

*Conservation Assessment
for
Cooper's Milkvetch (Astragalus Neglectus) (T & G) E. Sheld.*



Photo: Emmet J. Judziewicz

USDA Forest Service, Eastern Region

February 2003

Jan Schultz
2727 N. Lincoln Rd
Escanaba, MI 49829
906-228-8491



This Conservation Assessment was prepared to compile the published and unpublished information on Astragalus neglectus (Cooper's milkvetch). This is an administrative study only and does not represent a management decision or direction by the U.S. Forest Service. Though the best scientific information available was gathered and reported in preparation for this document, then subsequently reviewed by subject experts, it is expected that new information will arise. In the spirit of continuous learning and adaptive management, if the reader has information that will assist in conserving the subject taxon, please contact the Eastern Region of the Forest Service Threatened and Endangered Species Program at 310 Wisconsin Avenue, Milwaukee, Wisconsin 53203.

Table of Contents

INTRODUCTIONS/OBJECTIVES..... 4
ABSTRACT..... 4
ACKNOWLEDGEMENTS 4
NOMENCLATURE AND TAXONOMY 5
SPECIES DESCRIPTION..... 6
DISTRIBUTION AND ABUNDANCE 7
HABITAT AND ECOLOGY..... 9
PROTECTION STATUS..... 11
LIFE HISTORY 12
POTENTIAL THREATS..... 13
POPULATION VIABILITY AND PROTECTION 14
RESEARCH AND MONITORING..... 15
SUMMARY 16
LITERATURE AND CITATIONS..... 17
CONTACTS 20

INTRODUCTIONS/OBJECTIVES

The National Forest Management Act and U.S. Forest Service policy require that Forest Service lands be managed to maintain viable populations of all native plant and animal species. A viable population is one that has the estimated numbers and distribution of reproductive individuals to ensure the continued existence of the species throughout its range within a given planning area. In addition to those species listed as endangered or threatened under the Endangered Species Act, or Species of Concern by the U.S. Fish and Wildlife Service, the Forest Service lists species that are sensitive within each region (Regional Forester Sensitive Species List). The objectives of management for sensitive species are to ensure their continued viability throughout their range on National Forest lands, and to ensure that they do not become threatened or endangered because of Forest Service actions.

Astragalus neglectus is a Regional Forester Sensitive Species for the Eastern Region on the Monongahela National Forest in West Virginia and the Hiawatha National Forest in Michigan. It also occurs in two counties within the informal proclamation boundary of the Finger Lakes National Forest in New York.

Cooper's milkvetch is a widely distributed but poorly documented legume of the northeastern United States and adjacent Canada (Sather 1999, Web-3). There has been little fieldwork directed toward this particular species, possibly due its somewhat weedy appearance.

The objectives of this conservation assessment are (1) to review and compile currently known information on the biology, status and distribution of *Astragalus neglectus* (T. & G.) E. Sheld; and (2) to identify the information needed to develop a strategy to conserve this species. This is an administrative study only and does not include management direction or commitment.

ABSTRACT

This Conservation Assessment provides information regarding *Astragalus neglectus* (Torr. & Gray) Sheldon (Cooper's milkvetch) including its distribution, life history, habitat and range, status, and ecology. *Astragalus neglectus* occurs from Saskatchewan south to South Dakota, east to Virginia, and north to New York and Ontario. This species is uncommon and local in distribution over the eastern portion of its range. 1988). *Astragalus neglectus* preferred habitat is marshy to dry open clearings preferably on limestone or calcareous soils (Voss 1985), and recently disturbed soils in forests, fields or prairies (Sather 1999, Web-3). It is experiencing a decline in the western portion of the Great Lakes Region, where lakeshore and grassland habitats are selectively exploited (Coffin & Pfanmuller 1988).

ACKNOWLEDGEMENTS

Outside Reviewers

We would like to thank our academic reviewers and agency reviewers outside of the United States Forest Service for their helpful comments on this manuscript.

Nancy Sather, Botanist/Ecologist, Minnesota Natural Heritage & Nongame Research She was extensively involved with field surveys for Cooper's milkvetch in Minnesota and wrote a status report for this species in 1998.

National Forest Reviewers

We also thank our internal National Forest reviewers for their suggestions and corrections and for providing element occurrences for their National Forests.

Jan Schultz (Hiawatha), Jan Garrett (Monongahela), Diane Burbank (Finger Lakes), and Brad Nelson (Allegheny)

Herbarium and Heritage Data

We appreciate the sharing of occurrence information for this species from Heritage personnel both in the United States and Canada, along with the helpful assistance of Herbarium personnel. See Contacts section at end of report for a complete list.

Editorial Committee

We thank Jan Schultz, of the Hiawatha National Forest, for her suggestions and patience through numerous revisions and Beverly Braden, contract botanist.

Literature Search

We thank Laura Hutchinson of the North Central Research Library for performing initial species inquiries and sending us relevant research articles, Jan Schultz, of the Hiawatha National Forest, for use of the extensive library of materials to begin to compile information on this species and Beverly Braden, a contract botanist, for additional literature searches at Northern Michigan University in Marquette, Michigan State University in East Lansing, and the University of Michigan in Ann Arbor.

Initial Draft

We are grateful to LeAnn Kieft, contract horticulturist with the Hiawatha National Forest, for her efforts in providing us with an original draft for this Conservation Assessment.

NOMENCLATURE AND TAXONOMY

Scientific name:	<i>Astragalus neglectus</i> (T. & G.) E. Sheld.
Order:	Fabales
Family:	Fabaceae
Common name:	Cooper's milkvetch
USDA plant code:	ASNE2
Synonyms:	<i>Phaca neglecta</i> Torr. & Gray <i>Astragalus cooperi</i> Gray

Taxonomy note: *Astragalus neglectus* has no close relatives and is placed by itself in the separate section *Neglecti* (Barneby 1964). *A. neglectus* can be distinguished by its inflated single chamber

fruiting pods more than 1 cm thick. The chromosome number for *A. neglectus* is 11 (Spellenburg 1976 cf Bowles & Betz 1988); compared to 16 for *A. canadensis* (Welsh 1960 cf Bowles & Betz 1988).

SPECIES DESCRIPTION

Astragalus neglectus can be distinguished by technical fruit characters; an ovoid shaped pod with a single chamber (Ohio DNR, Web-1). *Astragalus neglectus* has an almost shrubby appearance and blooms in June-July with creamy-white flowers.

Technical characteristics include: (Gleason & Cronquist 1952), (Britton & Brown 1970)

Form:	Erect, 1-2 ft. tall, branching
Leaves:	Compound, 8-12 inches long, without stipules
Leaflets	9-23 leaflets, thin, oblong or elliptic; often minutely pubescent beneath
Peduncles	Generally exceeds leaves
Inflorescence	8-9" long in loose racemes or spikes
Flower	White tubular pea-like flowers; calyx pubescent with blackish hairs
Fruit	Pod, 1 celled, erect, sessile, inflated, ovoid, glabrous, 6-10" long, Slightly furrowed along both sutures. Pods change from green to Mottled purple, then to chocolate brown.

Identification notes:

Especially in the western portion of its range, *Astragalus neglectus* frequently occurs in mixed populations with Canada milkvetch (*Astragalus canadensis*). Both *Astragalus* species favor similar habitats. Both have an almost shrub-like appearance with creamy-white flowers in July.

There are a number of morphological characteristics by which the two species can be distinguished. "*Astragalus neglectus* has a campulate calyx with nigrescent hairs, short triangular stipules and inflorescence bracts, simple taproot and inflated ovoid, single-chambered pods around 1 cm thick" (Bowles & Betz 1988). *Astragalus canadensis* differs by its more elongated calyx with malpighian hairs, longer clasping stipules, slender bracts, oblique rhizomes and pods less than 1 cm. thick (Bowles & Betz 1988).

During the fruiting season beginning in early August, these species are easiest to distinguish. Cooper's milkvetch has open racemes and inflated ovoid pods with a single chamber. In contrast, Canada milkvetch (*Astragalus canadensis*) has a more narrow inflorescence with a crowded head of elongate two-chambered pods. The pods of *Astragalus neglectus* rapidly change throughout the month of August from green to mottled purple, then to chocolate brown. The dark pods persist on the plant throughout the fall and winter, even after the leaves have dropped (Sather 1999, Web-3).

Since mature fruits are necessary for positive identification, some pods need to be dried without pressing to preserve their shape (Ohio DNR, Web-1).

In West Virginia *Astragalus distortus* is a relatively short plant that grows on shale barrens, whereas *Astragalus neglectus* can be up to three feet tall and grows in open limestone woodlands. Both species have one-celled fruits. *A. distortus* has blue or lilac colored flowers instead of white or yellowish (USDA FS 1997).

DISTRIBUTION AND ABUNDANCE

The historic range for *Astragalus neglectus* was “local but widely dispersed about the Great Lakes” (Sather 1999, Web-3) and “from eastern Ontario and western New York (Syracuse to the Finger Lakes and Niagara River) to northern Ohio, and northern Indiana, Michigan, western Wisconsin, interruptedly west to the headwaters of the Mississippi in Minnesota” (Barneby 1964). Historically it was listed in floras of North Dakota and South Dakota, but no herbarium collections are available (Sather 1999). In the Canadian provinces, Cooper’s milkvetch is recorded in Saskatchewan, southeastern Manitoba, and Ontario (NatureServe, Web-2).

Canada

In Ontario, Canada, 70-85% of all *Astragalus neglectus* occurrences are confined to alvars with prairie as a secondary habitat (Catling 1995). Sixty records from Ontario suggest that *A. neglectus* is “primarily a species of alvars, open woodlands, and woodland edges” (Oldham pers. comm. 1997). Approximately 85% of the alvar sites of the Great Lakes region occur near the contact line of the granitic Canadian shield upland with the Ordovician and Silurian limestone and dolomites (Catling & Brownell 1995). In Ontario the species is most common on the Bruce Peninsula in gravelly thickets and limestone barrens and on Manitoulin Island in grassy areas and open woodland on limestone (Bowles & Betz 1988). *A. neglectus* was considered too widespread for inclusion in the Ontario Rare Plants Atlas with over 60 occurrences documented in Ontario (Oldham 1997). In southeastern Manitoba there are eight occurrences near the prairie forest border in the Big Sioux and Winnipeg Valleys (Punter pers. comm. 1998).

United States (outside Great Lakes area)

The documented locations in Ohio appear to have been extirpated. Previously it was documented from 5 counties bordering Lake Erie (Bowles & Betz 1988). The sole potentially extant Ohio occurrence is the 1980 report of a population, “on an actively eroding slump bluff along the Grand River, in a area of the bluff which is mostly bare soil, largely free of vegetation. The soil is very dry and probably somewhat calcareous” (McCormac 1995).

A. neglectus is reported for South Dakota (Van Bruggen 1985) and North Dakota (Bowles & Betz 1988). However, there is no evidence of collections from either state (Larson pers. comm. 1997, Lenz pers. comm. 1998).

On the Monongahela National Forest in West Virginia, there are four occurrences of *Astragalus neglectus*; they are all located in the Petersburg quadrangle. The habitat is the dry limestone-based

soil at Cave Mountain in Grant County within a prairie-like community (Garrett pers. comm.). A recently-discovered West Virginia location is given as “Knobly Mountain Cedar Glade, Cabins” (Hutton 1989). In Virginia, there is a single station in a dry woodlands (Sather 1999).

Astragalus neglectus does not occur on the Allegheny National Forest (Hays pers. comm.); initially it was collected in Pennsylvania (1938) from disturbed habitat (Rhoads & Block 2000). There are three newly-documented Pennsylvania records which were collected on limestone ledges above the Juniata River in Blair County (Grund pers. comm. 1997). *Astragalus neglectus* occurs on the Ontario Lake Plain in Seneca and Schuyler Counties in New York, which forms a proclamation boundary for the Finger Lakes National Forest; however, it occurs on land that is not likely to be purchased by the National Forest (Burbank pers. comm. 2001). Of the 42 historic locations reported for New York (Bowles & Betz 1988) two have been recently reconfirmed. Both occurrences were on steep shale banks of large ravines in natural habitat; no new populations were found (Young pers. comm. 1997).

Great Lakes States

Michigan

In Michigan’s Upper Peninsula, this species is found most extensively on Drummond Island’s Maxton Plains and in the Cedarville area on a band of mostly Silurian bedrock. Secondary populations occur on the Garden Peninsula and the Stonington Peninsula (Rahn *et al.* 1996).

In the Upper Peninsula, *A. neglectus* is often found on alvars characterized by a thin layer of neutral to moderately alkaline sandy loam or loamy sand. Four Upper Peninsula counties and Drummond Island contain recent sites for *Astragalus neglectus*: Chippewa, Delta, Menominee, and Ontonagon County (MNFI 2002).

Only one site is known on the Hiawatha National Forest; the site is in Delta county on a wide area of Lake Michigan shoreline (12 plants) in gravel overlying limestone pavement (MNFI 1999).. There are 12 current element occurrences in the Upper Peninsula of Michigan; however Dickinson and Marquette counties both have only historic entries from July 1905 (MNFI 2002).

Astragalus neglectus was found in 11 counties in the mid to lower portion of the Lower Peninsula: Bay, Clinton, Genesee, Gratiot, Ingham, Kalamazoo, Kent, Lapeer, Presque Isle, Tuscola, Washtenaw (MNFI 2002). However, only Bay County (1979) and Presque Isle County (1996) have current records; the others would be considered historical. Clinton, Gratiot, Ingham, and Kent were all from the 1890’s. Several other Lower Peninsula counties had occurrences from the 1920’s and 1930’s (MNFI 2002).

Wisconsin

Historically, *A. neglectus* was found in eastern Wisconsin along the Lake Michigan shoreline in five counties (Bowles & Betz 1988). By 1993 only two populations remained (WI DNR 1993); by 1999 only one of an original seven populations remained on a dry ridge in Kenosha County, Wisconsin (WI DNR, Web-5, Bowles & Betz 1988).

Minnesota

In Minnesota, the species range corresponds with recent Pleistocene glaciation (Coffin & Pfannmuller 1988) and is now documented from 12 northwestern Minnesota counties (MN Herb., Web-4). Recent discoveries in Minnesota's northwestern prairie-forest border counties raises the number of documented Minnesota populations to 191, of which over 100 are vouchered at the University of Minnesota herbarium (MN Herb., Web-4) and only 13 are historic occurrences. Nearly half of the occurrences for the state occur on the White Earth Indian Reservation in Mahnomen County; Polk County (19 occurrences) is second in number of total occurrences (MN Herb., Web-4). It is likely that the species always occurred in the Minnesota counties from which it has been documented since 1988 (Beltrami, Norman, Pennington, and Red Lake). It probably was overlooked by collectors because of its similarity to *A. canadensis* during the flowering season and its habit of growing in mixed patches with that species. Without historical information on the actual frequency and abundance of the species at the prairie-forest ecotone, where it is now quite abundant, it is impossible to assess whether the species has been declining or expanding in this portion of its range. However, repeated observation at several known sites suggests that presence in the area may be transitory, often lasting less than four years (Sather pers. comm. 2002).

Astragalus neglectus may be under documented because of its coarse appearance and its strong resemblance to *Astragalus canadensis* with which often grows (Sather 1999, Web-3). More surveys are needed during fruiting season so identification can be confirmed. In Minnesota, numbers of known populations increased from 17 known sites prior to 1988 to over 150 sites when surveys were done specifically for *A. neglectus* in late summer and early fall when fruit was available to aid in identification (Sather 1999, Web-3).

HABITAT AND ECOLOGY

Astragalus neglectus is found in a variety of semi-shaded to open situations: lakeshores, stream banks, cool ravines; more rarely on limestone cliff ledges, limestone barrens, in savannas overlying limestone bedrock, or on steep, eroding shale slopes (Ohio DNR, Web-1). All known habitat descriptions have two elements in common: the species' affinity for calcareous soils and high light (Sather pers. comm. 2002). Bowles and Betz (1988) found that most occurrences were in well-drained sand or gravel borders of glacial lakes or well-drained surficial dolomite habitats. Another favored habitat is open calcareous rocky ridges and bluffs.

Canada

Astragalus neglectus occurs more frequently on alvars (71-85%) than any other habitat in Canada (Catling 1995). It is also an element of successional alvar burns. At burn sites common associates include *Carex richardsonii* and *Cirsium discolor* (Catling & Brownell 1998). The alvar type "alvar savanna-subtype oak limestone savanna" is preferred by *A. neglectus* (Catling & Brownell 1995). This alvar type is characterized by 50% incomplete canopy of bur oak (*Q. macrocarpa*) along with *Q. alba*, *Q. borealis* and *Carya ovata*. Periodic fires reduce shrub growth. In this habitat, Cooper's milkvetch (*A. neglectus*) grows in association with Canada brome (*Bromus pubescens*), robin's plantain (*Erigeron pulchellus*), bottle-brush grass (*Hystrix patula*), false melic grass (*Schizachne purpurascens*), and several *Carex* species – *Carex cephalophora*, *C. pensylvanica*, *C. siccata*

(Catling & Brownell 1995). Other habitats in Ontario are open woodlands, and woodland edges (Oldham 1997).

Michigan

In the Upper Peninsula of Michigan *A. neglectus* is often found on alvars characterized by a thin layer of neutral to moderately alkaline sandy loam or loamy sand (MNFI 1999). Only one site is known for *Astragalus neglectus* on the Hiawatha National Forest; the site is in Delta County on a wide area of Lake Michigan shoreline (12 plants) in gravel overlying limestone pavement (MNFI 1999). At the HNF site (lakeshore) the associates were *Salix sp.*, *Lobelia kalmii*, *Agalinis purpurea*, *Selaginella eclipses*, *Campanula aparinoides*, *Helenium autumnale*, and *Eleocharis elliptica* (MNFI 1999). At an adjacent Delta County site it occurs along a river alvar (MNFI 2002). At this site, *A. neglectus* occurs within the driest portion of an alvar dominated by *Andropogon scoparius* and *Poa compressa*, associates were *Hedysarum alpinum*, *Galium boreale*, *Castilleja coccinea*, *Festuca rubra*, and *Iris lacustris* (Chapman 1986).

In Chippewa and Menominee Counties in Michigan's Upper Peninsula, *A. neglectus* was found in clearings in a dry woods, a powerline clearing, and in an area recently disturbed by logging (MNFI 2002). This disturbed habitat is similar to the most recent populations found in Minnesota.

Habitat in Michigan's Lower Peninsula is described as marshy to dry, open, sometimes rocky, clearings, shores, thickets, and river banks often in calcareous sites (Voss 1985).

Wisconsin

Wisconsin habitat is described as river banks and lakeshores, especially on limestone and in disturbed forests and fields (WI DNR 1993); Cochrane and Iltis (2000) list *A. neglectus* habitat as mesic prairies. Habitat in Michigan's Lower Peninsula is described as marshy to dry open, sometimes rocky, clearings, shores, thickets, and river banks often in calcareous sites (Voss 1985).

Minnesota

In Minnesota, it is likely that Cooper's milkvetch was originally adapted to disturbance caused by intermittent fires along the prairie forest border or to disturbed ice thrust zones at the edge of lakes (Sather 1999, Web-3). In Minnesota 127 of 181 known populations occur along road rights-of-way. The majority of these sites occur in early successional microhabitats, often with exposed soil, associated with oak and aspen forests such as old logging trails (Sather 1999, Web-3). *A. neglectus* appears to be a fugitive species dependent on intermittent soil disturbance and high light levels (Sather 1998). Unlike the situation with late-successional species, these observations suggest that timber harvest, trail development, and creation of wildlife openings are unlikely to adversely affect *A. neglectus* and might even enhance the species along the prairie forest border (Sather pers. comm. 2002).

Astragalus neglectus populations within prairies in Minnesota generally occur in areas where woody invasion is periodically set back by prescribed fire, leaving a zone with a lower cover of prairie grasses and a mix of shrubby and prairie species. Natural habitats in Minnesota include mesic

prairie, brush prairie, early successional field, and open oak woodland/savanna (Mn DNR 2002). Recently discovered populations in forested areas occur most frequently in openings characterized by higher light levels or more opportunity for soil disturbance than in the surrounding closed forests (Sather 1999).

PROTECTION STATUS

Currently the official status for *Astragalus neglectus* (Torr. & Gray) Sheldon with respect to federal, state, and private agencies is:

U.S. Fish and Wildlife Wetland Code: Facultative upland species, formerly C2

Global Rank: G4 (22 Dec 1997)

Rounded Global Conservation Status Rank: G4

National Rank: N4 (28 May 1993) 4 = the species is either globally or nationally widespread, abundant, or apparently secure, but with cause for long-term concern.

Michigan: Special Concern **Minnesota:** Special Concern **Wisconsin:** Endangered

U.S. Forest Service, Regional Forester Sensitive Species: Region 9:

Species is sensitive in the Monongahela National Forest (West Virginia) and the Hiawatha National Forest (Michigan). Species is listed as (+) in the Finger Lake National Forest (New York). The definition of (+) is: Species is present within proclamation boundaries but is not designated as Regional Forester Sensitive because it is not determined to be at risk on that Forest.

Note: Bowles and Betz (1988) study of herbarium records cited just 92 historically-documented stations for *A. neglectus*. Only 12 of populations rangewide were known to be extant. At that time *A. neglectus* was proposed to the US Fish and Wildlife Service for potential placement on the federal endangered species list (Sather 1999). Later more element occurrences were found, particularly in Minnesota where an additional 166 populations were located. Therefore, it is no longer recommended for inclusion on the federal endangered species list.

State Rank: (NatureServe, W2)

IOWA	SR	PENNSYLVANIA	S1
MICHIGAN	S3	SOUTH DAKOTA	SR
MINNESOTA	S4	VIRGINIA	S2
NEW YORK	S1	WEST VIRGINIA	S1
NORTH DAKOTA	S1	WISCONSIN	S1
OHIO	S1		

A. neglectus is listed as endangered in Wisconsin and Ohio, and proposed as endangered in Pennsylvania. It is treated as historic in North Dakota and South Dakota. It is special concern in

Michigan. It was down-listed from special concern to non-listed in Minnesota because of the large number of occurrences found. As of 1998, it had no legal status in New York, West Virginia or Virginia (Sather 1998).

Definition of State Rank:

S1 = Extremely rare; typically 5 or fewer known occurrences in the state; or only a few remaining individuals; may be especially vulnerable to extirpation.

S3 = Rare to uncommon; typically 21 to 50 known occurrences; S3 ranked species are not yet susceptible to becoming extirpated in the state but may be if additional populations are destroyed.

S4 = Common; apparently secure under present conditions; typically 51 or more known occurrences, but may be fewer with many large populations; usually not susceptible to immediate threats.

SR = Reported from the state, but without persuasive documentation that would provide a basis for either accepting or rejecting the species.

Canadian Provinces: (NatureServe, W2)

National Conservation Status Rank: N3 (17 Nov 1998)

Province Conservation Status Ranks:

Manitoba – S1

Ontario – S3

Saskatchewan – SR

LIFE HISTORY

Astragalus neglectus is a perennial herb to 1.3 m; flowering June-July; fruiting late July-September with a one-celled fruit pod. Pods have been observed on plants as late as December, but the relative rate of persistence is unknown. However, it is also common to observe plants from which nearly all the pod bearing stems have been browsed after the pods are fully expanded, but while they are still green (Sather pers. comm. 2002).

Barneby (1964) reports “12-20 ovules per pod in the Section *Neglectii*, dehisced apically through the beak”. The average number of seeds per pod in a Minnesota grab sample from twenty different plants was 10.3, with a range from zero (no pods) to 21 pods. Sixty-two percent of the seeds counted in these apparently mature, brown pods, appeared to be fully developed; 20% to be undeveloped; and 18% were insect damaged. Three of the twenty pods examined contained insect larvae. In one of the pods larvae had damaged all the seeds, in another pod 66% of the seeds had been damaged by insects, and in the third case 15% of the seeds were insect damaged.

Astragalus neglectus is an early succession plant. It has been observed with mature pod-bearing plants as soon as three years after a soil disturbance event. While no systematic effort has been made to re-locate Minnesota populations, casual observations have documented the species at a single known site for as long as four years, but to be quite transitory at other locations (Sather 1998).

Minnesota populations of *Astragalus neglectus* sustain a high level of browsing and although the vector and distance of pod dispersion is not documented, deer would likely be the most reasonable vector (Sather pers. comm. 2002). These plants are frequently browsed just as the pods begin to ripen. The question remains whether these early seeds are viable and can germinate after passing through a mammal's digestive system.

Little information is available on the life cycle of *Astragalus neglectus*. However, several western species have been studied more extensively than *Astragalus neglectus*; inferences drawn from these studies would need to be tested specifically for *Astragalus neglectus*.

Kaye (1999) studied the reproductive biology of *Astragalus australis* var. *olympia* from the Olympic Mountains in Washington. This perennial *Astragalus* species grows on gravelly subalpine slopes with sparse vegetation. An average plant produces over 300 flowers but less than 150 seeds per mature plant. Plants lost most of their reproductive potential through abortion of flowers. "Ovule loss was dominated by weevil (*Tychius* sp.) damage at two out of five sites (60.9% and 49.2%), followed by seed abortion, then lack of fertilization. Exclusion of insect pollinators reduced fruit set per inflorescence (from 23.3 to 12.2%); but not seed set per fruit or seed mass" (Kaye 1999). This suggests that this species is typically outcrossed, but genetically self-compatible.

Karron (1987) investigated the pollinators of several western species of *Astragalus*. The most frequent pollination visitors were polylectic bees (*Bombus* spp., *Osmia* spp., *Anthopora* spp. and *Apis mellifera*); however, the rare *Astragalus linifolius* received significantly lower levels of pollinator visitation than the widespread *Astragalus lonchocarpus* (Karron 1987).

Another study (Karron 1989) compared *Astragalus* species of limited distribution with widespread *Astragalus* species. Restricted *A. linifolius* and *A. osterhouti* as well as wide-spread *A. lonchocarpus* are self-compatible, setting similar numbers of fruits in the self-cross and control-pollination treatments. In contrast, fruit production by widespread *A. pectinatus* was significantly lower following self rather than cross-pollination. Inbreeding depression in *Astragalus* was not evident at seed germination, but was evident in seedling biomass. In restricted *A. linifolius*, progeny produced by selfing had one-third the dry weight of progeny resulting from outcrossing. If a significant proportion of naturally occurring *A. linifolius* seeds are produced by self fertilization, many progeny would exhibit high levels of inbreeding depression (Karron 1989).

POTENTIAL THREATS

The minimum population size for long term viability is not known for this species, but many known populations are very small. The largest population sizes appear to occur where the largest number of populations also occur, suggesting that there may be a metapopulation dynamic at work. A number of Minnesota populations that have been revisited within five years of their discovery were not relocated, suggesting that the species may be somewhat transient at any given location (Sather pers. comm. 2002).

Threats are unknown, but probably overshadowing by woody species may result in succession and a displacement of this species. Recovery potential is presumed poor in Wisconsin, due to a somewhat restricted and unstable habitat (WI DNR, Web-5).

In Michigan's Upper Peninsula and adjacent Ontario, Canada open alvars are favored habitat of *A. neglectus*, but alvars are also easily colonized by several non-native species such as St. John's wort (*Hypericum perforatum*), rough-fruited cinquefoil (*Potentilla recta*), yellow hawkweed (*Hieracium pratense*) and ox-eye daisy (*Chrysanthemum leucanthemum*) (TNC 1999). Sometimes *Astragalus neglectus* occurs on lakeshores of sand and gravel overlying limestone pavement such as on the Hiawatha National Forest site. This particular site is vulnerable to moderate recreational use (MNFI 1999) and weed infestation which could be in conflict with the plant's continued success at this site.

Numbers are likely underestimated for *Astragalus neglectus* as it grows in transitory areas that are less frequently surveyed. *Astragalus neglectus* strongly resembles other species in the same genus, especially *Astragalus canadensis* with which it often grows (Sather 1999, Web-3). More surveys are needed during fruiting season so identification can be confirmed. In Minnesota, numbers increased from 17 known sites prior to 1988, to over 180 sites when surveys were done late summer and early fall so its fruit was available to aid in identification and volunteers were trained to look for this species (Sather 1999, Web-3).

In Minnesota, whole populations appear to be selectively browsed by deer just as the pods begin to ripen. It is not known whether these early green pods are already viable and if they can germinate after passing through the deer's digestive system (Sather 1998).

Particularly in Minnesota, there is the potential that road management crews would switch from mowing (which is beneficial) to herbicide use to control roadside weeds negatively impacting *A. neglectus* populations that share the road right-of-ways (Sather 1998). Another concern related to the management of *Astragalus neglectus* is that roadsides may be mowed early in the season before seed set which would also likely have a negative impact (Sather pers. comm. 2002).

POPULATION VIABILITY AND PROTECTION

Astragalus neglectus presents an interesting challenge to plant conservation. It is one of a number of rare species that occurs most commonly in disturbed habitats. This species occurs most frequently on recently burned alvars in Ontario (Catling & Brownell 1998) and road right of ways in Minnesota (Sather pers. comm. 2002). Periodic mowing of roadsides may mimic successional setbacks that formerly occurred with periodic fires by reducing competition and potentially creating bare ground for germination (Sather 1999, Web-3). Creative protection of this species may rely more on continuation of physical roadside management practices than on protection of natural habitat. This approach to protection will require pro-active coordination with all local units of government that manage highway and railroad rights-of-way in which Cooper's milkvetch occurs (Sather 1999, Web-3).

Nancy Sather (pers. comm. 2002) noted that natural populations in Minnesota have very small numbers of plants, usually between 2-10. While there is no way to know the size of historic populations as this information was seldom noted, Sather doubted whether populations this small

would be viable. Sather's suggestion was to monitor known populations on a regular basis to determine how transient this species is at a location. Sather (pers. comm. 2002) also stressed that research is needed to determine seed transportation, what percentage of mature seed is viable, whether green seed is actually viable, and what percentage of seed is insect damaged.

With a chromosome number of 11, this species is at the end of a descending aneuploid series. This reduction could reduce possible genetic combinations, likely resulting in an affinity for ecologically narrow habitats (Spellenburg 1976 *cf* Bowles & Betz 1988). Narrow or extreme habitats may in turn provide the environment for chromosomal translocations that bring about aneuploidy (Stebbine 1974 *cf* Bowles & Betz 1988).

An understanding of the current status of this species is incomplete, but it is quite rare and requires preservation. Closer monitoring of its status and certainty of identification by examining fruits may result in a more complete understanding of *A. neglectus*.

Bowles and Betz (1988) concluded that Cooper's milkvetch appears to have always been rare. They reported a decline of over 78% in extant county records and over 90% in extant site records which likely shows its transitory presence at any one site. Its transitory characteristic makes it difficult to assess abundance status, whether it is declining or expanding in its overall range (Sather 1998). It appears that *A. neglectus* is a fugitive species, dependent on intermittent soil disturbance and high light levels (Sather 1998).

RESEARCH AND MONITORING

Cooper's milkvetch is a poorly documented legume of the northeastern United States and adjacent Canada (Sather 1999, Web-3). There has been little fieldwork directed toward this species, particularly little is known about its reproductive biology. Studies similar to Karron's (1987, 1989) study of self-compatibility and inbreeding depression are needed for *Astragalus neglectus*.

Monitoring of known populations is needed. It is suspected that this species is transitory in an area, but repeated monitoring would give a clearer picture (Sather 1999). Also in question is what types of disturbance (mowing or burning) works best for this species. The role of fire needs to be investigated more thoroughly as many Canadian occurrences were in burned over alvars (Oldham 1997).

Reasons for Ongoing Concern/Management:

As recently as 1988 this species was believed to be so rare throughout its range that it was proposed to the U.S. Fish and Wildlife Service for potential placement on the federal endangered species list. Using herbarium specimens as their source of information, Bowles and Betz in a 1988 report cited only 92 historically documented stations for the species in the United States, 17 of them in Minnesota. This species was down-listed from special concern to non-listed in Minnesota's last revision of the state's endangered species list because surveys subsequent to 1988 documented an additional 166 populations in Minnesota (Sather 1999, Web-3).

Minnesota conducted surveys between 1994 to 1998; as a result of these surveys 166 new populations were found. The Minnesota County Biological Survey produced a “wanted” poster to alert government managers and private citizens throughout the species’ historic Minnesota range. This poster was displayed in government offices and at county fairs in Clearwater and Polk Counties. A field training day was held for interested volunteers to assure they could recognize the species. Sixty of Minnesota’s 188 documented records resulted from reports generated by this poster (Sather 1998). It also became clear that the return rate for field search time increased greatly if Cooper’s milkvetch searches were conducted in late August and early September. At that time of year the expanded chocolate brown pods of *A. neglectus* were visible from a distance of 25 or more meters and it was easy to distinguish from *A. canadensis* (Sather 1998).

Cooper’s milkvetch presents a challenge to plant conservation. It is one of the few rare species that occurs most commonly in disturbed habitats. Particularly in Minnesota the majority of known populations occur within road rights-of-way. Minnesota’s right-of-way populations are along township or county roads maintained by periodic mowing. It is speculated that periodic mowing mimics successional setbacks that formerly occurred from periodic fires (Sather 1999). If the county or townships switched to the use of herbicides, this would likely be detrimental to *A. neglectus* populations. However, continued protection will require pro-active coordination with all units of government that manage these roadsides. Previous experience indicates that the greatest challenge in such coordination lies in assuring that all levels of the management hierarchy and maintenance crews are kept aware of this plant’s need for special management (Sather 1999).

SUMMARY

There is a range wide trend in extant populations from extreme rarity in the east to nearly rudimentary status at the species western range limit. Based on review of historical collection data available, Bowles and Betz (1988) concluded that Cooper’s milkvetch appears to have always been rare. They reported a decline of over 78% in extant county records, and over 90% in extant site records (Bowles & Betz 1988). It is unclear whether this analysis based on herbarium specimens reflects the true situation in the field. The species may be under documented for several reasons. The species is best identified when the fruits are ripe in the months of August and September. Without area-wide searches for new populations, the true status of the species may be underestimated (Sather pers. comm. 2002). In particular, additional occurrence and distribution information would help botanists determine if there is a metapopulation dynamic operating.

Astragalus neglectus appears to be favored by natural or anthropogenically disturbed habitats. Because disturbed habitats are often not the focus of biological surveys, and because it is easily confused with its congener *Astragalus canadensis*, populations in disturbed areas may be under-documented. *A. neglectus* appears to be transient in sites at which it has been formerly documented. The vector and mechanism of seed distribution are not known so it is unclear how wide an area around previously documented populations should be searched to confirm extirpation. Specific studies are needed to address *A. neglectus* reproductive life history (Sather pers. comm. 2002).

LITERATURE AND CITATIONS

- Barnaby, R.C. 1964. Atlas of North American *Astragalus*, Part I- The Phacoid and Homaloboid Astargali. Memoirs of the New York Botanical Garden Bol. 13.
- Bowles, M.L. and R.F. Betz. 1988. A preliminary assessment of the status and distribution of *Astragalus neglectus* (T.&G. Sheldon in the United States. The Morton Arboretum. Unpublished report to USFWS, Region 3, Office of Endangered species.
- Britton, N. and A. Brown. 1970. An Illustrated Flora of Northern United States and Canada. Dover Publications, Inc. New York. p.385.
- Catling, Paul M. 1995. The extent of confinement of vascular plants to alvars in southern Ontario. Canadian Field Naturalist. 109(2) 172-181.
- Catling, P. M. & V. R. Brownell. 1995. A review of the alvars of the Great Lakes Region: distribution, floristic composition, biogeography and protection. Canadian Field Naturalist. 109(2) p. 143-171.
- Catling, P. M. & V. R. Brownell. 1998. Importance of fire in alvar ecosystems – Evidence from the “Burnt Lands”, eastern Ontario. Canadian Field Naturalist. 112(4) p. 661-667.
- Chapman, K.A. 1986. *Alpine hedsarum (Hedysarum alpinum)* discovered in Michigan. The Michigan Botanist. Vol 25. p. 45-46.
- Cochrane, T.S. and H.H. Iltis. 2000. Atlas of the Wisconsin Prairie and Savanna Flora. Tech. Bulletin No. 191. Department of Natural Resources. Madison, WI 53707
- Coffin, Barbara, and Pfanmuller, Lee. Minnesota’s Endangered Flora and Fauna. University of Minnesota Press. Minneapolis, Minnesota, 1988. p. 167.
- Dobberpuhl, J. Botanist. Wisconsin Department of Natural Resources. Personal communication by electronic mail to N. Sather, Minnesota Natural Heritage and Nongame Research Program, Minnesota Department of Natural Resources, St. Paul, MN. November 19, 1998.
- Gleason, H.A. and A. Cronquist. 1991. Manual of Vascular Plants of Northeastern United States and Adjacent Canada. New York Botanical Garden. Bronx. New York. p. 282.
- Grund, S. Botanist, Western Pennsylvania Conservancy. Pittsburgh. Personal communication by letter to N. Sather, Minnesota Natural Heritage and Nongame Research Program, Minnesota Department of Natural Resources, St. Paul, MN. February 12, 1997.
- Harmon, P.J. Botanist. West Virginia Nongame Wildlife and Natural Heritage Program, Elkins, W.V. Personal communication by electronic mail to N. Sather Minnesota Natural Heritage

- and Nongame Research Program, Minnesota Department of Natural Resources, St. Paul, MN. November, 1998.
- Hutton, E.E. 1989. Four Western Plants New to West Virginia. *Castanea* 54(3): 203-207.
- Karron, J.D. 1987. The pollination ecology of co-occurring geographically restricted and widespread species of *Astragalus* (Fabaceae). *Biological Conservation* 39 (1987) 179-193.
- Karron, J.D. 1989. Breeding systems and levels of inbreeding depression in geographically restricted and widespread species of *Astragalus* (Fabaceae). *American Journal of Botany*. 76(3): 331-340.
- Kaye, T.N. 1999. From flowering to dispersal: Reproductive ecology of an endemic plant, *Astragalus australis* var. *olympicus* (Fabaceae) *American Journal of Botany* 86(9) p. 1248-1256.
- Larson, Gary E. Curator of the Herbarium. South Dakota State University. Brookings. Personal communication by letter to N. Sather Minnesota Natural Heritage and Nongame Research Program, Minnesota Department of Natural Resources, St. Paul, MN. February 12, 1997.
- Lenz, D. Botanist. North Dakota Natural Heritage Inventory. Bismarck. Personal communication by telephone with N. Sather Minnesota Natural Heritage and Nongame Research Program, Minnesota Department of Natural Resources, St. Paul, MN. February 12, 1998.
- Love, D. and J.P. Bernard. 1959. Flora and vegetation of the Otterburne area, Manitoba, Canada. *Svensk Botanisk Tidskrift* 53: 335-461.
- McCormac, J.S. 1995. 1994 Status Survey for Cooper's milk-vetch (*Astragalus neglectus*) in Ohio. Unpublished report to US Fish and Wildlife Service, Reynoldsburg, Ohio. Ohio Department of Natural Resources, Columbus.
- Michigan Natural Features Inventory (MNFI). 1999. Element Occurrence Record for Hiawatha National Forest. Lansing, MI.
- Michigan Natural Features Inventory (MNFI). 1999. County Element List. Lansing, MI.
- Michigan Natural Features Inventory (MNFI). 2002. Electronic database of element occurrences for *Astragalus neglectus*. At: <http://web4.msue.edu/mnfi/search/>
- Oldham, M.J. 1997. Personal communication by letter to N. Sather, Minnesota Department of Natural Resources from M. Oldham, Ontario Ministry of Natural Resources. February 17, 1997.
- Punter, E. Botanist. Manitoba Conservation Data Centre. Personal communication by electronic mail to N. Sather Minnesota Natural Heritage and Nongame Research Program, Minnesota Department of Natural Resources, St. Paul, MN. November 19, 1998.

- Rahn, G., and D. Ropke, N. Taylor, G. Wallwork. 1996. A Checklist of Vascular Plants of the Sault Ste Marie Area. Sault Ste. Marie Regional Conservation Authority.
- Rhoads, A.F. and T.A. Block. 2000. The Plants of Pennsylvania: An Illustrated Manual. University of Pennsylvania Press. Philadelphia. p. 401.
- Sather, Nancy. 1998. December plant of the Month, Cooper's milkvetch (*Astragalus neglectus*). Minnesota Natural Heritage and Nongame Research Program. St. Paul, Minnesota.
- Sather, Nancy. 1998. Status survey for *Astragalus neglectus*. Minnesota Natural Heritage and Nongame Research Program. St. Paul, Minnesota
- Sather, Nancy. Personal communication by written review of *Astragalus neglectus* Conservation Assessment. Minnesota Natural Heritage and Nongame Research Program, Minnesota Department of Natural Resources, St. Paul, MN. February 13, 2002.
- The Nature Conservancy (TNC). 1999. Conserving Great Lakes Alvars. Great Lakes Program. Chicago, Illinois. p. 98.
- USDA FS. 1997. Monongahela National Forest Endangered and Sensitive Plant Field Guide. *Astragalus neglectus*.
- Van Bruggan, T. 1985. The vascular plants of South Dakota. Second Edition. Iowa State University Press. Ames.
- Voss, Edward G. 1985. Michigan Flora (part II) Cranbrook Institute of Science and the University of Michigan Herbarium, Ann Arbor, Michigan. p. 494-495.
- Wisconsin DNR. 1993. Guide to Wisconsin's Endangered and Threatened Plants. Bureau of Endangered Resources. p. 100.

CITED IN OTHER REFERENCE

- Barneby, R.C. 1964. Atlas of North American *Astragalus*, Part 1 – The Phacoid and Homaloboid Astragali. Memoirs of the New York Botanical Garden. Vol. 13.
- Spellenburg, R. 1976. Chromosome numbers and their cytotaxonomic significance for North American *Astragalus* (Fabaceae). Taxon 25: 463-476.
- Stebbins, G.L. 1974. Flowering Plants, Evolution above the Species Level. Belknap Press of Harvard University Press. Cambridge, Massachusetts.

Web Sites

- W-1. Division of Natural Areas and Preserves, Ohio Department of Natural Resources.

www.dnr.state.oh.us/odnr/dnap/Abstracts/A/astrneg1.html

W-2. NatureServe – Comprehensive Species Report – *Astragalus neglectus*. Updated October 2002, Accessed January 24, 2003. www.natureserve.org/explorer/servlet/

W-3. Sather, Nancy. Cooper's Milkvetch, Plant-of-the-Month. Winter 1999. www.stolaf.edu/depts/biology/mnps/papers/sather1999182.html

W-4. University of Minnesota Herbarium
<http://wildflowers.umn.edu/public/results.asp?search=countyck&id=1157>

W-5. Wisconsin Department of Natural Resources—*Astragalus neglectus*
<http://www.dnr.state.wi.us/org/land/er/factsheets/plants/cprmlkvt.htm>

CONTACTS

- Hiawatha National Forest, Michigan: Jan Schultz, Forest Plant Ecologist (906) 228-8491
- Monongahela National Forest, West Virginia: Janet Garrett (304) 636-1800
- Alleghany National Forest, Pennsylvania: Brad Nelson (814) 723-5150
- Alleghany NF/Brandford, Rhode Island: Michael Hays (814) 362-4613
- Finger Lakes National Forest, New York: Diane Burbank (802) 388-4362 ext. 116
- TNC-Pennsylvania Field Office: Betsy Lyman, Assistant Director of Science & Stewardship
- Library Services, North Central Research Station: Laura Hutchinson
- lhutchinson@fs.fed.us
- Minnesota Natural Heritage & Nongame Research: Nancy Sather (651) 297-4964