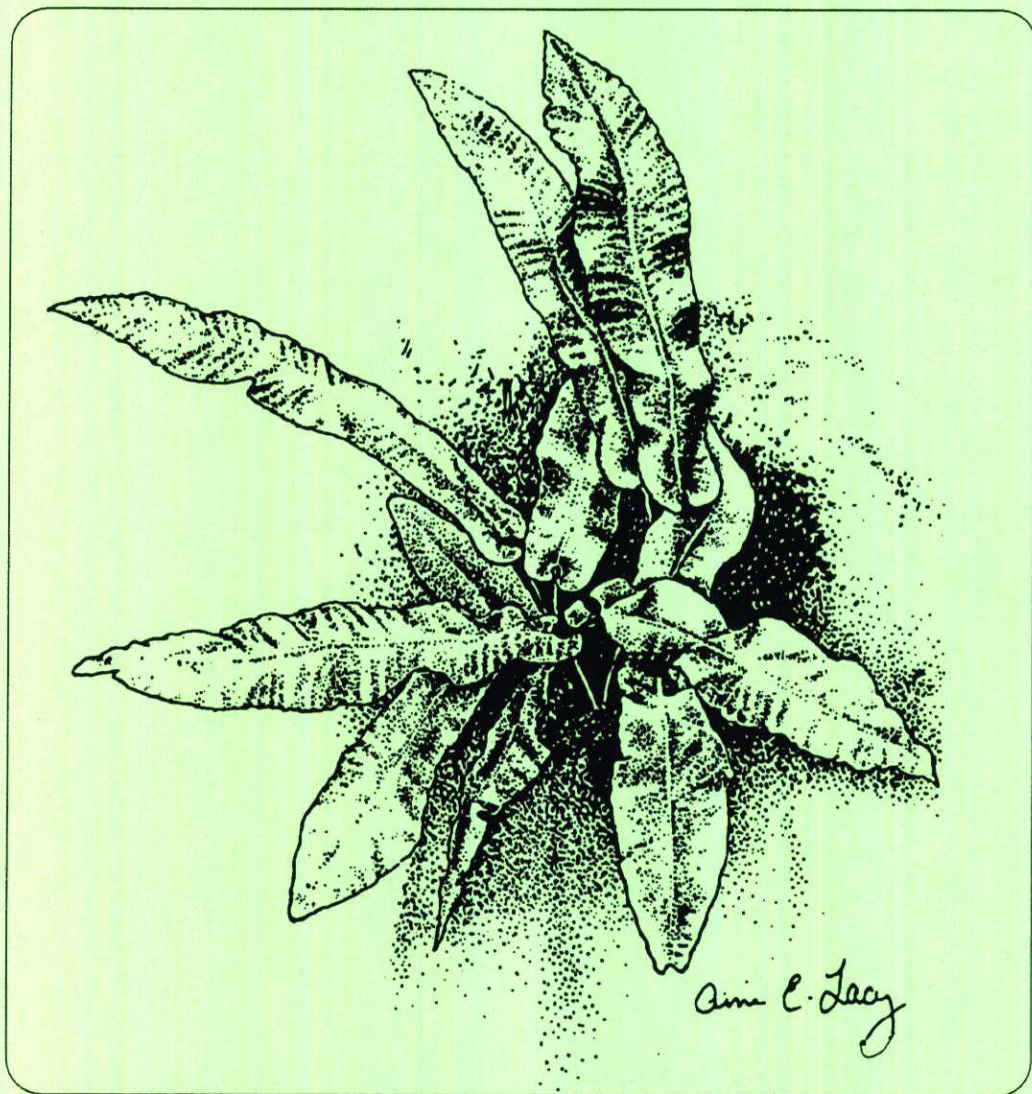


RECOVERY PLAN

American hart's-tongue

(*Asplenium scolopendrium* var. *americanum*)

(Synonym: *Phyllitis scolopendrium* var. *americana*
American hart's-tongue fern)



U.S. Fish and Wildlife Service

RECOVERY PLAN

for

American hart's-tongue (*Asplenium scolopendrium* L. var.
americanum [Fernald] Kartesz and Gandhi [Synonym: *Phyllitis*
scolopendrium (L.) Newman var. *americana* Fernald])

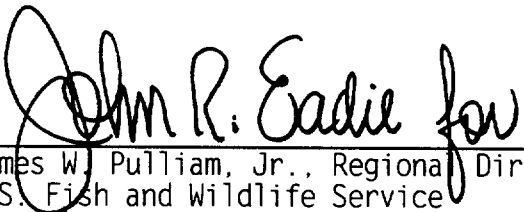
Prepared by

Robert R. Currie
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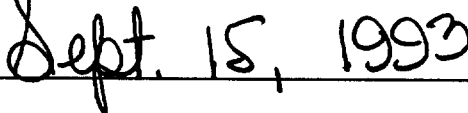
for

Southeast Region
U.S. Fish and Wildlife Service
Atlanta, Georgia

Approved: _____


James W. Pulliam, Jr., Regional Director
U.S. Fish and Wildlife Service

Date: _____



Recovery plans delineate reasonable actions which are believed to be required to recover and/or protect listed species. Plans are published by the U.S. Fish and Wildlife Service, sometimes prepared with the assistance of recovery teams, contractors, State agencies, and others. Objectives will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery plans do not necessarily represent the views nor the official positions or approval of any individuals or agencies involved in the plan formulation, other than the U.S. Fish and Wildlife Service. They represent the official position of the U.S. Fish and Wildlife Service only after they have been signed by the Regional Director or Director as approved. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

Literature citations should read as follows:

U.S. Fish and Wildlife Service. 1993. American Hart's-tongue Recovery Plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. 33 pp.

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Bethesda, Maryland 20814
Phone: 301/492-6403 or
1-800/582-3421

Fees for recovery plans vary, depending upon the number of pages.

EXECUTIVE SUMMARY

Current Status: *Asplenium scolopendrium* var. *americanum* is federally listed as a threatened species. It is currently known from 21 locations in the United States (2 in Alabama, 1 in Tennessee, 6 in Michigan, and 12 in New York). The species also occurs in Ontario, Canada.

Habitat Requirements and Limiting Factors: This rare fern is typically found growing in close association with dolomitic limestone. In the southern part of its range it is found only in entrances to pit caves. The entrance areas to these caves provide the humidity and moisture levels that are associated with the populations found at more northern latitudes. It is threatened throughout most of its range by trampling, logging, and development within and near its habitat.

Recovery Objective: To delist the species.

Recovery Criteria: American hart's-tongue will be considered for delisting when there are at least 15 self-sustaining populations in the United States that are protected to such a degree that the species no longer qualifies for protection under the Endangered Species Act.

Actions Needed: (1) Protect known populations; (2) conduct needed biological studies; (3) implement management, if needed; (4) protect genetic material and reestablish populations, if necessary; and (5) conduct enforcement and education programs and monitor recovery progress.

Costs (\$1,000s): (Does not include cost estimates for land acquisition, implementation of needed management, or reestablishment of extirpated populations.)

<u>Year</u>	<u>Need 1</u>	<u>Need 2</u>	<u>Need 3</u>	<u>Need 4</u>	<u>Need 5</u>	<u>Total</u>
1994	30.0	70.0	5.0	13.2	5.0	123.2
1995	35.0	55.0	5.0		5.0	100.0
1996	20.0	55.0	5.0		5.0	85.0
1997		45.0	5.0		5.0	55.0
1998			5.0		5.0	10.0
TOTAL:	85.0	225.0	25.0	13.2	25.0	373.2

Date of Recovery: Recovery should be achieved in 1999, provided the funds are available and needed recovery activities have been accomplished.

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PART I

INTRODUCTION

Background and Description

On July 14, 1989, the U.S. Fish and Wildlife Service officially listed American hart's-tongue (*Asplenium scolopendrium* L. var. *americanum* [Fernald] Kartesz and Gandhi [Synonym: *Phyllitis scolopendrium* (L.) Newman var. *americana* Fernald]) as a threatened species (U.S. Fish and Wildlife Service 1989).

American hart's-tongue (Figure 1) has evergreen strap-shaped fronds that are 5 to 17 inches long (12 to 42 centimeters [cm]), 0.75 to 1.75 inches wide (2 to 4.5 cm), and auriculate (lobed) at their base. The green petiole is 1 to 5 inches long (3 to 12 cm) and has cinnamon-colored scales. The sori (groups of spore-producing reproductive structures called sporangia) are linear in shape and occur on the underside of the blade portion of the frond. The fronds arise in a cluster from a short, creeping rhizome covered with cinnamon-colored scales (Evans 1981, Lellinger 1985). A detailed description of the species is provided by Lellinger (1985). Ferns recognized as belonging to the species *Asplenium scolopendrium* (then referred to as *Scolopendrium vulgare* Smith) were first discovered in the United States in 1807, when Pursh found the species growing in central New York (Maxon 1900).

Asplenium scolopendrium, described by Linnaeus in 1753, is common in the British Isles and is rare to frequent in Europe (Löve 1954, Small 1938). In 1849, Gattinger discovered the species in Roane County, Tennessee (Maxon 1900); in 1857, Hincks found it in Grey County, Ontario, Canada (Soper 1954). In 1953, Hall and Hagenah discovered the species growing in Chippewa County, Michigan (Hagenah 1953). Osterlund, Batchelder, and Short discovered it in Jackson County, Alabama, in 1979 (Batchelder 1979, Short 1979).

Fernald described the taxon *Asplenium (Phyllitis) scolopendrium* var. *americanum* in 1935. He distinguished it from the European variety on the basis of several distinct morphological features. These features include smaller fronds (3.5 to 23.5 inches [9 to 60 cm]) versus 4.25 to 13.5 inches [11 to 34 cm]), fewer and shorter indusia (coverings over the sori), the presence of elongate tips on frond veinlets, and the distance of the veinlets from the edge of the frond (Fernald 1935).

Britton (1953) determined that, in addition to the morphological characters described by Fernald, the North American representatives of *Asplenium scolopendrium* differed from European plants cytologically due to the fact that they have 144 rather than 72 chromosomes. Lellinger (1985) also notes that *Phyllitis (Asplenium) scolopendrium* var. *scolopendrium* is much more easily cultivated than is *Phyllitis (Asplenium) scolopendrium* var. *scolopendrium* var. *americana*. Löve and Löve (1973) included the

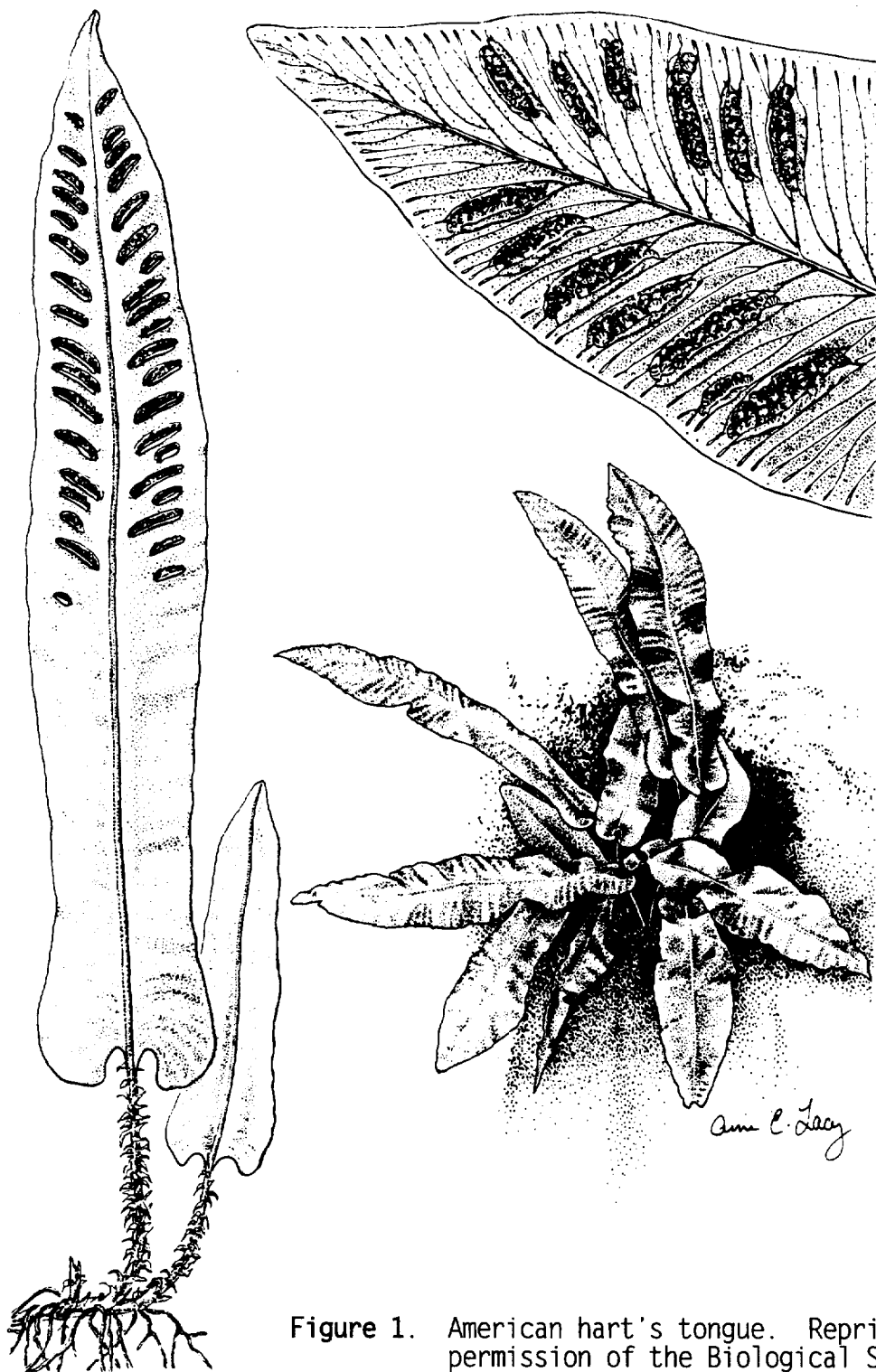


Figure 1. American hart's tongue. Reprinted by permission of the Biological Survey, New York State Museum, Albany, New York. Originally published in Ogden (1981).

American hart's-tongue within their concept of *Phyllitis japonica* Kom. and designated it ssp. *americana* (Fern.) Löve and Löve. Kartesz and Gandhi (1991) include the genus *Phyllitis* within *Asplenium*, and their treatment is followed here.

Current Status and Distribution

In North America, *Asplenium scolopendrium* var. *americanum* is found growing on or at least in close association with dolomitic limestone (limestone high in magnesium). This extremely rare fern is currently known from only seven counties in the Canadian Province of Ontario, two counties in New York, two counties in Michigan, two counties in Alabama, and one county in Tennessee. In the northern part of its range it usually occurs on or adjacent to dolomitic limestone outcrops. The southern populations are found only within limestone pits that trap cold air, have high humidity, and are well shaded. At all known locations, American hart's-tongue appears to require high humidity, shaded conditions, a moist substrate, and the presence of dolomitic limestone.

In the 183 years that have elapsed since first being discovered in North America, American hart's-tongue has remained an extremely rare taxon found in small, widely disjunct groups of populations. Concern for the continued existence of this species has long been voiced by those interested in the preservation of the flora of the United States. This concern is demonstrated in early articles by Benedict (1925) - "Saving the Hart's-tongue"; House (1934) - "Saving the Scolopendrium Fern"; and Faust (1960) - "Survival of Hart's-tongue Fern in Central New York". *Asplenium scolopendrium* var. *americanum* remains vulnerable to extinction throughout most of its range. A description of the species' status in each North American State or Province in which it occurs is provided below:

Alabama. There are two known populations of American hart's-tongue in Alabama. Both populations were discovered by cavers associated with the Huntsville Grotto of the National Speleological Society (Batchelder 1979, Evans 1982). One population occurs in a Jackson County sinkhole on lands managed as a national wildlife refuge by the U.S. Fish and Wildlife Service. Short (1979) observed 20 plants present when he first visited the site. Evans (1981) found that the population had dwindled to nine plants by July 1981. Evans further stated that this population appears, for undetermined reasons, to be in a static or declining condition. In 1990, members of the Huntsville Grotto surveyed the site and found only four plants (Huntsville Grotto 1990). In 1993 this site supported only two plants (Robert Currie, U.S. Fish and Wildlife Service, personal observation). The other population is in Morgan County, in the privately owned pit entrance to a limestone cave. This population is located about 25 miles (40 kilometers) southwest of the Jackson County population (Short 1980). Evans (1981) reported that this site contained a vigorous, healthy, reproducing population, which in 1981 supported 97 plants (26 fertile adults, 13 subadults, and

58 juveniles). Haynes Currie (*in litt.*) reports that this population had declined to about 50 plants by 1989. Members of the Huntsville Grotto resurveyed the site in 1990 and reported that the population had further declined to 39 plants, 85 percent of which had fertile fronds (Huntsville Grotto 1990). Alabama does not directly protect endangered and threatened plants. However, American hart's-tongue is protected as a form of cave life by the Alabama Cave Conservation Act of 1988.

Tennessee. Tennessee has two records of American hart's-tongue. The first of these was discovered in the entrance to a Roane County cave by Gattinger in 1849. Despite repeated searches for the plant at this site since the early 1900s, it has not been seen again and is considered to be extirpated from the area (Maxon 1900, Shaver 1954, Evans 1981). The only extant Tennessee population is in Marion County and was discovered by Cheatham in 1879 (Williamson 1879, Evans 1981). Originally supporting about 200 plants, this population contained only about 17 plants in 1980 (Evans 1981). G. Ramseur (University of the South, personal communication, 1993) reported that only one or two depauperate plants remained in 1991 and that the species may soon be extirpated from Tennessee. Early concern about the decline of this population led Graves to scatter American hart's-tongue spores at the site in 1929. The spores were obtained from a plant collected in Ontario, Canada (McGilliard 1936). There appear to be no morphological characters that distinguish Tennessee's representatives of this taxon from the Canadian representatives; therefore, without electrophoretic or other genetic analysis, it will be impossible to know the origin of the few plants that survive. From 1982 to the present time, the site has been leased by The Nature Conservancy for the express purpose of protecting this species. This species is listed in Tennessee under the Rare Plant Protection and Conservation Act. Taking without the permission of the landowner or land manager is prohibited by the Act.

Michigan. The Michigan Natural Features Inventory (MNFI) (1990) recognizes six extant occurrences of American hart's-tongue (M. Penskar, MNFI, personal communication, 1993). Five of these sites are in Mackinac County, and one is in Chippewa County. The Chippewa County site was thought to have been destroyed by collecting in 1975. However, Don Drife (*in litt.*) reports that he has observed the site since 1976. When he first visited the site there were no plants present. In 1979, he observed two immature plants. In 1988, one of these plants was found to have died. In 1992, one fertile-leaved plant remained at the site. Two of the Michigan sites are owned by the Michigan Nature Association (Association). Both of the Association's occurrences are healthy and support several hundred plants each. Two locations are on land managed by the U.S. Forest Service (Hiawatha National Forest) (Henson 1978 and Vande Kopple 1992). One population contains approximately 64 plants. To protect this occurrence, the Forest Service rerouted a trail that was proposed for the area (Voss *in litt.*). This occurrence may now be threatened by logging close to the plants (Penskar and Weise, *in*

litt.) In 1991 Janet Schultz, a Forest Service ecologist, discovered an additional population. This site was inventoried by Vande Kopple in 1992 and was found to support 532 plants. The last occurrence is on privately owned, unprotected land near the two occurrences owned by the Association. The history and biology of this species in Michigan is provided by Nepstad (1981), Futyma (1980), Hagenah (1953, 1956), and Vande Kopple (1992). American hart's-tongue is listed as endangered under Michigan's Endangered Species Act. This Act prohibits taking on all public and private lands without a permit.

New York. The plight of *Asplenium scolopendrium* var. *americanum* in New York has been carefully documented since the early 1900s (Hunter 1922, Faust 1960, Cinquemani *et al.* 1989). The delineation of individual occurrences provided here is that used by the New York Natural Heritage Program (Young *in litt.*). Their identification of occurrences is based primarily upon Faust (1960), Hunter (1922), and Cinquemani-Kuehn *et al.* (1989).

The fern is known from a limited area within Madison and Onondaga Counties. Seventeen occurrences are currently recognized by the program; three of these are in Madison County, and fourteen are or were in Onondaga County.

Five of the fourteen Onondaga County occurrences are believed to be extirpated. Three of these were destroyed by quarrying operations between 1924 and 1935 and two by undetermined means, one soon after 1959 and one in the late 1980s. Six occurrences are small and vulnerable; in 1988, they contained 39, 41, 49, 140, 271, and 371 individuals, respectively (Cinquemani *in litt.*). The remaining three occurrences are the largest in New York and indeed are the largest occurrences in the United States. These occurrences are located in a State park, and in 1988 they contained a combined total of 2,341 individuals (Cinquemani *in litt.*).

Madison County supports three occurrences. Two of these, containing 48 and 54 plants, respectively, are on unprotected, privately owned lands. The third, which contained 346 plants in 1988, is within a State park (Cinquemani *in litt.*). About half of the plants that were originally in the park were destroyed before 1980 by trail construction and subsequent erosion. Plants from one Madison County population were raised from spores and were transplanted to a site in Montgomery County in the 1940s, where 16 plants are still extant (Young *in litt.*).

In New York the species is protected under the Protected Native Plants Law. This law prohibits the removal of the fern without landowner permission. Violators are subject to a \$25 fine.

Canada. *Asplenium scolopendrium* var. *americanum* is listed as a rare species in the Atlas of the Rare Vascular Plants of Ontario (Argus and Pryer 1990). Although locally abundant in the center of its range in Grey County, it was included in the Atlas "...because most

of its world population occurs in the Province. On a continental basis, this is a very small area and all of the peripheral populations in the United States are at risk" (Dickson and White 1983). Adjacent southern Bruce County also supports healthy populations of the taxon. Much smaller and more isolated populations occur in Peel, Halton, Dufferin, and Simcoe Counties (Soper 1954, Britton *in litt.*). There is a historic occurrence located near Niagara Falls in Welland County. Soper (1954) states that these plants may have been transplanted to the site in the late 1800s. No plants have been observed there since 1925 (Dickson and White 1983).

Fernald (1970) includes New Brunswick in his description of the range of American hart's-tongue. However, Hinds (*in litt.*) states that the material collected in New Brunswick is the European variety and that the species is not believed to be native to the Province.

Life History and Habitat Requirements

Ostlie (1990) provides the following discussion of this species' life history and habitat needs (note that throughout this section the synonym *Phyllitis* is used for *Asplenium*):

Phyllitis scolopendrium var. *americana* reproduces only via spores. Sporelings apparently require the presence of cool, moist, calcareous environments for development (Crispin and Penskar 1990). Bryophytes appear crucial to the survival of *P. scolopendrium* var. *americana* sporelings (Cinquemani-Kuehn and Leopold, in review). Bryophyte beds apparently enhance seedling regeneration, providing a favorable site for fertilization, spore germination, and gametophyte growth. Reduced temperature extremes and moisture maintenance likely protect *P. scolopendrium* from desiccation during its early stages of growth. Over 80% of all sporelings observed at sites in New York occurred on bryophyte beds (Cinquemani-Kuehn and Leopold, in review).

As *P. scolopendrium* sporelings mature, they apparently out-compete bryophytes for available resources and replace them (Cinquemani-Kuehn and Leopold, in review). An indirect correlation between percent bryophyte cover and life stage of *Phyllitis* was noted in New York; the older a given hart's-tongue became, the less likely it would be found growing on bryophyte mats.

Distribution of *P. scolopendrium* is also apparently affected by herbaceous cover. Cinquemani-Kuehn and Leopold (in review) found that most adult plants were found beneath 0-25 percent herbaceous cover, while most sporelings were found beneath a higher percentage (26-50 percent) of herb cover. Few individuals of any life stage were found where herbaceous cover exceeded 75 percent. A lack of herbaceous cover over sporeling microsites typically resulted in lower

sporeling vigor. Herbs probably aid sporeling growth by maintaining humidity and preventing desiccation of sporelings and, as a result, function similarly to bryophytes. Since sporelings have no effective root system, they do not readily compete with other herbaceous plants for resources. Mature *P. scolopendrium*, however, likely compete with other herbs for resources. When mature hart's-tongue fully occupy a site, very few other herbs are present (Cinquemani-Kuehn and Leopold, in review).

The presence of shrubs is directly associated with sporeling vigor, but only indirectly with overall vigor (Cinquemani-Kuehn and Leopold, in review). Although shrubs likely create ideal germination and early lifestage growth sites, they eventually provide too much shade for maturing *P. scolopendrium*.

Positive relationships between sporeling vigor and substrate crevice depth were observed at New York sites (Cinquemani-Kuehn and Leopold, in review). Although crevice depth is apparently important in preventing desiccation during summertime droughts, it is not a factor in preventing desiccation during periods of freezing temperatures and absent snow cover.

Winter snow cover is apparently necessary for the vigor and long-term survival of a population. During periods of insufficient snow cover, *P. scolopendrium* may not be able to obtain adequate soil moisture and may be adversely affected by frost heaving (causing dislodged root system) and direct cold damage to individual plants (Cinquemani-Kuehn and Leopold 1992). In fact, distribution of this taxon in North America is apparently strongly influenced by depth of snow cover. Where populations are found in the northern United States and Canada, annual snowfalls range from 200-300 cm per year. Annual snowfalls greater than this probably persist longer into the summer and prevent individuals from obtaining enough springtime sunlight. Annual snowfall less than this amount likely leads to freeze damage (Cinquemani-Kuehn and Leopold 1992).

Slope position has been correlated with percent cover of *P. scolopendrium* at all life stages (Cinquemani-Kuehn and Leopold, in review). Individuals occur predominantly at upper and mid-slope positions, but are absent from the lower slope areas. Although significantly more nutrients are available at the lower slopes, *P. scolopendrium* growth is apparently not limited at upper slope areas. The absence of *P. scolopendrium* on lower slopes may be attributable to the lingering of winter snow during the spring at such sites (Cinquemani-Kuehn and Leopold 1992, Faust 1960).

The species appears to be able to colonize early successional habitats, as evidenced by a population found within a young *Populus* grove in Ontario (Futyma 1980). In fact, most northern populations occur in forests of secondary growth, where canopy openings are somewhat more abundant. Cinquemani-Kuehn and Leopold (in review) found a direct correlation between sporeling vigor and openings in the tree canopy. Gaps allow light and precipitation to reach sporelings during normal periods of precipitation. During drought periods or deforestation events (leaf miners, gypsy moths), however, sporelings growing directly beneath the openings are likely injured by higher light intensities (Cinquemani-Kuehn and Leopold, in review; Crispin and Penskar 1980). Sporelings growing under the edges of canopy openings receive adequate light and precipitation amounts and are also protected from desiccation during drought periods (Cinquemani-Kuehn and Leopold, in review).

Phyllitis scolopendrium rarely occur beneath conifers in New York (Cinquemani-Kuehn and Leopold, in review) and Michigan (Futyma 1980). When present, the most prominent conifer in New York was *Tsuga canadensis* (Cinquemani-Kuehn and Leopold, in review). The hart's-tongue is probably restricted from the areas of conifers by a number of factors:

- (1) concentrations of magnesium, calcium, potassium, percent nitrogen and organic matter were lower under conifers,
- (2) reduction of light intensity reaching *P. scolopendrium* under *Tsuga* in comparison to hardwood sites during early spring,
- (3) lack of protective winter snow beneath conifers, and (4) lack of bryophytes for sporeling germination sites beneath conifers (Cinquemani-Kuehn and Leopold, in review).

Fronds of the hart's-tongue remain green and functional throughout the winter and following growing season (Crispin and Penskar 1990). New fronds are produced at the start of each growing season and likewise remain functional for two growing seasons. In Michigan, new fronds typically emerge in mid-June. Spores are produced on year-old fronds from May through August (MNFI 1990).

Current Threats

American hart's-tongue is threatened throughout most of its range by trampling, habitat alteration, destruction by timber removal, quarrying, and residential development (Evans 1981, Nepstad 1981). The southern populations are especially vulnerable to extirpation by inadvertent trampling because of their small size and the steep, precarious nature of their habitat. Short (1979) reports that between October 21, 1978, and November 24, 1978, one of the 20 plants that occurred at the Jackson County, Alabama, site was destroyed by someone who had apparently slid off the main trail and onto the plant. Evans (1981) reports that in July 1981 only nine plants

remained at this location. Quarrying operations destroyed three of New York's populations, and quarrying remains a threat to at least one of the remaining New York sites and two of the southern sites (Clemants *in litt.*, Evans 1981). Timber removal at most of the sites would be expected to raise light levels and lower humidity levels to the detriment of the species. Alterations associated with residential or other development would, in most cases, either directly destroy the plants present or result in environmental changes that would make the sites unsuitable. Britton (*in litt.*) stated that lumbering, quarrying, or other types of development are the most significant threats to the Ontario populations of the species.

Commercial trade in *Asplenium scolopendrium* var. *americanum* is limited. The material currently in trade is believed to be of cultivated origin and not obtained from the wild. The original source of this material was one of the New York populations destroyed in the early 1900s by quarry operations (S. Clemants, New York Natural Heritage Program, personal communication, 1988). Most of the populations in New York, Michigan, Alabama, and Tennessee are much too small to support any collecting for scientific purposes, for fern enthusiasts, or for other reasons. Inappropriate collecting of entire plants remains a threat to these populations (Nepstad 1981). The larger Ontario populations have withstood, apparently without ill effects, low levels of collecting for some time (Pryer *in litt.*).

Because of climatic changes, the southern populations of the species are restricted to extremely rare sites with physical environments similar to conditions under which the northern plants grow. During the Wisconsin Glacial Period, the species may have been more widespread in southern limestone areas, but as the climate has warmed, it has become restricted to a few sites in or near caves (Evans 1982).

Crispin (personal communication, 1986) reports that in 1985 an infestation of leaf miners destroyed the leaves on the trees above one of the Michigan sites. The loss of shade that resulted from this alteration of the canopy desiccated many of the ferns growing on the forest floor. Insect infestations that temporarily remove the leaves of the canopy or result in long-term damage to the trees found there remain a potential threat to the species.

PART II

RECOVERY

A. Recovery Objectives

American hart's-tongue (*Asplenium scolopendrium* var. *americanum*) will be considered for delisting when there are at least 15 self-sustaining populations of the species in the United States (2 in Alabama, 2 in Tennessee, 4 in Michigan, and 7 in New York), which are protected to such a degree that the species no longer qualifies for protection under the Endangered Species Act. A self-sustaining population is a reproducing population that is large enough to maintain sufficient genetic variation to enable it to survive and respond to natural habitat changes. It must also occur within a sufficiently large area to ensure that, to the extent possible, natural processes within its habitat can continue without adversely affecting the population and that active management required to maintain suitable habitat is minimal. The number of individuals necessary and the quantity and quality of habitat needed to meet these criteria will be determined as one of the recovery tasks.

These recovery objectives are considered an interim goal. Because of the lack of specific data on genetic diversity, biology, and management requirements of the species, the recovery objectives may be modified at a later date as additional information is acquired. This information may permit refinement of the estimate of populations required to ensure the continued survival of American hart's-tongue. This objective will be reassessed at least annually in light of any new information that becomes available.

The first step toward recovery will be protection and management of all extant populations to ensure their continued survival. Little is known about the specific biological and habitat requirements of this species. Therefore, it will be necessary to conduct detailed genetic and demographic studies and ecological research for the purpose of gaining the understanding needed to develop appropriate protection and management strategies. The ultimate effects of various kinds of habitat disruption must be determined and, if necessary, prevented. Active management may be required to ensure continued survival and vigor. Therefore, American hart's-tongue shall be considered for removal from the Federal list when the following criteria are met:

1. It has been documented that at least 15 populations in the United States (2 in Alabama, 2 in Tennessee, 4 in Michigan, and 7 in New York) are self-sustaining and occur on sufficiently large tracts to ensure their perpetuation with a minimal amount of active management.

2. All of the populations and their habitat are protected from present and foreseeable human-related and natural threats that may interfere with the survival of any of the populations.

B. Narrative Outline

1. Protect existing populations and essential habitat. Only 21 populations of American hart's-tongue are currently known to exist in the United States. Until more is known about the species' biology, genetic diversity, and specific habitat requirements, and the measures necessary to protect the integrity of occupied sites, all existing populations must be protected. The long-term survival of 15 populations in four States is believed to be essential to the perpetuation of the species as a whole.
 - 1.1 Develop interim research and detailed site-specific management plans in conjunction with landowners.
 - 1.2 Search for additional populations and characterize all known populations. Several intensive searches have been conducted within the known range of American hart's-tongue. However, a thorough, systematic effort to locate additional populations and to carefully describe the nature of the habitat occupied by the species is needed. Searches should be preceded by an examination of soil, geologic and topographic maps, and aerial photographs to determine potential habitat and to develop a priority list of sites to search. Quantitative and qualitative characterization of all sites must be made. Methods used should follow Cinquemani *et al.* (1989) and Cinquemani-Kuehn and Leopold (in review, 1992).
 - 1.3 Determine protection priorities. Because of the small number of existing populations and the pervasive threats to the habitat, it is essential to protect as many populations as possible. However, efforts should be concentrated first on the sites in public ownership, or where current private landowners are cooperative, and where the largest and most vigorous populations occur.
 - 1.4 Implement habitat protection alternatives. The greatest possible protection must be obtained for most existing populations since all may be critical to the recovery of the species. Fee simple acquisition or conservation easements provide the greatest degree of protection. However, it is unknown as yet how much buffer land around each population is necessary to protect the integrity of occupied sites. Protection through management agreements or short-term leases may provide

adequate short-term protection but can only be considered as an intermediate step in the process of ultimately providing for permanent protection. Short-term protection strategies may be necessary if private landowners are not agreeable to or monies are not available for acquisition of conservation easements or fee simple title. Conservation agreements with adjacent landowners or owners of rights-of-way (power companies, highway departments, etc.) must be developed to prevent inadvertent adverse alterations of the habitat. This task should be initiated by formally contacting all landowners and notifying them of the presence of the species, its vulnerability, and the need to protect it from adverse activities.

2. Determine and implement management necessary for long-term reproduction, establishment, maintenance, and vigor. Protection of the species' habitat is the obvious first step in ensuring its long-term survival, but this alone may not be sufficient. Habitat management may be necessary to allow the species to perpetuate itself over the long term. However, since relatively little is known about this species, information on its genetic diversity, population biology, and ecology is necessary before effective management guidelines can be formulated and implemented.
 - 2.1 Determine population size and stage-class distribution for all populations. Population size and stage-class (size) distribution data are essential to predicting what factors may be necessary for populations to become self-sustaining (Menges 1987). Such data are needed for existing populations and for any newly discovered populations. This task should be combined with the work described under Task 1.2. This will ensure that funds are utilized in the most efficient manner.
 - 2.2 Study abiotic and biotic features of the species' habitat. An understanding of the nature of the habitat occupied by the species is essential to the long-term survival and recovery of American hart's-tongue. Required monitoring studies will include populations within a wide range of habitats, both altered and undisturbed. Permanent plots will be selected and established to determine the relationship between abiotic factors (such as soil depth and type, soil moisture content, and light intensity) and biotic factors (such as reproduction, germination, and degree of competition and predation). This information is necessary to determine the appropriate timing and type of management needed to ensure the continued vigor of existing populations and to accurately select good potential sites for reintroduction if necessary.

Special emphasis will be placed on determining the nature of the biotic and abiotic factors that permit the continued presence of the species at the southern sites in Alabama and Tennessee. Potential competition from other species, including exotics, will be examined.

- 2.3 Conduct long-term demographic studies and determine genetic variability within and between populations. Long-term demographic studies must be conducted in permanent plots located within each study site established for habitat analysis. Plots should be visited annually, for at least 4 consecutive years. The locations of individual plants of all stage-classes should be mapped; data collected should include overall plant size and the number and size of leaves. Larger plots, surrounding each of the smaller, more intensively measured and mapped plots, should be monitored for sporeling establishment. Sporelings should be mapped and measured. Any changes in the habitat within each plot (soil disturbance, increases or decreases in light intensity, moisture, etc.) should be noted at each visit. Through isozyme analysis, the degree of genetic variability within and between populations should be determined. This information will be essential to the determination of the location, distribution, and number of populations that need to be protected to ensure the long-term survival of the species. All monitoring must be conducted in a manner that eliminates or significantly reduces adverse impacts on the populations being studied.
- 2.4 Determine the effects of past and ongoing habitat disturbance. Establishment and long-term monitoring of permanent plots may be the most effective means of assessing the effects of disturbance. Appropriate methodology for this must be determined but will likely include measurement of many of the parameters specified in Tasks 2.2 and 2.3.
- 2.5 Define criteria for self-sustaining populations and determine the size of the area needed to protect each population. Currently, there is insufficient data to determine what this species requires in order for populations to be self-sustaining and how large an area is needed to allow natural processes to continue without adversely affecting the size and health of the species' population as a whole. Research as described under Tasks 2.2 through 2.4 should provide the information needed to protect and, if necessary, manage occupied habitat so that the continued survival of healthy populations is assured.

- 2.6 Implement appropriate management techniques as they are developed from previous tasks.
- 2.7 Develop techniques and reestablish populations in suitable habitat within the species' historic range. Techniques for propagation and transplantation of this species must be summarized and disseminated to appropriate organizations and individuals. Reintroduction efforts will have to be conducted in cooperation with knowledgeable personnel at private nurseries, botanical gardens, and the Center For Plant Conservation. When established, transplant sites in suitable habitat must be closely monitored to determine success and to adjust methods of reestablishment.
3. Maintain cultivated sources for the species and provide for long-term maintenance of selected populations in cultivation.
4. Enforce laws protecting the species and/or its habitat. Ferns are collected from the wild and sold as ornamentals. American hart's-tongue is not currently known to be a significant part of this trade, but this could become a threat in the future. The Endangered Species Act prohibits taking of the species from Federal lands without a permit and regulates trade. Section 7 of the Act provides additional protection of the habitat from impacts related to federally funded or authorized projects. In addition, for listed endangered plants, the 1988 amendments to the Act prohibit: (1) their malicious damage or destruction on Federal lands and (2) their removal, cutting, digging, damaging, or destruction in knowing violation of any State law or regulation, including State criminal trespass law.

Asplenium scolopendrium var. *americanum* is listed as endangered under Michigan's Endangered Species Act and Tennessee's Rare Plant Protection and Conservation Act. In Michigan, taking without a permit is prohibited on all public and private lands; in Tennessee, taking is only restricted when the permission of the landowner or manager has not been obtained. In New York, the species is protected under the Protected Native Plants Law, which states that removal of the fern without the landowner's permission is a violation of the law and subjects the violator to a \$25 fine. In Alabama, hart's-tongue is protected as a form of cave life by the Alabama Cave Conservation Act of 1988.

5. Develop materials to inform the public about the status of the species and the recovery plan objectives. Public support for the conservation of American hart's-tongue could play an important part in encouraging landowner assistance and conservation efforts. This is especially true for the populations that occur in areas being adversely affected by

development associated with expanding urban areas. Information materials must not identify the plant's locations so as not to increase the threat of taking. Cooperative education efforts with groups such as the National Speleological Society and its member grottos, native plant societies, and the Garden Club of America should be initiated.

- 5.1 Prepare and distribute news releases and informational brochures. News releases concerning the status and significance of the species and recovery efforts should be prepared and distributed to major newspapers in the range of the species, as well as to smaller newspapers in the vicinity of the species' habitat.
- 5.2 Prepare articles for popular and scientific publications. The need to protect the species in its native habitat and cooperation among local, State, and Federal organizations and individuals should be stressed. Scientific publications should emphasize additional research that is needed and solicit research assistance from colleges and universities that have conducted studies on this or closely related species.
6. Annually assess the success of recovery efforts for the species. Review of new information, evaluation of ongoing actions, and redirection, if necessary, is essential for assuring that full recovery is achieved as quickly and efficiently as possible.

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PART III
IMPLEMENTATION SCHEDULE

Priorities in column one of the following implementation schedule are assigned as follows:

1. Priority 1 - An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.
2. Priority 2 - An action that must be taken to prevent a significant decline in species population/habitat quality or some other significant negative impact short of extinction.
3. Priority 3 - All other actions necessary to meet the recovery objective.

Key to Acronyms Used in This Implementation Schedule

FWS - U.S. Fish and Wildlife Service
TE - Endangered Species Division of the U.S. Fish and Wildlife Service
LE - Law Enforcement Division of the U.S. Fish and Wildlife Service
PA - Public Affairs Office of the U.S. Fish and Wildlife Service
RW - Refuges and Wildlife Division of the U.S. Fish and Wildlife Service
CPC - Center for Plant Conservation
FS - U.S. Forest Service
MNA - Michigan Nature Association
SCA - State Conservation Agencies, including the following: Alabama Natural Heritage Program, New York Department of Environmental Conservation, New York Office of Parks, Recreation and Historic Preservation, Michigan Natural Features Inventory, and Tennessee Department of Environment and Conservation
TNC - The Nature Conservancy

AMERICAN HART'S-TONGUE IMPLEMENTATION SCHEDULE

Priority	Task Number	Task Description	Task Duration	Responsible Agency		Cost Estimates (\$000's)			Comments
				FWS	Other	FY1	FY2	FY3	
1	1.1	Develop research/management plans.	2 years	R3, 4, and 5/TE and RW	FS, MNA, SCA, TNC	10.0	10.0		
1	1.3	Determine priorities.	1 year	R3, 4, and 5/TE	SCA		5.0		
1	1.4	Implement protection.	3 years	R3, 4, and 5/TE and RW	FS, MNA, SCA, TNC	20.0	20.0	20.0	Doesn't include acquisition costs.
1	2.2	Study habitat.	4 years	R3, 4, and 5/TE	FS, SCA	15.0	15.0	15.0	Expansion of work conducted in New York.
1	2.3	Demographic and genetic studies.	4 years	R3, 4, and 5/TE	FS, SCA	30.0	15.0	15.0	Combine with Task 2.2.
1	2.5	Define self-sustaining and buffer areas.	1 year	R3, 4, and 5/TE	SCA			10.0	
1	2.6	Implement management.	Ongoing	R3, 4, and 5/TE and RW	FS, MNA, SCA, TNC	???	???	???	
1	3	Protect genetic material.	1 year	R3, 4, and 5/TE	CPC, SCA	13.2			
1	4	Enforce laws.	Ongoing	R3, 4, and 5/TE, LE, and RW	FS, SCA				No additional costs.
2	1.2	Search for new populations.	3 years	R3, 4, and 5/TE	SCA	15.0	15.0	15.0	
2	2.1	Characterize populations.	2 years	R3, 4, and 5/TE	FS, SCA	10.0	10.0		
2	2.4	Determine effects of disturbance.	Ongoing	R3, 4, and 5/TE	FS, MNA, SCA, TNC	5.0	5.0	5.0	

AMERICAN HART'S-TONGUE IMPLEMENTATION SCHEDULE (continued)

Priority	Task Number	Task Description	Task Duration	Responsible Agency		Cost Estimates (\$000's)			Comments
				FWS	Other	FY1	FY2	FY3	
2	2.7	Reestablish populations, if necessary.	Unknown	R3, 4, and 5/TE	CPC, SCA, TNC	???	???	???	No additional costs.
2	6	Assess recovery success.	Ongoing	R3, 4, and 5/TE	SCA				No additional costs.
3	5.1	News releases/brochures.	3 years	R3, 4, and 5/TE, PA	FS, SCA	5.0	5.0	5.0	
3	5.1	Prepare articles.	Ongoing	R3, 4, and 5/TE, PA	SCA				No additional costs.

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