

Knieskern's Beaked-rush
(*Rhynchospora knieskernii*)

5-Year Review:
Summary and Evaluation

U.S. Fish and Wildlife Service
New Jersey Field Office
Pleasantville, New Jersey

Fall 2008

5-YEAR REVIEW

Species reviewed: Knieskern's beaked-rush (*Rhynchospora knieskernii*)

TABLE OF CONTENTS

1.0	GENERAL INFORMATION	1
1.1	Reviewers.....	1
1.2	Methodology Used to Complete the Review	1
1.3	Background	1
2.0	REVIEW ANALYSIS	2
2.1	Application of the 1996 Distinct Population Segment (DPS) policy	2
2.2	Recovery Criteria	2
2.3	Updated Information and Current Species Status	7
2.3.1	Biology and habitat	7
2.3.2	Five-factor analysis.....	11
2.4	Synthesis	14
3.0	RESULTS	15
3.1	Recommended Classification	15
3.2	Recommended Recovery Priority Number	15
3.3	Recommended Listing / Reclassification Priority Number	15
4.0	RECOMMENDATIONS FOR FUTURE ACTIONS	15
5.0	REFERENCES	17
	Signature Page	20

Tables

Table 1.	Summary of Knieskern's beaked-rush occurrences, 1993 and 2007	4
Table 2.	Knieskern's Beaked-Rush Sites Suitable for Long-Term Protection Agreements	5

5-YEAR REVIEW
Knieskern's beaked-rush (*Rhynchospora knieskernii*)

1.0 GENERAL INFORMATION

1.1 Reviewers

Mary Parkin, Region 5, 617-876-6173

Anne Hecht, Region 5, 978-443-4325

John Staples, New Jersey Field Office, 609-383-3938, extension 12

Eric Davis, New Jersey Field Office, 609-383-3938, extension 31

Lead Field Office: New Jersey Field Office, Annette Scherer, 609-383-3938, extension 34, Annette_Scherer@fws.gov

Lead Regional Office: Region 5, Mary Parkin, 617-876-6173, Mary_Parkin@fws.gov

1.2 Methodology Used to Complete the Review

This 5-year review was conducted as an individual effort by the lead endangered species biologist for Knieskern's beaked-rush. State natural resource agency personnel and knowledgeable researchers and botanists were contacted for updated information on occurrences, threats, and recovery activities. All pertinent available literature, reports, and other documents on file at the New Jersey Field Office were used for this review.

1.3 Background

1.3.1 Federal Register Notice (FR) announcing initiation of this review: January 29, 2007, (Volume 72, Number 18; Page 4018-4019)

1.3.2 Listing history:

FR notice: July 18, 1991 (Volume 56, Number 138; Pages 32978-32983)

Date listed: August 19, 1991

Entity listed: Species

Classification: Threatened

1.3.3 Associated rulemakings / actions: None

1.3.4 Review history: The 1993 recovery plan includes an assessment of the species' status.

1.3.5 Species' Recovery Priority Number at start of 5-year review: The recovery priority for Knieskern's beaked-rush is 14, indicative of a species with a low degree of threat and high recovery potential.

1.3.6 Recovery plan:

Name of plan: Knieskern's Beaked-rush (*Rhynchospora knieskernii*)
Recovery Plan

Date issued: September 29, 1993

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

2.1.1 Is the species under review a vertebrate? No, the species is a plant; therefore, the DPS policy is not applicable.

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria? Yes.

2.2.2 Adequacy of recovery criteria:

2.2.2.1 Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat?

No, the recovery criteria are not current. It has been 14 years since the last comprehensive review of this species was completed. Since the 1993 recovery plan, survey efforts have revealed many new occurrences of Knieskern's beaked-rush and State and Federal regulatory programs have changed. Criterion 4 was not achieved during the targeted timeframe specified within the recovery plan and is now outdated.

2.2.2.2 Are all of the relevant listing factors addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)?

No. Although the habitat protection criterion is applicable to listing factor A (the present or threatened destruction, modification, or curtailment of habitat or range), the recovery criteria do not adequately address factors B, D, and E (overutilization, inadequacy of existing regulatory mechanisms, and other natural or manmade factors). Factor C (disease or predation) is not a known threat to Knieskern's beaked-rush.

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information:

According to the recovery plan, delisting of Knieskern's beaked-rush will be considered when the following conditions have been met.

Condition 1. Permanent habitat protection is secured for a minimum of nine occurrences. This number represents the sum of known populations that are: (1) Either self-sustaining or will require minimal management for long-term Maintenance, and (2) already occur on public lands or meet any of the biological criteria, stated below, that would warrant land acquisition for the primary objective of protecting the population. Habitat will be considered permanently protected when the R. knieskernii site, including an adequate buffer that ensures maintenance of the hydrological regime, is secured either through acquisition or conservation easement, and a formal commitment to long-range management is made by a government agency or conservation organization.

Priority for protection will be given to occurrences that meet any of the following criteria pertaining to biological significance:

- a. The occurrence is found on a naturally-maintained site such as a bog-iron deposit, a river or stream bank, or an area subject to natural wildfire.*
- b. The habitat is in excellent condition with, at most, only minor alterations or disturbances, none of which is directly impacting or significantly degrading the site. Population size consists of 1,000 or more plants in contiguous habitat.*
- c. The occurrence is key to maintaining the species' historical range limits or genetic variability.*

The recovery criterion presented in Condition 1 addresses Listing Factor A (destruction, modification, or curtailment of habitat). This criterion has not been met. The last comprehensive status review for Knieskern's beaked-rush occurred during preparation of the species' recovery plan. As shown in Table 1, a total of 50 occurrences (34 extant; 16 historic) of Knieskern's beaked-rush were documented in 1993 (U.S. Fish and Wildlife Service, 1993). Information available to the U.S. Fish and Wildlife Service (Service) in 2007 shows that an additional 21 occurrences have been documented in New Jersey, bringing the total number of recorded occurrences rangewide to 73 (W. Bien, Drexel University, pers. comm., 2001; Gordon, 2002; Schuyler and Gordon, 2002; New Jersey Natural Heritage Program, 2004; Engineering-Environmental Management, Inc., 2006). In the 1993 recovery plan, 14 sites in New Jersey and 2 sites in Delaware were reported as historic (U.S. Fish and Wildlife Service, 1993). Since that time, an additional New Jersey site is known extirpated as a result of development (Stafford Township Landfill) (J. Montgomerie, New Jersey Pinelands Commission, pers. comm., 2006) and, for the purposes of this review, an additional six New Jersey sites are categorized as historic because the last known survey reported habitat conditions to be no longer suitable due to succession (Cologne Road Railroad West, Reading-Darmstadt and Frankfurt Avenue Bog), flooding (Lazurus and East Plains Watering Place Pond), or other factors (Outside Earle) (New Jersey Natural Heritage Program, 2004; K. Anderson, botanist, pers. comm., 2006). Annual surveys are conducted in Delaware in potentially suitable habitats, but no extant sites have been found (W. McAvoy, Delaware Natural Heritage and Endangered Species Program, pers. comm., 2007).

Five sites are categorized as “presence unconfirmed” because the surveyor was unable to locate the plant during the last known survey (Berlin Avenue Bogs, Roosevelt City, Harry Wright Lake, Drosera Street and Atsion Burn), but indicated that suitable habitat remained (New Jersey Natural Heritage Program, 2004; M. Baker, biologist, pers. comm., 2005; K. Anderson, pers. comm., 2005 and 2006).

Drought and / or increased succession were reported as the likely cause for absence of the plant within previously occupied habitats. Because a seed-bank for Knieskern’s beaked-rush may still exist at these sites, the species has potential to occur in future years as long as suitable habitat remains.

Table 1. Summary of Knieskern’s beaked-rush occurrences¹, 1993 and 2007

State	1993				2007				
	Historic ²	Extant ³	Total	Sites Meeting Permanent Protection Criterion	Historic	Extant	Presence Unconfirmed ⁴	Total	Sites Meeting Permanent Protection Criterion
New Jersey	14	34	48	0	21	45	5	71	1
Delaware	2	0	2	0	2	0	0	2	0
Total	16	34	50	0	23	45	5	73	1

- 1 An element occurrence is the spatial representation of a species or ecological community at a specific location and represents the geo-referenced biological feature that is of conservation or management interest (NatureServe, 2007). Occurrences may or may not represent biologically distinct populations.
- 2 Historic sites are presumed extirpated based on age of last observation (50 to 100 years ago) and / or absence of plants and suitable habitat conditions at most recent site visit.
- 3 Extant sites are those in existence based on presence of plants at most recent site visit (usually within the past 5 to 20 years).
- 4 Sites categorized as presence unconfirmed are those sites where the species was not found during the last known survey, possibly due to drought conditions, but where suitable habitat remained.

As of 2007, a long-term protection agreement meeting the recovery criterion outlined in Condition 1 has been secured for only 1 site - the Warren Grove Range site. Knieskern’s beaked-rush was discovered in 2001 at the Air National Guard, Warren Grove Range in Burlington County, New Jersey following removal of herbaceous and woody vegetation to expand areas used for military training exercises. Subsequently, the Air National Guard revised its Integrated Natural Resources Management Plan (INRMP) to incorporate long-term protection and management for Knieskern’s beaked-rush (Engineering-Environmental Management, Inc., 2006).

Preserve Designs were developed for three New Jersey occurrences, specifically, the Sacred River - Five Points site in Burlington County, and the Fox Run and Whiting Clay Pits sites within the Bamber Macrosite in Ocean County (Kolaga and Schuyler, 1993). Conservation Plans were developed for the Big Doughnut site in Atlantic County, Shark River Station site in Monmouth County (Obee, 1995), and Crossly Preserve in Ocean County (Yurlina, 1997). In 1998,

development of landowner agreements was initiated for the Shark River Station, Fox Run, and Whiting Clay Pits sites (Dodds and Cartica, 1998). However, no information is available to the Service regarding implementation or effectiveness of these Preserve Designs and Conservation Plans or whether planning efforts secured a formal long-term commitment for protection of the Knieskern's beaked-rush by the landowner or managing agency.

Less than half of the extant Knieskern's beaked-rush populations occur on protected lands (Dodds and Cartica, 1998). For this review, an evaluation was conducted of information available for those sites that are known or were last recorded as extant, and appear suitable for development of long-term agreements to meet the habitat protection criterion in Condition 1 (Table 2).

Table 2. Knieskern's Beaked-Rush Sites Suitable for Long-Term Protection Agreements

EO#	Site Name	Managing Entity	Year Last Observed	Last Recorded Population Size
Sites with Current Long-Term Protection Agreements				
--	Warren Grove Range	New Jersey Air National Guard	2006	>15,000
Sites with Potential for Long-Term Protection Agreements				
007	Hawkins Bridge	NJDEP – Wharton State Forest	1994	2,000
022	Big Doughnut	NJDEP – Wharton State Forest	1994	5,000
026	Reega SSE	NJDEP – Hamilton Preserve	2006	Several thousand
031	Crossley	NJDEP – Natural Lands Trust, Crossley Preserve	1996	7,500
042	North of Lazurus	NJDEP - Stafford Forge Wildlife Management Area / Edwin B. Forsythe National Wildlife Refuge	1996	8,000 to 10,000
044	Stafford Forge Rail Branch	NJDEP - Stafford Forge Wildlife Management Area	1994	1,600
048	Little Plains Tower	Federal Aviation Administration	1992	3,640
054	Melrose	NJDEP - Stafford Forge Wildlife Management Area	1996	10,000
055	Hidden Pond	NJDEP - Stafford Forge Wildlife Management Area	1996	9,000
58	East Plains Fireshed Two Foot	NJDEP - Stafford Forge Wildlife Management Area	1996	1,000
59	Log Swamp	NJDEP - Stafford Forge Wildlife Management Area	2004	>500
63	Round Pond	NJDEP - Stafford Forge Wildlife Management Area	1996	4,000 to 5,000
66	South Branch Headwaters	Private - within acquisition area of Forked River Mountain Coalition	1996	6,000

In addition to the Warren Grove Range site with an existing protection agreement, 13 occurrences appear suitable for establishment of long-term protection agreements. While 12 of these occurrences are located on publicly managed State or Federal lands, no specific agreements have been developed to ensure protection of the species and ongoing / future land management objectives and practices should not be assumed to be compatible with long-term protection of the species and its habitat. Therefore, while this recovery criterion appears to remain relevant and achievable, field surveys are needed to determine the current status and continued suitability of the occurrences and coordination is needed with the managing land agency to secure a long-term commitment for protection of the species. In addition, further analysis of the distribution of sites is needed to ensure the sites are representative of Knieskern's beaked-rush's historical range limits and / or genetic variability.

Condition 2. The species is proven to be an efficient colonizer, as indicated by monitoring results, life history information, and / or the results of experimental introductions.

This criterion remains relevant; efforts to achieve this recovery criterion are ongoing.

In 1996 and 1997, Yurlina (1998) conducted several studies to gain information on Knieskern's beaked-rush germination rates, seed-banking, and response to habitat manipulations. Seed germination rates and emergence from soil seed bank samples suggests that Knieskern's beaked-rush may be re-established in historical habitats by unearthing potential seed banks through disturbance that exposes bare soil or by broadcasting seed directly onto bare soil. Knieskern's beaked-rush responded well to greenhouse conditions, was not difficult to maintain, and plants were easily transplanted. Thus, propagation of the species for eventual outplanting appears possible. Yurlina's (1998) research focused only on the species' short-term seed-banking properties. Further research is needed on the species ability for seeds to remain viable over longer time periods.

In 2001, Knieskern's beaked-rush was discovered at the Air National Guard, Warren Grove Range in Burlington County, New Jersey following removal of herbaceous and woody vegetation to expand areas used for military training exercises. Colonization of exposed mineral soils by Knieskern's beaked-rush at the Range indicates that a seed-bank had persisted at the site. However, because Knieskern's beaked-rush is difficult to distinguish from other sedges, presence of the species on the Range may have been overlooked in the past. The Air National Guard has identified several actions within its 2006 Warren Grove Range INRMP that address recovery tasks specific to this criterion, including research on seed banking properties of Knieskern's beaked-rush, applied habitat management to determine the effects of fire on the species, and characterization of the water regimes and sites conditions needed for germination (Engineering-Environmental Management, Inc., 2006).

Condition 3. A post-delisting strategy for monitoring the species' population dynamics, as well as introducing (if and when necessary) the plant to suitable habitats, is in place.

Development of a post-delisting strategy has not been initiated; therefore, this criterion has not been met.

Condition 4. No evidence of decline in the species' status is seen by 1996. This time frame takes into account the apparent stability or improvement in the status of the species seen since its listing 2 years ago [i.e., the 1991 listing].

The time frame specified within this criterion for evaluating evidence of decline has passed. Over the period of 1994 to 1996, a field survey was conducted at each of 24 previously known occurrences to determine species status. Four occurrences were confirmed to be historic. Of the remaining 20 extant occurrences surveyed, 12 were reported to have declined (60 percent) since the previously recorded survey, 6 occurrences were considered stable (30 percent), and 2 occurrences were found to be increasing (10 percent). Therefore, evidence of ongoing decline of Knieskern's beaked-rush populations was observed, and thus this recovery criterion was not achieved. No subsequent comprehensive monitoring of the species status has been conducted to allow for an assessment of population trends. More than 80 percent of occurrences known to be extant in 1993 have not been surveyed within the last 10 years; therefore, continued presence of the species or its habitat is undetermined at these sites.

2.3 Updated Information and Current Species Status

2.3.1 Biology and habitat:

2.3.1.1 New information on the species' biology and life history:

In 1996 and 1997, Yurlina (1998) conducted several studies to gain information on Knieskern's beaked-rush germination rates, seed-banking, and response to habitat manipulations. In 2006, Frank (2007) conducted greenhouse investigations of the survival dynamics of Knieskern's beaked-rush at varying water table levels to correlate hydrology with growth, survival and reproduction and the role of cold / wet stratification and scarification on germination. Frank (2007) also initiated field studies at two sites to measure soil attributes and hydrology in order to further characterize the species' habitat.

Seed Germination Trials

Knieskern's beaked-rush seeds were found to require cold / wet stratification and light to germinate. Less than 6 percent of seeds that did not receive stratification germinated, while germination rates of seeds receiving various stratification treatments with light ranged from 34 to greater than 57 percent. Seeds receiving stratification but no light had extremely low germination (less than 0.6 percent). The inability of Knieskern's beaked-rush to germinate upon maturation in autumn, as well as its need for exposure to light to break dormancy, are likely adaptations to prevent germination when conditions are adverse to further growth and development. Exposure to light initiates germination when a seed is positioned on bare soil surface. Seeds are unlikely to germinating in darkness, such as under leaf litter or biomass of neighboring plants, supporting the characterization of Knieskern's beaked rush as a poor biotic competitor. The high percentage of seeds germinating (57 percent) after storage in cold, dark, wet storage for nearly 1 year suggests that Knieskern's beaked-rush is capable of long-term persistence in the soil seed banks of wetlands where the species occurs (Yurlina, 1998).

Frank (2007) found that Knieskern's beaked-rush showed a significant increase in germination when seeds were scarified. Increased germination in response to scarification during laboratory studies implies that Knieskern's beaked-rush seed coats are abraded in the field under natural conditions (Frank, 2007).

Soil Seed Bank Study

Results of soil seed bank trials did not show a statistically significant difference between soils that were continually flooded versus well-drained soils. However, soil moisture conditions significantly affected plant height. Average height of fruiting stems in flooded soil was 22.7 centimeters (cm) as compared to only 10.3 cm in well drained soils. Plants grown in flooded soils were noticeably taller than the parent plants from which seed had been collected at the Crossley Preserve (Yurlina, 1998).

Perennial Structures

Plants from the soil seed bank study successfully overwintered as perennials in an open cold frame. Small, stout, green tufts at the base of browning stems were produced in overwintering trays. These spiny tufts expanded into the next year's growth once placed back into the greenhouse. These findings indicate that Knieskern's beaked-rush plants are capable of overwintering during mild winter seasons (Yurlina, 1998). Similarly, M. Palmer (Columbia University, pers comm., 2006) found that Knieskern's beaked-rush can produce vegetation buds at the base of large individuals that can develop into adult plants the following growing season (Frank, 2007).

Field Manipulations

Soil moisture appears to be a limiting factor determining the establishment of Knieskern's beaked-rush. Habitat manipulation trials adjacent to a trailside site at the Crossley Preserve implied that even slightly higher elevations translated into inadequate soil moisture for the species. In bog edge manipulation trials, Knieskern's beaked-rush was found to occur at greater density in the highest portion of the slope in 1996 when rainfall was above normal and within furrows in a lower section of the slope during the drier summer of 1997 (Yurlina, 1998).

Hydrology

Knieskern's beaked-rush seedlings were subjected to variations in surface hydrology ranging from -2 cm to +2.5 cm. Seedlings subjected to constant flooding (-2 cm) showed a decline in survivorship with progression of time. No significant differences in survivorship were found among five other treatments ranging from -1 cm to +2.5 cm. Growth of plants, as measured by plant height, was significantly less under flooded (-2 cm and -1 cm) conditions than under non-flooded or partially flooded (+2 cm and +2.5 cm) conditions after 11 weeks of growth. These results indicate that Knieskern's beaked-rush may not be adapted to constantly saturated soil conditions (Frank, 2007), but may be adapted to fluctuating hydrology.

Soil Characteristics

Chemical and compositional analyses were performed on soil cores from the Reega and Warren Grove Knieskern's beaked-rush sites. Soil samples had low pH (4.2), conductance, ammonia concentration, and percent of organic carbon. Organic carbon was significantly higher at the Warren Grove site (4.1 percent) compared to the Reega site (0.8 percent). Soil composition consisted primarily of sand (87 to 92 percent), with a small proportion of clay (7 to 13 percent) and silt (5 to 10 percent). Soil within Knieskern's beaked-rush populations is acidic, nutrient poor, and generally retains more water in the top organic horizon than lower alluvial horizon. Low accumulation of organic matter in soils colonized by Knieskern's beaked-rush is indicative of early-successional habitats where accumulation of decaying matter has not yet occurred (Frank, 2007).

In Situ Habitat Characterization

Measurements of plants along transects at the Reega and Warren Grove sites indicate a great deal of variability in plant density, growth, and fecundity within and between Knieskern's beaked-rush populations. Hydrology at Warren Grove fluctuated throughout the fall 2006 season, occasionally flooding the surface. Variability in Knieskern's beaked-rush sites suggests that the species may be physiologically and anatomically adapted to survival in variable soil conditions (Frank, 2007).

2.3.1.2 Abundance, population trends, demographic features, or demographic trends:

Abundance and Trends: As shown in Table 1, the number of known occurrences of Knieskern's beaked-rush increased from 50 in 1993 (as described in the recovery plan) to 73 in 2007, due to additional survey efforts and likely increased reporting of the species due to its Federal status as a threatened species. However, some occurrences of Knieskern's beaked-rush are clearly declining (Kolaga and Schuyler, 1993). Since 1993, as discussed in Section 2.2.3, seven New Jersey populations have been extirpated and species presence could not be confirmed at another five sites. During field surveys conducted from 1994 to 1996, over 60 percent of extant occurrences visited were found to be declining.

While 45 occurrences in New Jersey are categorized as extant in this review, the species' continued presence within the past 10 years has been confirmed at only 7 of those occurrences (16 percent). The remaining 38 occurrences (84 percent) have not been surveyed for more than 10 years and continued presence of the species or its habitat is undetermined. Although a volunteer monitoring program was established in New Jersey in 2005, available information to date is insufficient to look for any trends in plant numbers over time in New Jersey.

2.3.1.3 Genetics, genetic variation, or trends in genetic variation:

No information relevant to the genetics of Knieskern's beaked-rush is available.

2.3.1.4 Taxonomic classification or changes in nomenclature:

There have been no changes in the taxonomic classification or nomenclature of Knieskern's beaked-rush since listing.

2.3.1.5 Spatial distribution, trends in spatial distribution, or historic range:

Although additional Knieskern's beaked-rush occurrences have been discovered while some have been lost, no change in Knieskern's beaked-rush distribution or historic range has been identified since the 1993 recovery plan.

2.3.1.6 Habitat or ecosystem conditions:

Habitat Loss and Degradation Due to Development

Wetlands within the range of Knieskern's beaked-rush continue to be lost, but at a slowing rate. From 1972 to 2001, New Jersey lost about 190,000 acres of wetlands, a decline of about 20 percent. Wetland loss averaged about 11,000 acres / year between 1972 and 1984 (Lathrop, 2004a). More recently, the rate of wetland conversion to developed areas has slowed dramatically, from about 2,000 acres / year between 1986 and 1995 to about 1,000 acres / year from 1995 to 2000. Rates of wetland conversion to agriculture have likewise dropped

significantly (Lathrop, 2004b). The New Jersey Department of Environmental Protection (NJDEP) (2002) estimates a total (not annual) permitted net loss (*i.e.*, acres of permitted impacts minus acres of compensatory mitigation) of 718 acres of freshwater wetlands from 1989 to 1999, suggesting that additional losses over this time period, as reported by Lathrop (2004a), were of coastal wetlands and / or from unpermitted activities.

Some occurrences of Knieskern's beaked-rush are found within small (<1 acre) early successional wet areas, such as spring seepage areas, saturated gravel pits and borrow areas, clay pits, roadsides, streamside scour areas, wet bog iron deposits, or other isolated wetlands, that are often too small in scale to be identified and mapped on State or Federal wetlands inventories. Due to the inconspicuous nature of the plant, any such areas that have not been previously documented are likely to be missed during regulatory reviews where a site inspection is not conducted by a biologist familiar with the species. Some such sites are known by local botanists, but may not have been reported to the New Jersey Natural Heritage Program or may not have yet been mapped or included within Heritage database due to State staffing shortages. Loss of such sites continues to be reported by local botanists (J. Arsenault, pers. comm., 2005; W. Bien pers. comm., 2005; G.R. Juleg, Pinelands Preservation Alliance, pers. comm. 2005; T. Gordon, Pine Barrens Inventories, pers. comm., 2005).

2.3.1.7 Other: None.

2.3.2 Five-factor analysis (threats, conservation measures, and regulatory mechanisms):

2.3.2.1 Factor A. Present or threatened destruction, modification or curtailment of its habitat or range:

Habitat succession and resulting competition with woody and herbaceous species continues to be a major cause of loss of Knieskern's beaked-rush habitat, particularly at disturbed sites (Radis, 1995; Gordon, 1996). Erosion, soil compression and rut creation caused by off-road vehicles also continues to be a significant threat causing degradation of habitat (Radis, 1995). However, while identifying off-road vehicles as detrimental at some sites, Gordon (1996), found that Knieskern's beaked-rush "demonstrates a remarkable resilience" to off-road vehicles at other sites, and perhaps, in some instances, benefits from the disturbance. Activities that severely degrade or destroy Knieskern's beaked-rush plants and / or habitat continue. Road maintenance, particularly bulldozing and mowing, were identified as major threats to roadside occurrences (Gordon, 1996; Dodds and Cartica, 1998). Dumping of trash directly onto plants, at roadside sites or within clay pits was also identified as a concern. In some cases trash dumping was to a degree that the plants and or habitat were buried (Radis, 1995; Dodds and Cartica, 1998). Many of these threats were considered under Factor E at the time when the species was listed.

2.3.2.2 Factor B. Overutilization for commercial, recreational, scientific, or educational purposes:

At the time of listing, most collections had been for scientific purposes and at relatively low levels. No new information relevant to this threat has been identified.

2.3.2.3 Factor C. Disease or predation:

Disease was not known to be a threat and the role of herbivory was not determined at the time of listing. No new information relevant to this threat has been identified.

2.3.2.4 Factor D. Inadequacy of existing regulatory mechanisms:

Regulatory mechanisms in New Jersey have improved since the species was listed but are still inadequate to protect Knieskern's beaked-rush from threat of habitat loss or degradation. Further protections for Knieskern's beaked-rush that may be afforded by several proposed regulatory changes in New Jersey will be considered during the next 5-year review.

Regulation of Wetlands: In 1993, after publication of the Knieskern's beaked-rush recovery plan, New Jersey assumed the Federal regulation of freshwater wetlands under Section 404 of the Clean Water Act (33 U.S.C. 1344 *et seq.*) (CWA). Regulatory jurisdiction for all wetlands supporting Knieskern's beaked-rush was assumed by the State, eliminating Federal authorization by the U.S. Army Corps of Engineers (Corps) and thereby also removing the protections afforded by Section 7 of the Endangered Species Act (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*) (ESA). To avoid the loss of Service review under the ESA, a Memorandum of Agreement (MOA) was signed by the Service, the NJDEP, and the U.S. Environmental Protection Agency (EPA) concurrent with State assumption to serve as a functional equivalent of Section 7 consultation. Under the MOA, the Service reviews State wetland applications in municipalities with known occurrences of Knieskern's beaked-rush.

The Freshwater Wetlands Protection Act (N.J.S.A. 13:9B-1 *et seq.*) (FWPA) and its implementing regulations (N.J.A.C. 7:7A) are the basis for State assumption, and must therefore be at least as protective as the Federal 404 program. The FWPA includes several provisions that are more restrictive than the CWA. For example, the FWPA regulates essentially all activities in wetlands (*e.g.*, disturbances to soils, vegetation, or the water table), while the CWA only regulates the placement of fill material. The FWPA also regulates "transition areas," or upland buffers, either 50 or 150-foot wide depending on resource value, while the CWA provides no regulation of uplands. As a State law, the FWPA retains full jurisdiction over isolated and non-navigable waters and wetlands, while Federal jurisdiction over these areas under the CWA has been curtailed by recent court decisions as discussed below.

The FWPA requires the larger, 150-foot buffer on wetlands that support federally listed species or State-listed wildlife, but not State-listed plants. Under current regulations, delisting Knieskern's beaked-rush would limit the State-mandated buffer to a maximum of 50 feet (or 150 feet if a State-listed animal also occupies the same habitat). In contrast, with the current protection of the ESA, 300-foot buffers are often negotiated on wetlands supporting federally listed plants through the MOA process.

State laws do not prohibit the collection or destruction of Federal- or State-listed plants on private lands with permission of the landowner. Although it offers no special protections for State-listed plants, New Jersey's FWPA regulates "*destruction of plant life which would alter the existing pattern of vegetation*" within freshwater wetlands.

Pinelands Region: The New Jersey Pinelands Protection Act of 1979 (N.J.S.A. 13:18-1 *et seq.*) prohibits development within the Pinelands Area unless it is designed to avoid irreversible adverse impacts on habitats that are critical to the survival of any local populations of threatened or endangered species. The 1993 recovery plan erroneously stated that the Pinelands Protection Act prohibited such development within the boundaries of the Pinelands National Reserve. However, the protections afforded by the Pinelands Protection Act apply only within the "Pinelands Area," specifically that area encompassed by the Pinelands Comprehensive Management Plan. A major portion of the Pinelands National Reserve is not included within the Pinelands Area. Many Knieskern's beaked-rush populations are located within Pine Barrens habitats outside of the Pinelands Area and are thus not afforded protection under the Pinelands Protection Act (T. Korth, Pinelands Preservation Alliance, pers. comm., 2002).

Regulation of Stormwater Management: In 2004, the NJDEP adopted a new set of State-wide stormwater rules (N.J.A.C. 7:8 and 7:14A). The primary focus of these rules is to steer management practices away from stormwater collection and point discharge and encourage groundwater recharge and less concentrated discharges. To the extent that these rules are implemented, they should reduce localized groundwater or water table modifications and stormwater surges -factors known to degrade Knieskern's beaked-rush habitat. However, for those populations already in urban and suburban landscapes where past stormwater practices dominate, the rules offer little help. While retrofitting and improving old systems is encouraged, little to no funding for major overhauls of existing systems is provided.

2.3.2.5 Factor E. Other natural or manmade factors affecting its continued existence:

As stated above, off-road vehicles, trash dumping, and trampling were considered under Factor E at the time of listing but can also be considered under Factor A inasmuch as they destroy or modify habitat for the species.

Climate change was not considered in the recovery plan. Much more investigation would be necessary to begin assessing the potential effects of climate change on Knieskern's beaked-rush. However, potential changes in temperature, carbon dioxide concentrations, precipitation, stream flow, water quality, human demand for water supplies, and sea level rise could impact Knieskern's beaked-rush. At the time of listing, changes in the water table related to extremely wet or drought periods were documented to affect Knieskern's beaked-rush populations.

Germination of Knieskern's beaked-rush was shown to benefit from stratification of seeds under cold and wet conditions. The plant was also found to be perennial when over-wintered in a protected cold frame (Yurlina, 1998). Changes in climate may affect germination and growth of Knieskern's beaked-rush.

2.4 Synthesis

The number of known occurrences of Knieskern's beaked-rush increased from 50 in 1993 to 73 in 2007, due to additional survey efforts and likely increased reporting of the species due to its Federal status as a threatened species. Annual surveys are conducted in Delaware in potentially suitable habitats, but no extant sites have been founding that state. Since 1993, seven New Jersey sites have been extirpated and species presence could not be confirmed at another five sites. During field surveys conducted from 1994 to 1996, over 60 percent of extant occurrences visited were found to be declining. While 45 occurrences in New Jersey are categorized as extant in this review, the species' continued presence within the past 10 years has been confirmed at only 7 of those occurrences (16 percent). The remaining 38 occurrences (84 percent) have not been surveyed for more than 10 years and continued presence of the species or its habitat is undetermined. No change in Knieskern's beaked-rush distribution or historic range has been identified since the 1993 recovery plan.

As of 2007, a long-term protection agreement meeting the recovery criterion outlined in Condition 1 has been secured for only one site; an additional 13 occurrences appear suitable for establishment of long-term protection agreements. Less than half of the extant Knieskern's beaked-rush populations occur on protected lands.

In seed germination trials, Knieskern's beaked-rush seeds were found to require cold / wet stratification and light to germinate. The need for exposure to light to break dormancy is likely an adaptation to prevent germination when conditions are adverse to further growth and development. The high percentage of seeds germinating after storage in cold, dark, wet storage for nearly 1 year suggests that Knieskern's beaked-rush is

capable of long-term persistence in the seed banks of wetlands where the species occurs. Knieskern's beaked-rush showed a significant increase in germination when seeds were scarified.

Knieskern's beaked-rush plants were found capable of overwintering during mild winter seasons. Soil moisture appears to be a limiting factor determining the establishment of Knieskern's beaked-rush. Knieskern's beaked-rush may not be adapted to constantly saturated soil conditions, but the plant may be adapted to fluctuating hydrology. Soil within Knieskern's beaked-rush populations was characterized as acidic, nutrient poor, and generally retaining more water in the top organic horizon than lower alluvial horizon.

Habitat succession and resulting competition with woody and herbaceous species continues to be a major cause of loss of Knieskern's beaked-rush habitat, particularly at disturbed site. While habitat destruction or degradation caused by off-road vehicles is detrimental at some sites, Knieskern's beaked-rush demonstrated resilience to off-road vehicles at other sites. In some instances, the plant may benefit from the disturbance caused by off-road vehicles. Road maintenance, particularly bulldozing and mowing, and dumping of trash were also identified as significant threats to roadside occurrences of the species.

Climate change was identified as a threat not previously considered for this species. More investigation is necessary to fully characterize the effects of climate change on Knieskern's beaked-rush, but changes in temperature, precipitation, and frequency and length of droughts may further decrease availability of suitable habitat for the species. In addition, changes in climate may affect germination and growth of Knieskern's beaked-rush plants.

These continuing and potential continuing threats together with uncertainties about the population status of this species and its relatively narrow distribution indicate that Knieskern's beaked-rush remains likely to become endangered in the foreseeable future throughout its entire range.

3.0 RESULTS

3.1 Recommended Classification: Threatened. No change needed.

3.2 Recommended Recovery Priority Number: 14. No change needed.

Rationale: Knieskern's beaked-rush is considered a valid species. The species is subject to a low degree of threat and has a high potential for recovery.

3.3 Recommended Listing / Reclassification Priority Number: Not applicable.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

Revise the recovery plan to include measurable criteria that specifically address each of the relevant listing factors and incorporate currently available information about population abundance and distribution. Pending plan revision, implement recovery actions listed below (numbers in parentheses refer to tasks in the 1993 recovery plan that these actions relate to).

Secure Protection of Occurrences

- Identify sites suitable for long-term protection agreements, ensuring sites are representative of Knieskern's beaked-rush historical range limits and / or genetic variability. (tasks 1.1 and 1.4)
- Pursue formal, long-term Knieskern's beaked-rush protection agreements with landowners. (tasks 1.3 and 1.5)
- Conduct a study to determine any correlations between protective buffer width and changes in population size and vigor. (task 2.2)
- Determine impact of groundwater withdrawals or changes in surface runoff on Knieskern's beaked-rush populations. (task 2.2)
- Establish recommended protective buffers and / or restrictions on groundwater withdrawal to ensure maintenance of hydrological regime for Knieskern's beaked-rush wetlands. (task 1.2)
- Develop Best Management Practices to protect Knieskern's beaked-rush habitat, and encourage their adoption by Federal and State regulatory agencies, local governments, and public and private landowners. (task 1.2)
- Incorporate protection of Knieskern's beaked-rush into local planning efforts, especially where multiple occurrences are clustered in small watersheds. (task 1)
- Continue to protect Knieskern's beaked-rush sites through various regulatory processes as necessary and appropriate. (task 1.6)

Continue to Characterize Species' Biology and Life History (task 3)

- Conduct applied habitat management to determine the effects of fire on the species.
- Study seed dispersal mechanisms.
- Conduct research on the ability for seeds to remain viable in the seed bank over long time periods.
- Measure fluctuations in hydrology throughout an entire growing season and across years with different climatic conditions to better characterize optimal habitat conditions for the species.

- Characterize the type and degree of habitat disturbance that is beneficial vs. deleterious to the species.
- Investigate Knieskern's beaked-rush root anatomy and hormonal response to varying soil conditions to determine adaptive mechanisms.
- Investigate the impact of climate change on the species and its habitat.

Monitor Populations and Track Recovery

- Develop a scheme for monitoring and assessing trends to determine if Knieskern's beaked-rush is a naturally ephemeral species. Such information would be relevant to whether the species' status is more appropriately measured by the balance of increasing and declining sites than by whether known sites are stable or improving.
- Survey Knieskern's beaked-rush sites to obtain updated information on the species' status and trends, applying the aforementioned scheme, and ensure information is entered into Natural Heritage Program databases. (task 2.2)
- Develop a method to distinguish new discoveries from recently established populations.

Develop a post-delisting strategy (task 4)

5.0 REFERENCES

Literature Cited

- Dodds, J.S. and Cartica, R.J. 1998. Landowner agreements for *Rhynchospora knieskernii* populations in New Jersey. New Jersey Department of Environmental Protection, Division of Parks and Forestry, Office of Natural Lands Management, Trenton, New Jersey. 6 pp. + Appendices.
- Engineering-Environmental Management, Inc. 2006. Final Integrated Natural Resources Management Plan / Environmental Assessment, Warren Grove Range, New Jersey. Air National Guard Readiness Center, Environmental Planning Division, Andrews Air Force Base, Maryland and 177th Fighter Wing, New Jersey Air National Guard, Egg Harbor Township, New Jersey. 199 pp + Appendices.
- Frank, M. 2007. *Rhynchospora knieskernii* in the New Jersey Pine Barrens: The life history of early-successional sedge. Senior project thesis. Columbia University, New York, New York. 40 pp.
- Gordon, T. 1996. *De novo* field survey of *Rhynchospora knieskernii* in New Jersey. Unpublished report prepared for the New Jersey Department of Environmental Protection,

Division of Parks and Forestry, Office of Natural Lands Management, Trenton, New Jersey. 21 pp.

Gordon, T. 2002. Documentation and status in 2001 of the rare, threatened, and endangered flora of the Middle Branch of Forked River Watershed west of the Garden State Parkway in Lacey Township, Ocean County, New Jersey. Unpublished report prepared for Forked River Mountain Coalition, Forked River, New Jersey. 23 pp. + Appendices.

Kolaga, V.J and Schuyler, A.E. 1993. Preserve design studies for priority *Rhynchospora knieskernii* populations in New Jersey – 1993. Unpublished report prepared for the New Jersey Department of Environmental Protection and Energy, Division of Parks and Forestry, Office of Natural Lands Management, Trenton, New Jersey. 5 pp. + Appendices.

Lathrop, R.G. 2004a. New Jersey land use / land cover update: 2000-2001. Grant F. Walton Center for Remote Sensing and Spatial Analysis, Cook College, Rutgers University, New Brunswick, New Jersey. 35 pp.
http://www.crssa.rutgers.edu/projects/lc/download/reportsdata00_01/landuselancov_web.pdf. Accessed July 20, 2007.

_____. 2004b. Measuring land use change in New Jersey: land use update to year 2000, a report on recent development patterns 1995 to 2000. Grant F. Walton Center for Remote Sensing and Spatial Analysis, Cook College, Rutgers University, New Brunswick, New Jersey. 32 pp.
http://www.crssa.rutgers.edu/projects/lc/download/reportsdata00_01/landuse_upd.pdf. Accessed July 20, 2007.

NatureServe. 2007. Natural Heritage methodology: Supporting interoperability within the NatureServe Network. Arlington, Virginia.
<http://www.natureserve.org/prodServices/heritagemethodology.jsp> Accessed September 26, 2007.

New Jersey Department of Environmental Protection. 2002. Environmental indicators technical report, 2nd edition, Land and natural resources chapter. Division of Science Research, and Technology, Trenton, New Jersey. <http://www.state.nj.us/dep/dsr/indicator-report/>. Accessed July 30, 2007.

New Jersey Natural Heritage Program. 2004. Natural Heritage Database. New Jersey Department of Environmental Protection, Natural and Historic Resources Group, Trenton, New Jersey.

Obee, E.M. 1995. Conservation plans for *Rhynchospora knieskernii*: Big Doughnut and Shark River Station populations. Unpublished report. New Jersey Department of Environmental Protection, Division of Parks and Forestry, Office of Natural Lands Management, Trenton, New Jersey. 6 pp. + Appendices.

Radis, R.P. 1995. Monitoring and survey research on *Rhynchospora knieskernii* Carey in New Jersey. Unpublished report prepared for the New Jersey Department of Environmental

Protection and Energy, Division of Parks and Forestry, Office of Natural Lands Management, Trenton, New Jersey. 16 pp.

Schuyler, E. and T. Gordon. 2002. Rare Plants in the Middle Branch of the Forked River Watershed, Lacey Township, Ocean County, New Jersey. *Bartonia* 61:117-121.

U.S. Fish and Wildlife Service. 1993. Knieskern's Beaked-Rush (*Rhynchospora knieskernii*) Recovery Plan. Hadley, Massachusetts. 40 pp.

Yurlina, M.E. 1997. Conservation plan for *Rhynchospora knieskernii* at Crossley Preserve, New Jersey. Unpublished report. New Jersey Department of Environmental Protection, Division of Parks and Forestry, Office of Natural Lands Management, Trenton, New Jersey. 12 pp. + Appendix.

_____. 1998. Management of the rare sedge *Rhynchospora knieskernii*: seed banking investigations and habitat manipulations. Unpublished report. New Jersey Department of Environmental Protection, Division of Parks and Forestry, Office of Natural Lands Management, Trenton, New Jersey. 7 pp.

Personal Communications

Arsenault, J. 2005. Environmental Consultant. Franklinville, New Jersey.

Anderson, K. 2005. Botanist. Woodbury, New Jersey.

_____. 2006. Botanist. Woodbury, New Jersey.

Baker, M. 2005. Biologist. Cream Ridge, New Jersey.

Bien, W. 2001. Assistant Director, Center for Biodiversity and Conservation, Drexel University. Philadelphia, Pennsylvania.

_____. 2005. Assistant Director, Center for Biodiversity and Conservation, Drexel University. Philadelphia, Pennsylvania.

Gordon, T. 2005. Environmental Consultant, Pine Barrens Inventories. Southampton, New Jersey.

Juelg, G. R. 2005. Director for Outreach, Pinelands Preservation Alliance. Southampton, New Jersey.

Korth, T. 2002. Program Manager for Law and Policy, Pinelands Preservation Alliance. Pemberton, New Jersey.

McAvoy, W. 2007. Botanist, Delaware Natural Heritage and Endangered Species Program. Smyrna, Delaware.

Montgomerie, J. 2006. Environmental Specialist, New Jersey Pinelands Commission. New Lisbon, New Jersey.

Palmer, M. 2006. Professor. Columbia University. New York, New York.


U.S. FISH AND WILDLIFE SERVICE
5-Year Review of Knieskern's Beaked-rush (*Rhynchospora knieskernii*)

Current Classification: Threatened.


Recommendation Resulting from the 5-Year Review: Retain as threatened.

Review Conducted by: Annette Scherer, New Jersey Field Office.

LEAD FIELD OFFICE APPROVAL:

Approve  Date 7/23/09
Field Supervisor, New Jersey Field Office, Fish and Wildlife Service
A.S.

REGIONAL OFFICE APPROVAL:

Approve  Date 8/19/08
Acting Regional Director, Region 5, Fish and Wildlife Service