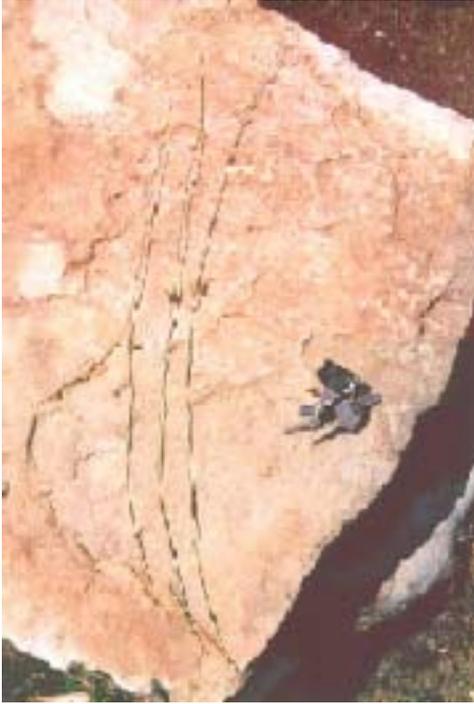


Conservation Assessment
for
Thread rush (Juncus filiformis)



Photos: M. Hays

USDA Forest Service, Eastern Region
September 2001

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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This Conservation Assessment was prepared to compile the published and unpublished information on the subject taxon or community; or this document was prepared by another organization and provides information to serve as a Conservation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.

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SUMMARY

This Conservation Assessment provides a review of known information regarding the distribution, habitat, ecology and population biology of thread rush (*Juncus filiformis*) within its range. Special emphasis is given to Pennsylvania and in particular the Allegheny National Forest. There is also applicability to West Virginia, where it occurs on the Monongahela National Forest. The ANF and MNF are the only Region 9 Forests that classifies it as a sensitive species. The range of this species is broad, extending across North America. It occurs in all provinces of Canada and most of the northern United States. It extends south through all the Rocky Mountain States. It is most rare in states bordering the southern part of its range, including Pennsylvania and West Virginia. Throughout this range, it is found in a variety of wetland and riparian habitats.

The rarity of this species is not well understood. While it occurs in many moist habitats across an extensive area, it is very sparse in distribution. There have been several potential threats to the survival of this species including habitat alteration through logging, agricultural uses, railroad construction and many others. More recent 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.

Disclaimer:

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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 plants 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 existing 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. *Juncus filiformis* is included on the R9 list for the ANF and MNF and was included with the species needing a conservation assessment.

The objectives of this document are to review and compile currently known information on the biology, status and distribution of *Juncus filiformis* across its range, particularly on the ANF in Pennsylvania and to identify the information needed to eventually develop a strategy to conserve the species. It is an administrative study only and does not include management direction or management commitment.

NOMENCLATURE AND TAXONOMY

Scientific name: *Juncus filiformis* L.

Full bibliographic citation: Sp. pl. 1:326. 1753 (Europe)

Common name(s): Thread rush, Kissinger grass.

Taxon codes: PMJUN01150 (NatureServe); JUFI (NRCS)

Size of genus: A cosmopolitan genus with about 225 species (Gleason 1952).

Family name: Juncaceae. Includes eight genera and about 300 species (Gleason 1952).

Common name of family: Rush 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: a) 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 in most 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? (01 Aug 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	Wyoming	
S2	Colorado Utah West Virginia	Alberta
S3	Pennsylvania	Prince Edward Island
S4		Ontario
S5		Manitoba
SR	Alaska Idaho Maine Maryland Massachusetts Minnesota Montana Nebraska New Hampshire New Mexico New York Oregon Vermont Washington	British Columbia Newfoundland (Newfoundland Island and Labrador) New Brunswick Northwest Territories Nova Scotia Nunavut Quebec Yukon Territory
S?	Michigan	Saskatchewan

Figure 1. Rank Status by State and Province

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).

S3: Vulnerable – Vulnerable in the state (province) either because rare and uncommon, or found only in a restricted range (even if abundant at some locations), or because of other factors making it vulnerable to extirpation. Typically 21 to 100 occurrences or between 3,000 and 10,000 individuals.

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.

Other State Rankings:

Massachusetts – T (Threatened). Threatened species are native species which are likely to become endangered in the foreseeable future, or which are declining or rare as determined by biological research and inventory.

Pennsylvania – PR (Pennsylvania Rare). Plant species, which are uncommon within this Commonwealth. All species of the native wild plants classified as Disjunct, Endemic, Limit of Range and Restricted are included writing the Pennsylvania Rare classification.

Utah – Peripheral. Plants rare or uncommon in Utah, but more common and widespread outside the state.

DESCRIPTION

General nontechnical description: A perennial rush with slender, erect stems that are clumped or arranged in rows from long rhizomes. The leaves are reduced to sheaths near the base of the plant, while the long bract appears to be a continuation of the stem and is at least half as long as the true stem. The green to straw-colored flowers are arranged in small, apparently lateral head. The light brown fruit is a capsule tipped by a short beak (Chadde 1998, Rhoads and Block 2000).

Technical descriptions: Rhizome slender, emitting stems in rows, or abbreviated with stems cespitose. Stems slender, rarely over 1 mm, finely grooved, round in section, 1-5 dm tall; surmounted by an erect, sharp-pointed, involucre bract, round in section and half to fully as long as stem, 6-20 cm. Leaves, bladeless or with a bristle-like vestige, basal

sheaths, pale brown, seldom more than 6 cm long, tight, with the top one rounded to truncate. Inflorescence a tight to open panicle, appearing lateral, sparingly branched, 1-3 cm, each primary branch 1 cm, bearing 1-4 flowers. Sepals lanceolate, 2.7-4.3 mm long, acute. Petals 2.3-4.1 mm long, acutish or obtuse. Margins of tepals chaffy; stamens 6, the anthers 0.4-0.6 mm long, shorter than the filaments; capsule light brown, 2.4-3.7 mm long, obovoid to broadly ovate, short-beaked, firm, tardily rupturing, slightly triquetrous above and slightly longer than the tepals; seeds obliquely cylindrical-ellipsoid, about 0.4 mm long, apiculate, finely and lightly reticulate-wrinkled (Gleason 1952, Hitchcock et al. 1969, Chadde 1998).

Local field characters: Several members of the genus *Juncus*, are very similar and can be very difficult to distinguish. The erect involucral bract that appears to be a continuation of the stem is the key in identifying thread rush. This feature that gives the appearance of a lateral inflorescence in many species of the genus, is nearly unique with thread rush in that its length is always at least half as long as the stem and often exceeding it.

The species most similar to thread rush in Pennsylvania is *Juncus gymnocarpus* (Pennsylvania rush). It also has a bract extending above the inflorescence that is over half as long as the stem. It is separated from *Juncus filiformis* by having a capsule that is much longer than the short (1.5-2.2 mm) sepals (Gleason 1952). The capsule of thread rush is approximately equal to the sepals. Also *Juncus gymnocarpus* is rare and local, presently known in or near Schuylkill County (Rhoads and Block 2000) in Pennsylvania. While there may be some overlap in the range of these similar species in eastern Pennsylvania, only *Juncus filiformis* extends to the western part of the state (Rhoads and Klein 1993).

Other species with the inflorescence appearing to emerge from the side of the stem include *Juncus effuses*, *Juncus inflexus* and *Juncus balticus* (Grund 2002). Thread rush can be distinguished from these species by its slender stature and very long involucral bract (Voss).



Figure 2. Drawing of *Juncus filiformis* (from Hitchcock and Cronquist 1969).

GEOGRAPHICAL DISTRIBUTION

Geographical range: In North America, thread rush has a mostly northern distribution from Alaska to Greenland and southward into New England and the Great Lakes and Rocky Mountain states (Gleason 1952). Specifically it occurs in, Alaska, Colorado, Idaho, Maine, Maryland, Massachusetts, Michigan, Minnesota, Montana, Nebraska, New Hampshire, New Mexico, New York, Oregon, Pennsylvania, Utah, Vermont, Washington, West Virginia, Wisconsin, Wyoming. In Canada it can be found in all Provinces and Territories (NatureServe 2000). It also occurs in Eurasia.

R9 National Forests: *Juncus filiformis* is widespread in its distribution across the northeast United States and thus would be expected to occur in most National Forests in the Eastern Region. It is classified as Sensitive only on the Allegheny National Forest and the Monongahela National Forest.

Allegheny National Forest: Thread rush is known from three locations along the Kinzua arm of the Allegheny Reservoir and one location along the Allegheny River below Warren (PNDI 2001). It is anticipated that other populations occur along tributary riparian areas that provided seed for these populations.

Distribution in Pennsylvania: In Pennsylvania it is very rare with most populations being found in the northeast and some in the northwest portions of the state (Rhoads and Klein 1993). The northwest populations are found Warren and McKean counties. Eastern counties include Wayne, Lackawanna, Monroe, Carbon, Northampton, and Schuylkill Counties (Rhoads and Klein 1993). See Figure 3 for the occurrence of *Juncus filiformis* in Pennsylvania.

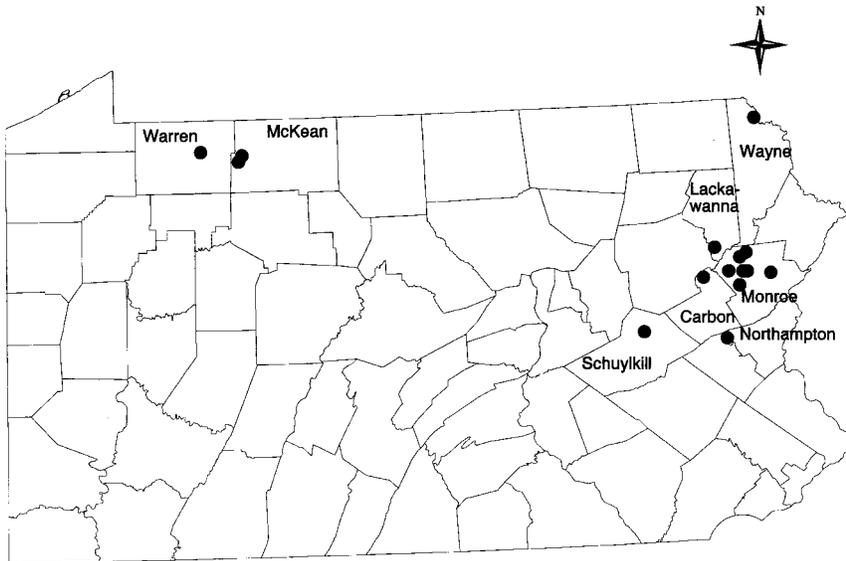


Figure 3. Distribution of *Juncus filiformis* in Pennsylvania (Rhoads and Klein 1993).

Distribution in West Virginia: *Juncus filiformis* is known from 13 locations (R9 RFSS List 1999), from Tucker, Randolph and Pleasant Counties (USDA, NRCS 2001).

GENERAL ENVIRONMENT AND HABITAT DESCRIPTION

General summary: Thread rush occupies a variety of moist or wet habitats including sandy shores of streams and lakes, bogs and alpine meadows (Gleason 1952). It prefers peaty soil types. Local populations inhabit the artificial lakeshore of the Allegheny Reservoir and the fluctuating river below the dam, where the substrates are made up of shale and sand with pebbles and cobbles (PNDI 2001). These areas are often inundated. In eastern Pennsylvania where the species is more common, it inhabits similar transitional or artificial areas, but is also found in sphagnum bogs and shrub swamps with peaty soils (PNDI 2001).



Figure 4. Photograph of *Juncus filiformis* habitat.

Thread rush often forms a distinct band of vegetation between the low plants of the lakebed and the taller wetland community behind. (M. Hays photo)

Physical characteristics

Climate: *Juncus filiformis* occurs in diverse regions with highly variable climates across the United States and Canada. The following details are provided for the local 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 remains on the ground throughout the 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); *Juncus filiformis* is considered both a Facultative Wetland (FACW) and Obligate (OBL) species. It is considered FACW in Regions 1, 3, 9 and A, and an OBL in regions 8 of the United States (USDA, NRCS 2001). Species designated as FACW have a probability of occurring in wetlands under natural conditions of 67-99%, while OBL species occur in wetlands at least 99% of the time.

Physiographic province: Across its North American range, thread rush occurs on many Physiographic provinces. In Pennsylvania, almost all populations of *Juncus filiformis* 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).

The Allegheny Plateau Physiographic Province is made up of several distinct sections. In Pennsylvania, the Glaciated Pocono Plateau Section and the High Plateau Section are most important when considering the distribution of *Juncus filiformis*. 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 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 suitable habitat for *Juncus filiformis*. Deposits of earlier Illinoian till occur south of the Wisconsinan border in several areas. Very few occurrences of thread rush 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 many thread rush 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). Other thread rush occurrences occur in a variety of soil types including sand, gravels and muck of lake and stream shores and fine depositional material and glacial till. Soils can range from inundated to seasonally dry.

Dependence of this taxon on natural disturbance: The dependence of *Juncus filiformis* on natural disturbance processes is not clearly understood. The species occurs in intact wetland communities that are free from disturbances, but also is found in areas of moving and fluctuating water levels. Such areas often possess transitional moisture and light regimes. Thus, it appears likely that physical disturbances or other mechanisms of change may contribute to the preferred habitat or possibly aid species dispersal and establishment.

BIOLOGICAL CHARACTERISTICS

Vegetation physiognomy and community structure: On the Allegheny National Forest, the known populations of *Juncus filiformis* are restricted to mudflats and shores of the Allegheny Reservoir. It is one of only a few plant species that occupies this zone, which is flooded for extended periods while the reservoir is full. It forms patches or a dense band separating this zone from the wetland vegetative community found at the immediate high water line (see Fig. 4). It is most common in this transitional area, but some plants do spread into the fringing wetland community.

In other areas thread rush is found along the edge of pools, depressions and wetlands and between the high and low water marks of streams and rivers (PNDI 2001). It would appear the species prefers such transitional areas, however it is uncertain whether this is to utilize edge influences or whether it prefers disturbances often found in such areas or both.

Regional vegetation type: Under Bailey's system (1995), thread rush occurs in many, perhaps most, regional vegetative types of the United States. Due to the wide distribution and variety of habitats thread rush may occur in, regional vegetation types would not be important when considering species occurrence. However, in Pennsylvania and West

Virginia, most occurrences would be in the Eastern Broadleaf Forest Province, Central Appalachian Broadleaf Forest – Coniferous Forest – Meadow Province and Laurentian Mixed Forest Province.

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 Pennsylvania and West Virginia. 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 pine, yellow poplar, 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. Again, due to the wide distribution and variety of habitats thread rush may occur in, there are many landtypes that could host this species. Flood plain landtypes (FP) would likely be the most common and includes most river valleys and larger stream riparian areas across the ANF. Other occurrences probably occur in UB (upper bottom), T (terrace), FS (foot slope or colluvial), and DS (depressions) slope positions (Moriarity 1996).

Typical associated species: Across North America this species can occur with too many species to list. Generally, in suitable habitats along stream and lakeshores or in various wetland types, any species could be considered a potential associate. Given its widespread, yet sparse distribution, there are probably no species that it closely occurs with and could be considered an indicator. However, there are some general associates.

Pennsylvania (PNDI 2001)

Trees: balsam fir (*Abies balsamea*), red maple (*Acer rubrum*), red spruce (*Picea rubens*), eastern white pine (*Pinus strobus*), tamarack (*Larix laricina*), hemlock (*Tsuga canadense*) and various oaks (*Quercus* sp.).

Shrubs: leatherleaf (*Chamaedaphne calyculata*), rhodora (*Rhododendron canadense*), highbush blueberry (*Vaccinium corymbosum*), sheep laurel (*Kalmia angustifolia*), cranberry (*Vaccinium macrocarpon*), swamp dewberry (*Rubus hispidus*), winterberry (*Ilex verticillata*), meadow-sweet (*Spiraea latifolia*), mountain holly (*Nemopanthus mucronata*).

Herbs (including ferns): sundew (*Drosera rotundifolia*), goldthread (*Coptis groenlandica*), cinnamon fern (*Osmunda cinnamomea*).

Graminoids: three-seeded bog sedge (*Carex trisperma*), gray sedge (*Carex canescens*), long sedge (*Carex folliculata*), tussock cotton-grass (*Eriophorum spissum*), tawny cotton-grass (*Eriophorum virginicum*), soft rush (*Juncus effusus*), fowl managrass (*Glyceria striata*).

Ground Covers: sphagnum mosses (*Sphagnum* spp.), polytrichum mosses (*Polytrichum* spp.).

ANF populations (PNDI 1989)

Local populations on the ANF are found in areas of fluctuating water and thus do not support stable plant communities. Species present are limited to those able to withstand such changing conditions or are temporary in their occurrence. Plants found on the open flats below the normal shoreline are few and limited to stunted willow (*Salix* spp.), blunt spike-rush (*Eleocharis obtusa*), swamp-candles (*Lysimachia terrestris*) and sharp-fruited rush (*Juncus acuminatus*). Thread rush also extends into the lush fringing wetland vegetation that begins at the high water line. It is less common here and is found with the above species and sensitive fern (*Onoclea sensibilis*), short-hair sedge (*Carex crinita*), shallow (*Carex lurida*), hop sedge (*Carex lupulina*), broom sedge (*Carex scoparia*), soft rush (*Juncus effusus*), reed canary-grass (*Phalaris arundinacea*), wool-grass (*Scirpus cyperinus*), dwarf St.-John's-wort (*Hypericum mutilum*), spotted St.-John's-wort (*Hypericum punctatum*), willow-herb (*Epilobium* sp.), field mint (*Mentha arvensis*) and others.

Dominance and frequency: Considering the extensive suitable habitats rangewide, *Juncus filiformis* generally is an uncommon constituent. On a more local scale, it may occasionally be abundant, but normally makes up a minor component, only occupying a small portion of the apparently suitable habitat where it occurs.

Successional phenomena: Thread rush appears to have broad hydrologic requirements being found in a wide variety of wetland or riparian habitats. Any changes in the environment that raise or lower water levels, would be expected to have negative impact on some existing plants. However, it appears the species is capable of dispersing to other suitable sites during such times. Thus it appears there are both positive and negative responses by this species to successional changes.

This ability to colonize disturbed open ground is illustrated by the ANF occurrences, which are along fluctuating artificial lakeshores and a frequently fluctuating river. Seed from plants above the high water line or from tributary streams disperses readily on the open shorelines of the Allegheny Reservoir. These plants do well on the open substrates above the low water line. However, long-term survival of these plants is probably low given the frequent long-term inundations associated with the reservoir. These populations probably expand during periods of drought when water levels remain low (PNDI 2001).

Element occurrence records for Pennsylvania (PNDI 2001) note several occurrences inhabiting transitional or artificial environments. Among those listed in the records include a former artificial lake and swamps, areas of periodic water fluctuation, degraded swamps, abandoned rock pits, remains of old skid roads, old burrow pits and along trail margins. Thread rush has also been observed to invade newly planted cranberry marshes and low empty wet areas (WSCGA 2001).

Other species of concern: *Juncus filiformis* is usually associated with riparian or various wetland habitats, some of which may be uncommon or rare and host to other

species suited to such habitats. Thus the associated plant communities often harbor many other species of concern.

Due to the extensive range and diverse habitats that *Juncus filiformis* occurs in, a list of potential associated rare species is too extensive to include. However, a partial list of rare wetland species that may occur with thread rush across the State of Pennsylvania includes: sweet-gale (*Myrica gale*), pod grass (*Scheuchzeria palustris*), waterberry (*Lonicera villosa*), small yellow lady's-slipper (*Cypripedium calceolus* var. *parviflorum*), bog rosemary (*Andromeda polifolia* var. *glaucophylla*), Labrodor 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*), rough cotton-grass (*Eriophorum tenellum*), and bog bluegrass (*Poa paludigena*) among others (Rhoads and Klein 1993).

POPULATION BIOLOGY

General summary: Most occurrences of *Juncus filiformis* are very small and obscure in areas of 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. Generally populations are small despite an apparent abundance of suitable habitat.

One of the Allegheny Reservoir populations consisted of 3 patches totaling about 100 sq. ft. when discovered in 1988. In 1991 the colony was found to be covering 200 sq. ft. with several patches of 1 to 100 sq ft. each. The second population consists of 3 or 4 scattered clumps (51-100 ramets, 2 or 3 genets) covering 5-10 sq yd. (PNDI 2001). The third population on the reservoir was discovered in 2001 and covers several thousand square feet in many small to large patches and strips. The population probably consists of 10,000s of ramets and has yet to be thoroughly surveyed. The population along the Allegheny River at Warren consisted of one dense colony, but has not been relocated since its discovery in 1980 (PNDI 2001).

Phenology: *Juncus filiformis* blooms in July to August, with fruits persisting into late summer or fall. The Allegheny populations have a variable phenology that is controlled by water levels of the reservoir. Plants found in the fringing wetland community at the high water line bloom in early July. Plants found on the mudflats below the high water line are submerged at that time and will not flower until late July or early August when the water level recedes. At this time the higher plants are with mature fruits.

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

Seed biology: The numerous seeds are obliquely cylindrical-ellipsoid, about 0.4 mm long, apiculate, finely and lightly reticulate-wrinkled. They are typically water spread from a firm, tardily rupturing capsule (Hitchcock et al. 1969).

Cultivation: This species has been observed to sometimes serve as an increaser in disturbed areas. Thus it would appear to have potential for successful cultivation for management or conservation purposes. However, use of this species for such purposes is unknown.

POPULATION ECOLOGY

General summary: Generally populations of *Juncus filiformis* are small and localized and only rarely occur across extensive areas of apparently suitable habitat. It is assumed that disturbances that alter water tables or disturb riparian areas would be harmful to this species, however there are known examples of the species readily invading disturbed areas and persisting in areas of ongoing habitat alteration. Due to the sporadic occurrence of thread rush, there is little or no quantitative data regarding the effects of herbivores, disease, competition, hybridization or allelopathy on population viability.

No native plant species appear to substantially compete with *Juncus filiformis* for space or moisture. It is not certain if any exotic species pose a significant threat at this time. Most weedy species invade habitats not utilized by thread rush, however there are some including purple loosestrife (*Lythrum salicaria*) reed canary-grass (*Phalaris arundinacea*) and Japanese knotweed (*Polygonum cuspidatum*) that do invade suitable wetland or riparian habitats. Japanese knotweed is present along the Allegheny River in the vicinity of Warren, where one occurrence of thread rush is reported. Surveys of known thread rush 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 for this species as rushes are not often preferred forage for 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. Most of the ANF populations are 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. In western Pennsylvania, the three populations on Kinzua Reservoir, though within the ANF boundary, are on lands managed by the U.S. Army Corps of Engineers. The exact location of the Warren population is not known, thus ownership cannot be determined.

MANAGEMENT

The wet habitats inhabited by thread rush generally are not sites of specific management activities. Historically, these sites were sometimes used for transportation purposes, due to the open nature and gentle grade of the valley bottoms. Any management activity that would impact the water level in wetlands or riparian areas could impact the species. The potential impacts of these activities are discussed in the following section.

Land management activities at the four ANF populations are limited by the changing water levels of the reservoir and the Allegheny River below Kinzua Dam and by general riparian use restrictions.

There is no significant use or management of thread rush itself and there are no formal conservation measures in place for this species or for the sites where it occurs on the ANF. Current management appears compatible with the long-term viability of thread rush at these locations.

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 areas. Large-scale timber removal was significant early in the 1900s when harvest occurred without regard to the sensitive habitats such as those utilized by thread rush. Many areas of suitable habitat were likely drained and cleared for agricultural purposes. Due to the sensitive water table of suitable habitats, any action impacting the ground surface would likely have harmful effects. 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 are generally 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. Potential disturbances of wetland habitats on the ANF include ORV use and installation of oil and gas wells and pipelines. Fluctuating water levels both above and below the dam are known to impact populations. However, this species has demonstrated the ability to disperse to open ground in zones of water fluctuation and may invade disturbed areas in its preferred habitat. The response of this species to disturbance needs to be more adequately assessed.

Other impacts noted in eastern Pennsylvania populations include beaver activities, recreation and the construction of homes along the edges of wetlands (PNDI 2001). Some of these activities may create disturbed or transitional habitats that may enhance some occurrences or favor dispersal of the species. However, they may also completely transform habitat through displacement or water table alteration. On the Allegheny NF, the four known populations occur in areas utilized to some degree for recreational activities. No impacts are apparent.

Potentially significant modification of this species' habitat could come from invasive plant species. Purple loosestrife (*Lythrum salicaria*) and Japanese knotweed (*Polygonum cuspidatum*) are found on the ANF and are likely to continue expanding into appropriate habitats in the future. Where they do occur, both these weeds severely reduce species diversity. Additional invasive species that have invaded moist habitats on the ANF include common reed (*Phragmites australis*), reed canary grass (*Phalaris arundinaceae*) and others.

Overutilization for commercial, sporting, scientific, or educational use: Human uses of this species are insignificant or absent. Due to its rarity there is some potential for collection by concerned parties for documentation or educational purposes.

As stated, there is some potential for ORV impacts to wetlands and moist meadows where this species occurs.

Disease, predation, or grazing: Another potential direct impact to the species or its potential habitat could be through grazing pressure. In some parts of its range, livestock may contribute to soil compaction and alterations in site hydrology, but this impact does not occur on the ANF. However, the region's excessive deer population may pose some grazing pressure, but the extent of the problem is unknown. Some grazing by deer on the ANF populations has been noted.

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.

There are no regulatory mechanisms in place to account for the possible impacts to shoreline plant species that may occur due to the fluctuating water levels of the Allegheny River or the Allegheny Reservoir.

Other natural or manmade factor: Many populations of thread rush are 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. Natural succession, which may result in some open swamps or meadows closing, has also been cited as a possible threat to the species' habitat (PNDI 2001).

RESEARCH AND MONITORING

Thread rush has a widespread range, yet it is uncommon or rare across most of that range despite an abundance of habitat. It is a member of intact wetland communities, but often grows best in moist areas of disturbance or transition. Reasons for such an existence are unclear. There is a need for more research and monitoring of known populations to

obtain baseline information to better understand the distribution, biology and ecology of this species. There is no formal research or monitoring of thread rush, however the ANF populations are visited periodically to assess general trends in population size.

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PEER REVIEW

The following individuals have provided much appreciated comments for the benefit of this Conservation Assessment:

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