bulrush obviously found suitable conditions for germination, and the periodic reduction of competing vegetation seems beneficial. Perhaps these open habitats resemble conditions that were once more widespread at these wetland sites when they were burned on a frequent basis by Native Americans.

THREATS TO TAXON

Threats to Long's bulrush are primarily anthropogenic in origin. Habitat destruction by filling probably destroyed the former Alewife Brook site in Cambridge, Massachusetts. In southeastern Massachusetts, thousands of acres of wetlands have been placed in cranberry production, and some undiscovered Long's bulrush populations were likely destroyed as a consequence.

Ditching and channelization have damaged Long's bulrush habitats, most recently at the Newburyport-West Newbury site where attempts are being made to drain the wetland to improve grazing conditions for cattle. In 1998, I observed whole clumps of Long's bulrush ripped out and dumped amid the dredge spoils there. Citing the historical accounts of Barrows (1938), John Lortie (1996: 10-11) provided the following remarkable story of channelization along the Saco River during the early 19th century:

> "The area now containing the largest population of Long's bulrush was drastically altered by the early settlers of the region who grazed their animals in the fens, hayed the fens, and changed the course of the Saco River by over 30 miles. This major change occurred when a drainage canal was dug in 1817 from William Russell's place to General Frye's Hill to Bog Pond, a distance of about 3 miles. In 1820, the immense amount of water passing through the canal turned the whole current of the river in a new direction, bypassing a meandering section of the river known as the Intervales. The Intervales was a serpentine section of river that ran a course of 32 miles, but only went three miles downstream. It has been estimated that the Intervales contained a 10,000 acre floodplain wetland system, which contained sheet flow during spring freshets and storm events, and meandering channelized flow during the rest of the year. It is quite possible that this area contained a large expanse of *Scirpus longii* prior to being drained and converted into farmland."

Ditching often lowers the water table, which then allows red maple to achieve dominance on sites where it formerly was kept in check by the seasonal high water levels. The lowering of the water table also causes a disturbance conducive to invasive plants such as purple loosestrife (*Lythrum salicaria*), common reed (*Phragmites australis*), and glossy buckthorn (*Rhamnus frangula*). It would be too simplistic to suggest that these invasives directly out-compete Long's bulrush. Such invasive plants are often symptomatic of other environmental perturbations affecting these sites.

Wildlife management agencies may inadvertently threaten Long's bulrush sites if they construct waterfowl impoundments or manipulate water levels in wetlands likely to support the species. The large impoundments created by the U.S. Fish and Wildlife Service at the Great Meadows National Wildlife Refuge in Massachusetts apparently destroyed a former Long's bulrush population. The plant was last collected from that site in 1950. At a nearby state-owned wildlife management area, Long's bulrush was discovered *after* the construction of a nearby wildlife impoundment. It was a close call for that population. Similarly, the Rhode

Island population was almost destroyed before it was discovered. Plans to convert that area into a wildlife impoundment were abandoned, in part because the site supported a globally rare dragonfly, *Williamsonia lintneri* (Rawinski 1990).

Eutrophication is certainly one of the major threats to Long's bulrush in New England. With higher nutrient levels in the surface waters, competing vegetation will be favored over Long's bulrush, which requires rather oligotrophic, nutrient-poor conditions. At present, many streams and lakes in New England have unnaturally high levels of nutrients, derived from municipal wastewater treatment facilities, agricultural and urban runoff, landfills, and myriad other sources. Road salt runoff might explain why common reed is encroaching on Long's bulrush populations near Route 24 and Interstate 95 in Massachusetts. At the Taunton, Massachusetts site, a manure pile was observed on the slope directly above the Long's bulrush population. Nutrient-rich leachate no doubt entered the subtending wetland.

Eutrophication impacts are apparent along the Quaboag River at the confluence of tributary streams, especially Dunn Brook, Willow Brook, and Coys Brook. Long's bulrush does not occur in these zones of eutrophic marshland. Anthropogenic sources of nutrient enrichment in these tributary streams include agricultural runoff, the recently capped Brookfield landfill, and North Brookfield's wastewater treatment facility.

Grazing of Long's bulrush by cattle at the Newburyport-West Newbury site has been a double-edged sword. This area has been grazed and kept open for centuries, and the bulrush has persisted, if not increased. Under this grazing regime, the bulrush plants have shown a phenomenal flowering response, and are reproducing on the exposed soil created by the trampling. However, some dead clones are present, perhaps due to locally heavy grazing and trampling. Also, the grazed area is now infested with purple loosestrife, which thrives in such disturbed settings. The cow "flops" have introduced unwanted nutrients into this wetland system. In sum, I regard the present heavy grazing of Long's bulrush to be a threat. The situation is complicated, however, by the ongoing ditching and the hydrologic disruption caused by adjacent Interstate 95.

Herbivory by muskrats is most prevalent along the Quaboag River, but even if some plants are killed, the impact seems negligible in the context of the site's vast population of Long's bulrush. If anything, herbivory by muskrats seems to stimulate fertile culm production at the Quaboag, which might be regarded as desirable.

Fire suppression, or the absence of periodic burning, should be regarded as threats to Long's bulrush populations. Historically, fires were rather common on the New England landscape, especially near the coast. Native Americans and European Americans both appear to have set fires on a frequent basis (Cronon 1983, Foster and Motzkin 1999). Railroads also apparently spawned numerous fires in Long's bulrush wetlands. Charcoal has been found in the sediments of two Massachusetts Long's bulrush sites situated near railroad tracks (Kennedy Clark and William Patterson, University of Massachusetts Amherst, personal communication). I believe that most Long's bulrush sites, if examined closely, would show evidence of past fire. I have observed recent evidence of fire in the riparian marshes of the Neponset, Charles, and Quaboag Rivers in Massachusetts. Long's bulrush populations in New England should probably be regarded as artifacts from the period of frequent burning, which occurred centuries ago. The elimination or reduced incidence of fire in these wetland systems will likely prove deleterious to Long's bulrush over the long term.

The power line populations of Long's bulrush face a unique set of threats from herbicides, brush-cutting activities, and damage caused by off-road vehicles. These sites might also be susceptible to invasive plants such as common reed.

Natural processes must also be considered as potential threats. Some populations of Long's bulrush might decline as open marsh/fen vegetation slowly succeeds to wooded vegetation. This would be especially true if the open vegetation was originally created by fire, and if fire failed to return for a long period of time. A stream might also change its course, thereby affecting associated bulrush sites. However, a meandering stream, such as the Saco River, will likely create as much potential habitat as it destroys.

Throughout New England, abandoned beaver ponds are being colonized by common reed at an alarming rate. When beavers impact Long's bulrush sites, the threat of subsequent common reed infestation is very real. Common reed occurs at several of the Massachusetts sites, and could threaten other sites in the region.

A potential threat to Long's bulrush is posed by water withdrawals from subterranean aquifers for municipal usage. Wells sited in the vicinity of Long's bulrush sites may be lowering the water table and disrupting the natural hydrology of these wetlands. While there are no known populations of Long's bulrush along the Ipswich River flood plain, habitat conditions there seem entirely suitable, and I suspect that the species occurs there somewhere. Environmentalists have become very concerned that the flow of the Ipswich River has been seriously affected by municipal water withdrawal in the watershed. The Ipswich River, in fact, now ceases to flow during drought periods. This diminished water supply to the river means that the flood plain marshes and sedge meadows are now more susceptible to woody plant invasion. The Parker River system in Massachusetts *does* support Long's bulrush, and like the Ipswich River, its flow regime is being altered by excessive water withdrawal.

Finally, the species might be negatively affected by management activities intended to stimulate fertile culm formation, establish seedlings, or reduce competing vegetation, e.g., cutting, burning, and soil scarification. There is always a risk that management or research activities will have unintended negative consequences.

DISTRIBUTION AND STATUS

General status

Long's bulrush is endemic to northeastern North America, ranging from New Jersey to Nova Scotia. The plant has been characterized as a coastal plain species -- an appropriate description, since most populations occur within 100 km of the Atlantic coast.

While the plant may be locally abundant, it has a limited distribution and is regarded as a rare species throughout its range (Rawinski 1990, Hill 1994, Lortie 1996). According to current information, approximately 58 populations of the species are known to exist (Table 1). The *Flora Conservanda: New England* list developed by Brumback and Mehrhoff et al. (1996) assigned Long's bulrush to Division 1, reflecting its global rarity. Long's bulrush was considered a candidate for Federal listing as endangered or threatened in the United States under the Endangered Species Act of 1973, as amended, and was assigned status category 2 (Federal Register 50:39526). A range-wide status survey funded by the U.S. Fish and Wildlife Service led to a recommendation not to list the species as threatened or endangered (Rawinski 1990). In Canada, however, the species was assigned the status of "vulnerable" because of its "restricted range and limited sexual reproduction with significant reduction of one site due to road development" (Hill 1994). The North American distribution of Long's bulrush is summarized in Figure 1.

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

OCCURS & LISTED (AS S1, S2, OR T &E)	HISTORIC (LIKELY EXTIRPATED)
Maine (S1): 10 extant occurrences	Connecticut (SH)
Massachusetts (S1): 16 extant occurrences	New York (SX)
New Hampshire (S1): 1 extant occurrence	
New Jersey (S2): 12 extant occurrences	
Rhode Island (S1): 1 extant occurrence	
Nova Scotia (S1): 18 extant occurrences	

Once identified as a globally rare species, Long's bulrush recently has received increased attention from botanists in the region. A chronology of recent discoveries in New England provides a useful historical perspective. Prior to 1987, no extant populations of Long's bulrush were known in New England, although collection records existed for Connecticut, Massachusetts, and Maine. In 1978 Coddington and Field (1978) assessed the Massachusetts situation:

> "All MA populations were from populous areas, and probably have been extirpated by development or competition with *Lythrum salicaria*."

Crow and others (1981) and Crow (1982) made no mention of extant populations of Long's bulrush in New England, and concurred with Coddington and Field's assessment:

> "In Connecticut recent field work has failed to locate that state's single population of *Scirpus longii*, and heavy industrial development in the area suggests that it may have been extirpated. In Massachusetts six historical sites are known, most of which are in the greater Boston area where many formerly rich wetland areas have been destroyed for development. Field work has failed to relocate Long's Bulrush at any of these sites."

In 1987, Long's bulrush was found in Massachusetts and Rhode Island. In 1988, populations were documented in New Hampshire and Maine. By 1996, there were 16 extant occurrences of Long's bulrush in New England. From 1997 to 2001, 12 new populations were discovered in Massachusetts, bringing the New England total to 28. The recent discoveries suggest that new populations will continue to be found in New England and elsewhere in its range.

Status of all New England Occurrences -- Current and Historic

Figures 2 and 3 illustrate the distribution of Long's bulrush in New England, while Table 2 summarizes the status of each New England occurrence of the species. The sites are simply identified by their town, element occurrence number, and state. Brief descriptions of each occurrence follow.

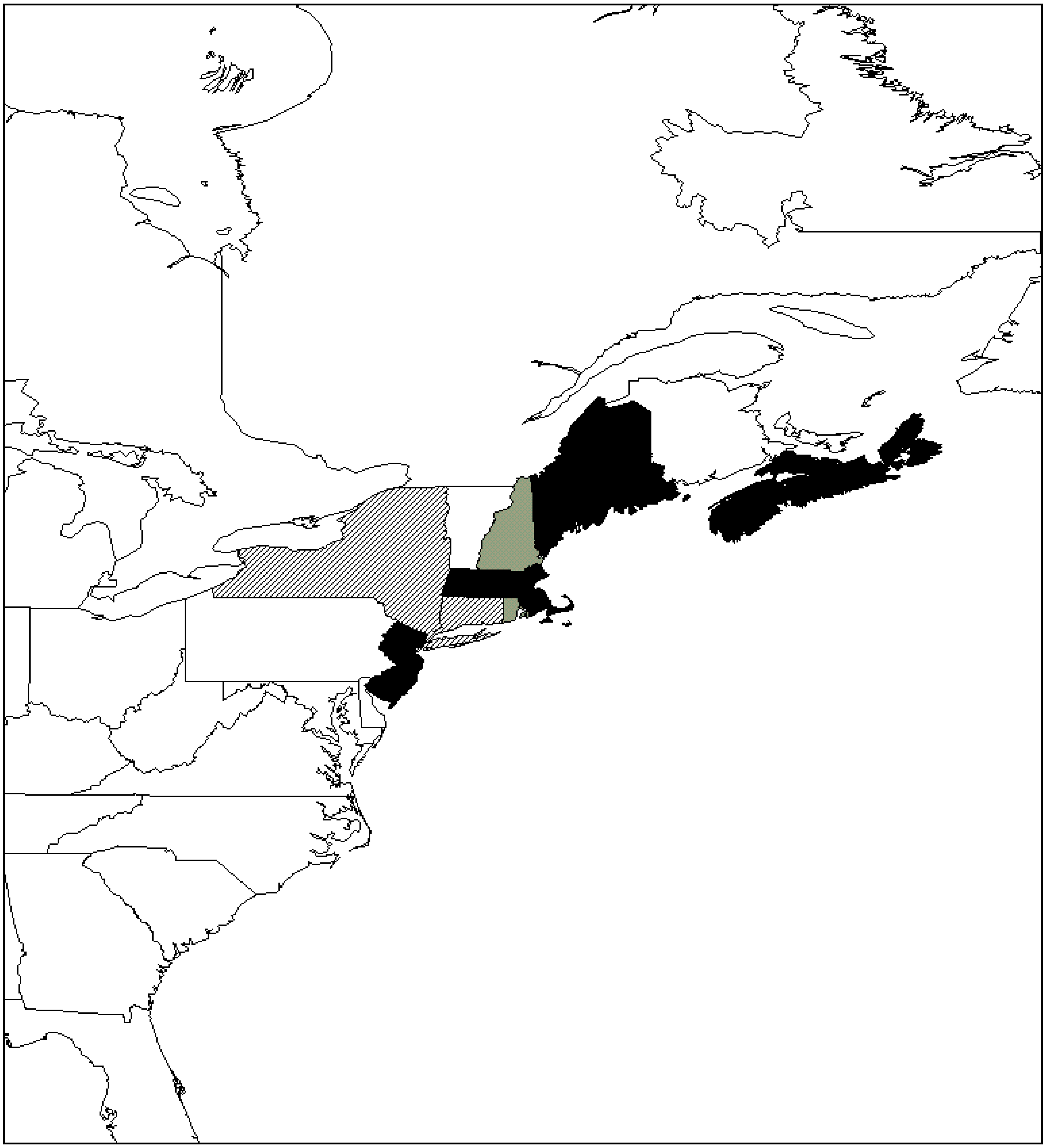

Figure 1. Distribution of *Scirpus longii* in North America. States or provinces shaded in black have more than five confirmed, extant occurrences of the taxon. States shaded in gray have one to five current occurrences. States with diagonal hatching are considered "historic" or "presumed extirpated," where the taxon no longer occurs.

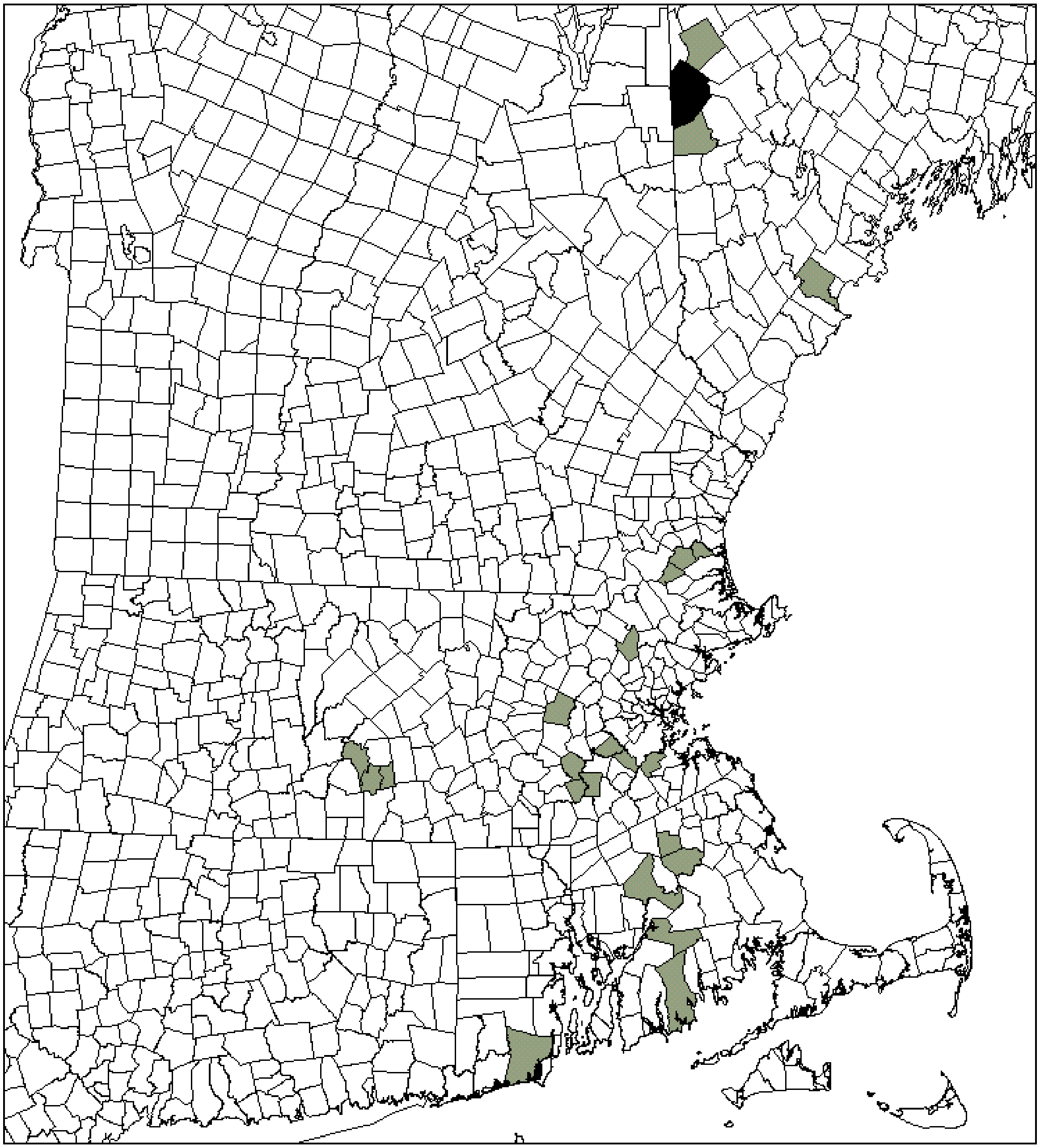

Figure 2. Extant occurrences of *Scirpus longii* in New England. Town boundaries for New England states are shown. Towns shaded in gray have one to five confirmed, current occurrences. The town shaded in black (Fryeburg, Maine) has more than five extant occurrences.

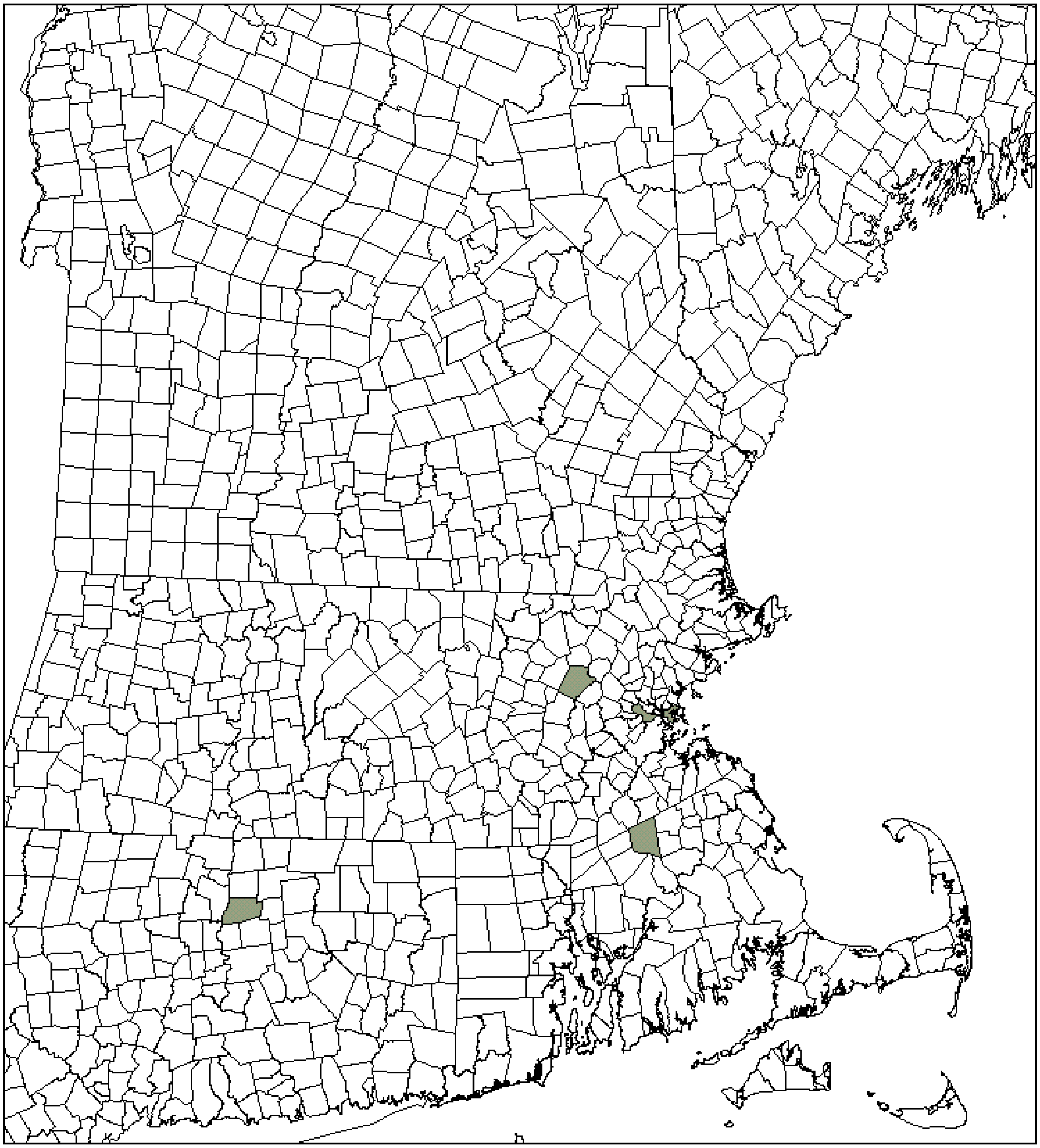

Figure 3. Historic occurrences of *Scirpus longii* in New England. Towns shaded in gray have one to five historic records of the taxon.

Table 2. New England Occurrence Records for *Scirpus longii*. Shaded occurrences are considered extant.

State	EO #	County	Town
ME	**.001**	**Oxford**	**Lovell**
ME	**.002**	**Oxford**	**Fryeburg**
ME	**.003**	**Oxford**	**Brownfield**
ME	**.004**	**Oxford**	**Fryeburg**
ME	**.005**	**Oxford**	**Fryeburg**
ME	**.006**	**Oxford**	**Fryeburg**
ME	**.007**	**Oxford**	**Fryeburg**
ME	**.008**	**Oxford**	**Fryeburg**
ME	**.009**	**Oxford**	**Brownfield**
ME	**.010**	**York**	**Saco**
NH	**.001**	**Strafford**	**Rochester**
MA	**.001**	**Norfolk**	**Milton**
MA	**.003** **.009**	**Norfolk**	**Needham**
MA	.004	Middlesex	Cambridge
MA	.005	Middlesex	Concord
MA	.006	Bristol	Easton
MA	.007	Suffolk	Boston
MA	**.010**	**Bristol**	**Dartmouth**
MA	**.011**	**Plymouth**	**West Bridgewater/ Bridgewater**
MA	**.012**	**Bristol**	**Freetown**
MA	**.013**	**Middlesex**	**Wilmington**
MA	**.014**	**Bristol**	**Taunton**
MA	**.015**	**Essex**	**Newburyport/West Newbury**
MA	**.016**	**Middlesex**	**Sherborn**
MA	**.017**	**Norfolk**	**Medfield**
MA	**.018**	**Worcester**	**East Brookfield/ Brookfield/ West Brookfield**
MA	**.019**	**Middlesex**	**Sudbury**
MA	**.020**	**Norfolk**	**Dedham**
MA	**.021**	**Norfolk**	**Medfield**
MA	**.022**	**Norfolk**	**Medfield/ Millis**

Table 2. New England Occurrence Records for *Scirpus longii*. Shaded occurrences are considered extant.			
State	**EO #**	**County**	**Town**
MA	**None**	**Essex**	**Groveland**
RI	**.001**	**Washington**	**South Kingstown**
CT	.001	Hartford	South Windsor

CURRENT CONSERVATION MEASURES IN NEW ENGLAND

Long's bulrush is receiving considerable conservation attention throughout New England. Habitat protection has been the single most effective approach to conserving the species. A notable achievement in recent years was the protection of the Dartmouth, Massachusetts site by the state. Research at that site has sought to document fire history, as a prerequisite to future prescribed fire management.

Elsewhere, conservation organizations and agencies have met with private landowners to discuss long-term conservation of unprotected sites. Local land trust organizations have also made headway at some sites. State natural heritage programs and NEPCoP volunteers continue to monitor known sites, search for new sites, and lay the groundwork for future protection.

At least 12 of the 28 New England sites occur on public land, and the managers of most of these properties have been informed of the significance of these sites. These managers seem genuinely pleased that they have something of great ecological significance under their stewardship. At the same time, these agencies, for the most part, lack the in-house expertise, will, and resources to carefully monitor or manage these populations. It is therefore important that other individuals and conservation organizations continue to provide assistance to these agencies as needed, and hound them to do right by nature.

The New England Wild Flower Society and NEPCoP volunteers have been collecting seeds from Long's bulrush populations. Placed in a long-term storage facility, these seeds may help perpetuate gene pools of populations that become extirpated, and provide a seed source for possible re-introduction.

The Nature Conservancy (1996) produced a Long's bulrush element stewardship abstract to guide the management and protection of the species. The abstract is rich in information, but definitely needs to be updated.

II. CONSERVATION

CONSERVATION OBJECTIVES FOR THE TAXON IN NEW ENGLAND

With the involvement of government agencies, conservation organizations, volunteers, and philanthropic institutions, and with coordination provided by the New England Wild Flower Society, it is reasonable to expect that the following recovery objectives could be achieved within the next 10 years:

1) Develop management plans for all Long's bulrush sites occurring on public lands, private conservation lands, and utility rights-of-way.
2) Discover ten new populations of Long's bulrush.
3) Protect five unprotected privately owned sites through land acquisition or conservation easements.
4) Mitigate imminent threats from hydrologic alteration, pollution, or invasive plants at the most vulnerable sites.
5) Conduct research to better understand the ecology of the species, and to develop effective methods for enhancing population size and vigor.
6) Those involved with Long's bulrush protection or management should meet regularly to exchange information and discuss conservation issues.

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IV. APPENDICES

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1. An explanation of conservation ranks used by The Nature Conservancy and Natureserve

1. 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 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.