Conservation Assessment

for

Rough cotton-grass (Eriophorum tenellum)

M. Hays photo

USDA Forest Service, Eastern Region
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Prepared by:
Michael Hays, Botanist
Allegheny National Forest

This document is undergoing peer review, comments welcome.

This Conservation Assessment was prepared to compile the published and unpublished information on the subject taxon or community; or this document was prepared by another organization and provides information to serve as a Conservation Assessment for the Eastern Region of the Forest Service. It does not represent a management decision by the U.S. Forest Service. Though the best scientific information available was used and subject experts were consulted in preparation of this document, it is expected that new information will arise. In the spirit of continuous learning and adaptive management, if you have 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, Suite 580 Milwaukee, Wisconsin 53203.

TABLE OF CONTENTS

LIST OF FIGURES

SUMMARY

This Conservation Assessment provides a review of known information regarding the distribution, habitat, ecology and population biology of rough cotton-grass (*Eriophorum tenullum*) within its range. Special emphasis is given to Pennsylvania and in particular the Allegheny National Forest, which is the only Region 9 Forest that classifies it as a sensitive species. The range of this species extends from the east coast of Canada and the northeast U.S. west to Ontario and some of the Great Lake States with an extension west to Saskatchewan. It is very uncommon or rare in states bordering the southern part of this range, including Pennsylvania. Throughout this range, it is found in bogs or open swamp habitats, often on hummocky ground in association with Sphagnum moss.

The rarity of this species is attributed to several factors. The most significant natural factor is the narrow hydrologic conditions that place limitations on occupied habitat. There have been several threats to the survival of this species including habitat alteration through logging, agricultural uses and railroad construction. More recent significant threats include recreational use of habitat, development, invasion of noxious weed species and possibly herbivory.

There is a need to monitor known sites of occurrence and survey suitable habitats to obtain necessary baseline information needed for the management of this species. Specific topics of research that may enhance understanding of distribution, life history, habitat requirements, threats and viability may include studies in soil analysis, hydrologic conditions, light regimes and community structure.

INTRODUCTION/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 number and distribution of reproductive individuals to ensure the continued existence of the species throughout its range within a given planning area (FSM 2670.5.22). In addition to those species listed as threatened or endangered under the Endangered Species Act, or that are candidates for such listing; the Forest Service has recognized the need to implement special management direction for other rare species on the lands it administers. Such species may be designated as sensitive by the Regional Forester. The objectives of management for such 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 (FSM 2670.22).

The Eastern Region (R9) of the Forest Service updated its Sensitive Species list on February 29, 2000. Part of that process included identification of priority species for conservation assessments and strategies. *Eriophorum tenellum* is included on the R9 list for the ANF and is one of the species requiring a conservation assessment.

The objectives of this document are to review and compile currently known information on the biology, status and distribution of *Eriophorum tenellum* across its range, particularly on the ANF in Pennsylvania and to identify the information needed to eventually develop a strategy to

conserve the species. This is an administrative study only and does not include management direction or management commitment.

NOMENCLATURE AND TAXONOMY

Scientific name: *Eriophorum tenellum* Nutt.

Pertinent synonyms: *Eriophorum tenellum* Nutt. var. *monticola* Fern.

Common name(s): rough cotton-grass, fewnerved cotton-grass, filiforme cotton-grass, delicate cotton-grass.

Taxon codes: PMCYPOAOBO (NatureServe)

Size of genus: About 20 species of the north temperate and arctic zones (Gleason 1952).

Family name: Cyperaceae. Includes approximately 4000 species in about 75 genera (Gleason 1952).

Common name of family: sedge family

Major plant group: Monocotyledoneae (Monocotyledons)

PRESENT LEGAL OR OTHER FORMAL STATUS

U.S. Fish and Wildlife Service: none

U.S. Forest Service (Region 9): Regional Forester Sensitive
Definition: The Regional Forester has identified it as a species for which viability is a concern as evidenced by: 1) significant current or predicted downward trends in population numbers or density and or b) significant current or predicted downward trends in habitat capability that would reduce its existing distribution (FSM 2670.5.19).

NatureServe

Global Conservation Status Rank: G5
Definition of G5: Secure – Common, widespread and abundant globally (although it may be rare in parts of its range, particularly on the periphery). Not vulnerable inmost of its range. Typically with considerable more than 100 occurrences and more than 10,000 individuals. (All ranking definitions are from NatureServe 2000).

National Conservation Rank (United States): N? 31 July 1993)
Definition of N?: Unranked – National rank not yet assessed.

National Conservation Rank (Canada): N? (09 Aug 1993)

Subnational Rank (States and Canadian Provinces)

Status	State	Province
S1	Illinois New Jersey Pennsylvania	Saskatchewan
S2	Rhode Island	
S5		Ontario Prince Edward Island
SR	Connecticut Maine Massachusetts Minnesota New Hampshire New York Wisconsin	Newfoundland (Newfoundland Island and Labrador) New Brunswick Nova Scotia Quebec
S?	Michigan	
SU	Vermont	

Figure 1. Rank Status by States and Provinces.

Status Definitions:

S1: Critically Imperiled – Critically imperiled in the state because of extreme rarity or because of some factor(s) making it especially vulnerable to extirpation from the state (province). Typically 5 or fewer occurrences or very few remaining individuals (<1000).

S2: Imperiled – Imperiled because of rarity or because of some factor(s) making it very vulnerable to extirpation from the state (province). Typically 6 to 20 occurrences or few remaining individuals (1,000 to 3,000).

S5: Secure – Common, widespread and abundant. Essentially ineradicable under present conditions. Typically with considerably more than 100 occurrences and more than 10,000 individuals.

S?: Unranked – State (province) rank not yet assessed.

SR: Reported – Element reported in the state (province), but without a basis for either accepting or rejecting the report, or the report not yet reviewed locally. Some of these are very

recent discoveries for which the program hasn't yet received first-hand information; others are old, obscure reports.

SU: Unrankable – Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.

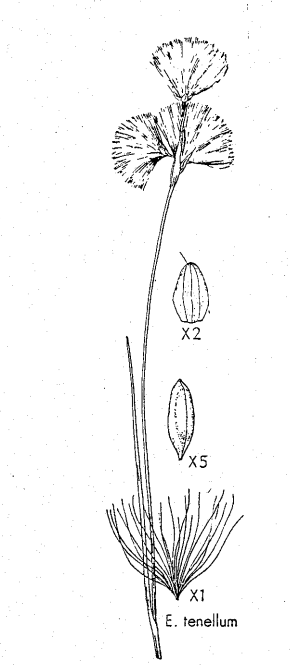
Other State Rankings:

New Jersey – E (Endangered). An endangered species is one whose prospects for survival within the state are in immediate danger due to one or many factors – a loss of habitat, over exploitation, predation, competition, disease. An endangered species requires immediate assistance or extinction will probably follow.

Pennsylvania – PE (Pennsylvania Endangered). Plant species, which are in danger of extinction throughout most or all of their natural range within this Commonwealth, if critical habitat is not maintained or if the species is greatly exploited by man.

DESCRIPTION

General nontechnical description: A perennial with a stiff and erect stem, 3-8 dm tall. The upper angles rough to touch. The leaf blades are 1-2 mm wide, channeled with the uppermost to 15 cm. The flowers are situated behind a membranous scale and have a perianth made up of bristles that are very long at maturity. The many flowers are in 3-6 terminal spikelets that form a dense cluster to give the inflorescence a head-like, cottony appearance. The involucral bracts are usually shorter than the inflorescence (Gleason 1952, Chadde 1998).



Technical descriptions: A grass-like rhizomatous perennial. Culms single, stiff and erect, obtusely trigonous, 3-8 dm tall, scabrous on the upper angles. Blades 1-2 mm wide, channeled, the uppermost up to 15 cm long, exceeding its sheath. Involucral bract leaf like, stiff and erect, usually shorter than the umbel. Spikelets 3-6, all short-peduncled in a head-like cluster, or 1 or 2 on scabrous peduncles up to 5 cm long. Scales straw-color or brown, ovate, obtuse or rounded. Anthers 3-4 mm long. Achenes brown, narrowly obovate-oblong, about 2-3 mm long; bristles sordid-white (Gleason 1952, Chadde 1998).

Local field characters: Superficially all species of cotton-grass look similar and grow in similar habitats. Though there are five species that occur in northwest Pennsylvania, only one other is documented for the ANF at this time. This species, *Eriophorum virginicum* (tawny cotton-grass) is generally larger than *Eriophorum tenellum* and has flat leaf blades that are 2-4 mm wide rather than the channeled, 1-2 mm wide blades of rough cotton-grass. The involucral bract is shorter than the inflorescence with *Eriophorum tenellum*, but longer than the inflorescence with *Eriophorum virginicum*.

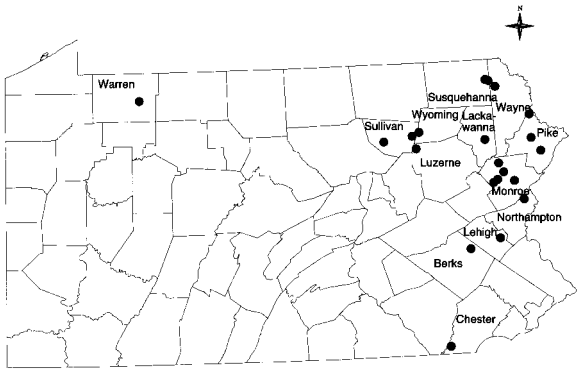
Figure 2. Drawing of *Eriophorum tenellum* (from Gleason, 1952).

The cottony bristles of *Eriophorum virginicum* are tawny or copper-colored while *Eriophorum tenellum* is sordid-white (Gleason 1952). *Eriophorum tenellum* forms fruit in June, while the more common *Eriophorum virginicum* forms fruit from August to September (Rhoads and Block 2000).

While the other species of cotton-grass in the region are not known to occur on the ANF, the presence of these is a distinct possibility. There is a need to document all populations of these species because two are listed under the Pennsylvania Wild Plant Conservation Act. Due to taxonomic similarities and difficulties in identification, technical keys and knowledgeable individuals should be consulted to correctly identify occurrences of this genus.

GEOGRAPHICAL DISTRIBUTION

Figure 3. Distribution of *Eriophorum tenellum* in Pennsylvania (Rhoads and Klein 1993).



Geographical range: *Eriophorum tenellum* is found from Newfoundland to Minnesota and south to Pennsylvania and Illinois (Gleason 1952). Though secure in most of this range it is uncommon or rare in the south. It is also found in Saskatchewan, where it is also rare (NatureServe 2000).

R9 National Forests: *Eriophorum tenellum* would be expected to occur on most of the northern National Forests of the Eastern Region. It is not recorded nor would it be expected from the Monongahela, Wayne, Hoosier, Mark Twain or Shawnee National Forests.

Allegheny National Forest: There is only one small population known to occur within the proclamation boundary of the Allegheny National Forest. This occurrence is in a bog on private land near Clarendon (Western PA Conservancy 2001). Other areas of suitable habitat can occasionally be found throughout the Forest. There are no other known occurrences in the vicinity of the ANF.

Distribution in Pennsylvania: In Pennsylvania, rough cotton-grass is mostly limited to the northeast portion of the state. The only western occurrence is the population near Clarendon within the Allegheny National Forest. It has been recorded from the following counties: Susquehanna, Sullivan, Wyoming, Lackawanna, Wayne, Pike, Luzerne, Monroe, Northampton, Lehigh, Berks, Chester, and Warren (Rhoads and Klein 1993).

GENERAL ENVIRONMENT AND HABITAT DESCRIPTION

General summary: Habitat for this species is generally described as bogs and swamps (Gleason 1952). Such areas are generally hummocky with sphagnum moss. The Allegheny National Forest location is described as a *Pinus strobus – Betula* acid savannah swamp with large sphagnum and sphagnum shrub openings between trees. Dominant shrubs are

Nemopanthus, Gaylussacia, Toxicodendron vernix, Ilex verticillata, Viburnum cassinoides, with scattered *Abies balsamifera* and *Rhododendron maxima*. The occurrence is in a sphagnum opening near the center of the bog (Western PA Conservancy 2001, Bissell 2001).

Figure 4. Photograph of *Eriophorum tenellum* habitat (M. Hays photo)

PHYSICAL CHARACTERISTICS

Climate: *Eriophorum tenellum* occurs in diverse regions with highly variable climates across the United States and Canada. The following details are provided for the ANF region only.

In the Koppen-Trewartha system (Trewartha 1968), this area is designated as Dcb, described as a cold, snowy winter climate with a warm summer. The Dcb climate has four to seven months when temperatures exceed 50°F (10°C), with no dry season. The average temperature during the coldest month is below 32°F (0°C). A short growing season imposes severe restrictions on agriculture; the frost-free season lasts from 100 to 140 days. Snow usually stays on the ground all winter. During this period, the region lies north of the main cyclonic belt; but during summer it lies within this belt, and the weather is changeable. The warm summer signified by the symbol b has an average temperature during its hottest month that never exceeds 72°F (22°C). Precipitation is ample all year, ranging from 24 to 45 inches (610 to 1,150 mm), but is substantially greater during the summer.

Measures on the northern unglaciated portion of the Allegheny Plateau, where the ANF is situated are generally slightly cooler and wetter than the region generally. Precipitation ranges from 40 to 50 inches (1020 to 1270 mm) per year, evenly distributed throughout the year. Snowfall averages from 50 to 100 inches (1270 to 2540 mm). Mean annual temperature ranges from 46 to 48°F (8 to 9°C). The growing season lasts from 120 to 150 days (McNab and Avers 1994).

Air and water requirements: According to the U.S. fish and wildlife Service wetland code (Reed 1988); *Eriophorum tenellum* is considered an Obligate (OBL) wetland species in

Regions one and three of the United States (USDA, NRCS 2001). Species designated as OBL species occur in wetlands at least 99% of the time.

Physiographic province: Across its North American range, rough cotton-grass occurs on many Physiographic provinces, but in Pennsylvania, almost all populations of *Eriophorum tenellum* occur in the Allegheny Plateau Province. It is the largest physiographic region in the Appalachian Mountains and consists of rolling uplands that appear to be flat, and rolling uplands that are cut by deep, steep valleys. The plateaus have broad, shallow anticlines and synclines that trend in a northeast-southwest direction (Cuff et al. 1989). A few scattered occurrences also occur in the Valley and Ridge Province, Piedmont Province and the New England Province within Pennsylvania (Rhoads and Klein 1993).

The Allegheny Plateau Physiographic Province is made up of several distinct sections. In Pennsylvania, the Glaciated High Plateau Section, Glaciated Low Plateau Section and the Glaciated Pocono Plateau Section are more important than others when considering the distribution of *Eriophorum tenellum.* The ANF occurrence is in the High Plateau Section. These sections are briefly described below. More complete descriptions of these and other sections of the Allegheny Plateau Physiographic Province in Pennsylvania can be found at the Pennsylvania DCNR web page (2001).

Glaciated Low Plateau: This section includes an area of diversified topography in northeastern Pennsylvania. The topography consists of rounded hills and broad to narrow valleys all of which have been modified by glacial erosion and deposition. Swamps and peat bogs are common in the eastern part of the section. The section reflects the interplay between bedrock of various types, mainly sandstones and siltstones, and glacial erosion and deposition. The more erosion-resistant rocks form the hills, while the less erosion-resistant rocks occur in the valleys. Glacial deposits, mainly glacial till or sand and gravel, may occur anywhere, but are found mainly in the valley bottoms and margins.

Glaciated High Plateau: This section consists of broad to narrow, rounded to relatively flat, elongate uplands separated in most places from the adjacent Glaciated Low Plateau section by a steep-sloped, well defined escarpment. These uplands are dissected by steep to shallow valleys. Each elongate upland corresponds to a syncline whose axis is in the approximated center of the up-land.

Glaciated Pocono Plateau Section: The Glaciated Pocono Plateau Section is a broad upland surrounded on all but its western side by a steep to moderately steep slope that marks the boundary with an adjacent Section. The upland is underlain mainly by tough, erosion resistant sandstones that are relatively flat lying. Relief on the upland is generally less than 200 feet, but can be as much as 600 feet where small hills rise above the general level of the uplands. The upland is drained by several small streams that flow from the upland interior to and away from the margins. The low relief and relative smoothness of the upland surface results from both the flatness of the underlying rock and the scouring of the surface by glacial ice. The area was glaciated at least three different times in the past million years. In addition to erosion, the most recent glacier also left behind a variety of glacial deposits that occur on the surface of the upland. Swamps and peat bogs have developed in small undrained depressions by glacial scour and deposition.

High Plateau Section: The High Plateau Section consists of broad, rounded to flat uplands cut by deep angular valleys. The uplands are underlain by flat-lying sandstones and conglomerates. Drainage of the area has a dendritic pattern. The western boundary of the Section is the Late Wisconsinan glacial border. The area between this border and the Allegheny River a few miles to the east was glaciated by pre-Wisconsinan glaciers. The Allegheny National Forest is largely situated in this Section.

As indicated, glaciation contributed to the shaping to the Pennsylvania landscape. Most recently, the Wisconsinan Glaciation covered the northeast and northwest corners of the state leaving surficial deposits of till which disrupted drainage patterns and created kettlehole lakes, bogs and extensive wetlands (Rhoads and Klein 1993). These habitats and associated areas often form prime suitable habitat for *Eriophorum tenellum*. Deposits of earlier Illinoian till occur south of the Wisconsinan border in several areas. Very few occurrences of rough cotton-grass are known south of the line of glaciation (Rhoads and Klein 1993).

Edaphic factors: The underlying rock types found in this province are residuum from sandstone, siltstone and shale with some conglomerate. The greatly varying soils include peat, muck, marl, clay, silt, sand, gravel and boulders in various combinations. Soil orders are highly variable depending upon the Physiographic sections. However, in areas of the northern Allegheny Plateau, Alfisols, Entisols, Inceptisols, and Ultisols are the dominant orders in the region. Temperature regime ranges from frigid at the summit of the plateau, to mesic in the valleys. Moisture regimes are udic and aquic (McNab and Avers 1994).

The hydric soils of the typical cotton-grass site are moist to occasionally dry upland peat and wet sphagnum with a pH of 4.0-6.5 (USDA-NRCS 2001). Such soils are usually saturated with water and deprived of oxygen. Since decomposition is typically slow in the absence of oxygen, partially decomposed plant remains tend to accumulate in areas where water movement is minimal. The resulting soil type is called a Histosol or peat. In areas where water tends to circulate, organic matter may be continuously washed away leaving soils dominated by silt and clay (Purdue University 2001).

Dependence of this taxon on natural disturbance: The dependence of *Eriophorum tenellum* on natural disturbance processes is not clearly understood. In Pennsylvania, occurrences appear to be mostly limited to appropriate, intact wetland habitats that have no significant disturbances.

BIOLOGICAL CHARACTERISTICS

Vegetation physiognomy and community structure: *Eriophorum tenellum* is limited to intact bogs and swamps or other similar wetland communities. According to Element Occurrence records for Pennsylvania, most populations in the State are situated in the openings within these appropriate habitats (PNDI 2001). Cotton-grasses in general tend to be situated in open sites.

Regional vegetation type: Under Bailey's system (1995), rough cotton-grass occurs in many regional vegetative types in the northeast United States. These ecological units are as follows:

Humid Temperate Domain
Warm Continental Division
Laurentian Mixed Forest Province
Warm Continental Division – Mountain Provinces
Adirondack-New England Mixed Forest-Coniferous Forest-Alpine Meadow
Hot Continental Division
Eastern Broadleaf Forest (Oceanic) Province
Eastern Broadleaf Forest (Continental) Province

In Pennsylvania, most occurrences of *Eriophorum tenellum* occur in the Laurentian Mixed Forest and the Eastern Broadleaf Forest (Oceanic) Provinces.

The Kuchler (1964) vegetation types for these provinces would include the Northern Hardwoods forest, which occupies the higher elevations of the Allegheny Plateau and the Appalachian Oak forest, which is more dominant in the southern part of the Pennsylvania. Eastern hemlock and American beech-hemlock forests are abundant on moist sites, while American beech-sugar maple forests are common on better-drained sites. Common associates include red maple, sweet birch, black cherry, white ash, yellow birch, eastern white pin, yellow popular, and cucumber tree (McNab and Avers 1994). Other recognized forest types might include maple-ash-oak swamp forest, wet beech forest, beech-sugar maple forest, oak-maple forest, and mixed oak forest (McNab and Avers 1994).

On the local scale, ecological landtype units are used to characterize sites. The known rough cotton-grass location within the Allegheny National Forest boundary falls in the DS3W (depression with very wet group III soils) landtype (Moriarity 1996). This landtype is described as poorly drained, deep to very deep, depression and swale landforms formed in colluvium and residuum of sandstone, siltstone, and shale. The depth to bedrock is 4 to 6 feet and a frangipan exists at 15 to 30 inches. Soils are moderately to very strongly acid. These areas are hydric and have a perched water table at 6 inches. Wetlands are common. The solum has 5 to 35% rock fragments. It is found near the heads of drainages, swales, benches, broad upland basins, and depressions on broad plateaus and is irregular or elongated in shape. No intermittent or perennial streams border on or pass through this landtype (Moriarity 1996).

Other similar and adjacent landtypes are closely intermingled in a mosaic that also may provide suitable habitat and occurrences of rough cotton-grass. These landtypes are various units in the UB (upper bottom) and FP (flood plain) types where wetlands also occur. Refer to Moriarity (1996) for descriptions of these landtypes.

Typical associated species:
Across its range, *Eriophorum tenellum* has many associated species. The site of the ANF occurrence contains the following species:

Trees: eastern white pine (*Pinus strobus*), balsam fir (*Abies balsamea*), birch (*Betula* sp.), and quaking aspen (*Populus tremuloides*).

Shrubs: mountain holly (*Nemopanthus mucronatus),* black huckleberry *(Gaylussacia baccata),* cranberry (*Vaccinium macrocarpon*), Poison sumac *(Toxicodendron vernix),* winterberry *(Ilex verticillata),* with-rod *(Viburnum cassinoides),* dewberry (*Rubus hispidus*), highbush blueberry (*Vaccinium corymbosum*), red willow (*Cornus amomum*), hardhack (*Spiraea tomentosa*) and rosebay (*Rhododendron maxima).*

Herbs: tearthumb (*Polygonum sagittatum*), boneset (*Eupatorium perfoliatum*), spotted joe-pye-weed (*Eupatorium maculatum*), jewelweed (*Impatiens capensis*), round-leaved sundew (*Drosera rotundifolia*), swamp milkweed (*Asclepias incarnata*), clubspur orchid (*Platanthera clavellata*), common cat-tail (*Typha latifolia*), bogbean (*Menyanthes trifoliata*), dwarf St.-John's-wort (*Hypericum mutilum*), spotted St.-John's-wort (*Hpericum punctatum*).

Ferns: sensitive fern (*Onoclea sensibilis*), cinnamon fern (*Osmunda cinamomea*), royal fern (*Osmunda regalis*), marsh fern (*Thelypteris palustris*).

Graminoids: wool-grass (*Scirpus cyperinus*), soft rush (*Juncus effusus*), bristly sedge (*Carex comosa*), three-way sedge (*Dulichium arundinaceum*), shallow sedge (*Carex lurida*), inland sedge (*Carex interior*), short-hair sedge (*Carex crinita*), bristly sedge (*Carex comosa*), Autumn bent (*Agrostis perennans*), fowl managrass (*Glyceria striata*), tawny cotton-grass (*Eriophorum virginicum*),

Ground Cover: sphagnum mosses (*Sphagnum* spp.), Hypnum moss (*Hypnum* sp.)

Dominance and frequency: Despite an apparent abundance of suitable habitat in western Pennsylvania, the ANF population is the only occurrence and consists of only a single stem (Western PA Conservancy 2001). Most populations in eastern Pennsylvania are also very small (PNDI 2001).

Successional phenomena: *Eriophorum tenellum* appears to have narrow hydrologic requirements being found in bogs and wetlands and on hummocky ground in such habitats. Any changes in the environment that would raise or lower the water table or close the open nature of the general habitat, would be expected to have negative impacts.

Other species of concern: *Eriophorum tenellum* is usually associated with unique or specialized habitats that are uncommon or rare. These habitats are host to an assortment of other specialist species, many of which are species of concern.

Due to extensive range and various plant communities that rough cotton-grass occurs in across the eastern United States, a list of potential associated rare species would be too extensive to include. However, a list of such species that may occur across the State of Pennsylvania could include, pod grass (*Scheuchzeria palustris*), waterberry (*Lonicera villosa*), creeping snowberry (*Gaultheria hispidula*), small yellow lady's-sliper (*Cypripedium calceolus* var. *parviflorum*), large water-smartweed (*Polygonum robustius*), bog rosemary (*Andromeda polifolia* var. *glaucophylla*), Labrador tea (*Ledum groenlandicum*), mud sedge (*Carex limosa*), few-seeded sedge (*Carex oligosperma*), few-flowered sedge (*Carex pauciflora*), many-fruited sedge

(*Carex lasiocarpa*), soft-leaved sedge (*Carex disperma*), bog bluegrass (*Poa paludigena*), and thread rush (*Juncus filiformis*) among others (Rhoads and Klein 1993).

POPULATION BIOLOGY

General summary: Generally, occurrences of *Eriophorum tenellum* are very small and obscure in areas of suitable habitat that are often large in area. Due to the similarity in habit and general appearance, it is often very difficult to distinguish or accurately count individuals of grass-like species. Identification problems with this and other similar species also make assessing populations difficult. Due to these difficulties, accurate data or even estimates on population size are generally lacking.

The species is better represented in eastern Pennsylvania where there are 16 known occurrences (PNDI 2001). However, many of these are either extirpated or have not been relocated in recent years. Population data exists only for one population. The population within the ANF proclamation boundary consists of a single stem (Western PA Conservancy 2001, Bissell 2001). Recent surveys of the site have not found additional plants.

Phenology: *Eriophorum tenellum* forms fruit in June (Rhoads and Block 2000).

Type of reproduction: Reproduction is by water-dispersed seed and through the vegetative spread of soft rhizomes.

Seed biology: The seed is in a brown achene that is narrowly obovate-oblong in shape and about 3 mm long (Gleason 1952).

POPULATION ECOLOGY

General summary: Generally populations of *Eriophorum tenellum* are small and localized. It has been observed that disturbances that alter water tables are harmful to this species (PNDI 2001). Due to the sporadic occurrence of rough cotton-grass, there is little or no quantitative data regarding the effects of herbivores, disease, competition, hybridization or allelopathy on population viability.

It is not certain if any exotic species pose a significant threat at this time. Most weedy species invade habitats not utilized by rough cotton-grass, however there are some including purple loosestrife (*Lythrum salicaria*) and Japanese knotweed (*Polygonum cuspidatum*) that do invade suitable wetland or riparian habitats. The local population of rough cotton-grass occurs in a bog that has a small infestation of purple loosestrife along a disturbed margin. Surveys of known rough cotton-grass sites or suitable habitat should note any weed species in the area that could potentially be a detriment to the native plant community.

Herbivory is not anticipated to be a significant problem to this species as species of cotton-grass are not often preferred forage of wildlife, however this needs to be assessed in the field. Indirect effects, such as recreational impacts and habitat degradation would be considered more serious threats. A final concern for the species is the small population size of some occurrences. The ANF population is very small, thus there are concerns for population

viability in the face of natural fluctuations in habitat and population structure. In addition, impacts from any potential disturbance agents would be greatly enhanced due to the small baseline population size.

CURRENT LAND OWNERSHIP

Populations occur on a variety of ownerships across the State of Pennsylvania. The single population in western Pennsylvania occurs on private land within the ANF proclamation boundary.

MANAGEMENT

The boggy and swampy habitats inhabited by rough cotton-grass generally are not sites of specific management activities. Historically, these habitats were sometimes used for transportation purposes, due to the open nature and gentle grade of the valley bottoms. Occasionally these bogs support large populations of native cranberries (*Vaccinium macrocarpon*), which may be visited by berry pickers. Numerous adjacent management activities may have indirect impacts to these habitats through changes to the water table. The potential impacts of these activities are discussed in the following section.

There are no significant past or current uses of rough cotton-grass or its habitat at the ANF occurrence. The population is found on private land, but the current management appears compatible with the long-term viability of rough cotton-grass at the site. There are no formal conservation measures in place for this species on the ANF.

EVIDENCE OF THREATS

Threatened destruction, modification or curtailment of habitat or range: Direct physical destruction of this species or its habitat probably occurred more often historically due to habitat alterations in wetlands and riparian area. Large-scale timber removal was significant early in the 1900s when harvest occurred without regard to the sensitive habitats such as those utilized by rough cotton-grass. Many areas of suitable habitat were likely drained and cleared for agricultural purposes. Numerous old railroad beds redistributed water movements, altering the hydrology of drainage bottoms. It is likely that any physical disturbance in these areas altered the preferred habitat. Natural disturbances such as fire, ice storms or tornados may rarely impact suitable habitat, but generally would not have long lasting impacts on this species.

In more recent times, wet habitats generally are protected from direct impacts that may alter the ground surface. However, any action that raises or lowers the water table could potentially impact this species due to its narrow hydrologic requirements. In eastern Pennsylvania populations have been lost or harmed through encroaching development, beavers and other factors that have altered the water table (PNDI 2000). In some areas ORV use in meadows or wet bogs for recreation is increasing. Such actions will result in loss of habitat through significant destruction of the ground surface and possible extirpation of this and other species present. The installation of oil and gas wells and pipelines may be harmful to suitable habitat.

Potentially significant modification of this species' habitat could come from invasive plant species. However, most weedy species are limited to open, dry sites such as rock pits, roadsides or waste areas and are not a threat to rough cotton-grass or its habitat. However, there are some species that do invade wetlands or swamp areas. Purple loosestrife (*Lythrum salicaria*) is found on the ANF and is likely to expand into appropriate habitats in the future. Where it occurs, purple loosestrife can significantly reduce species diversity and eliminate many native species. Additional invasive species that have potential to invade moist habitats include Japanese knotweed (*Polygonum cuspidatum*), common reed (*Phragmites australis*), reed canary grass (*Phalaris arundinacea*) and others.

Overutilization for commercial, sporting, scientific, or educational uses: Human uses of this species are very light and probably limited to a small ornamental industry that includes cotton-grasses in general. On the ANF, such use is non-existent due to the very low occurrence. *Eriophorum tenellum* is a species of concern throughout much of its southern range. As a result, its sensitive habitats are sometimes visited by concerned parties, who may make collections for educational uses or to document occurrence. It is suggested that at least one Pennsylvania population may have been extirpated through such collections (PNDI 2000).

Disease, predation, or grazing: Another potential direct impact to the species or its habitat could be through grazing pressure. Livestock or wildlife cold easily dislodge it due to shallow root depths. Concentrations of livestock in some areas may also contribute to soil compaction and alterations in site hydrology. On the ANF, livestock does not pose a significant threat to this species. However, the region's excessive deer population may pose some grazing pressure, but the extent of this threat is unknown.

Inadequacy of existing regulatory mechanisms: Fragmented ownership, such as found within the ANF boundary presents a potential problem in the conservation of this species, because private lands are not subject to most land use restrictions. Any changes in the habitat on these lands could result in loss or reduction of potential populations or the degradation of suitable habitats.

Other natural or manmade factors: The narrow habitat conditions this species seems to occupy makes it susceptible to any natural or manmade changes in its environment. This narrow existence combined with small population sizes makes it especially vulnerable.

RESEARCH AND MONITORING

Rough cotton-grass is common in parts of its range in northeast maritime North America, however in the southern portion of its range it is quite rare. In these areas there is much to learn about the distribution, biology and ecology of the species. No formal monitoring or research has taken place for the region. Monitoring the known populations in Pennsylvania and elsewhere as well as continued field searches for additional occurrences are needed to answer management questions and to obtain baseline information.

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Information Contacts

Bissell, J. personal communication. Museum of Natural History, Cleveland OH.