

**KNIESKERN'S BEAKED-RUSH (*Rhynchospora knieskernii*)**

**RECOVERY PLAN**

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for

Region Five  
U.S. Fish and Wildlife Service  
Hadley, Massachusetts

Approved: \_\_\_\_\_



Regional Director, Region Five  
U.S. Fish and Wildlife Service

Date: \_\_\_\_\_

9-29-93

## EXECUTIVE SUMMARY OF THE KNIESKERN'S BEAKED-RUSH RECOVERY PLAN

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**Current Status:** Knieskern's beaked-rush (*Rhynchospora knieskernii*) was listed as a threatened species on July 18, 1991. Thirty-four extant populations are currently known to exist in five counties in New Jersey; 14 historical populations are presumed extirpated. Many of the extant populations are small and subject to habitat loss or alteration due to vegetative succession and excessive disturbance. The species appears to efficiently colonize newly disturbed sites, possibly offsetting any threats posed to those populations on human-altered habitats. All known naturally maintained populations occur on public lands.

**Habitat Requirements:** *R. knieskernii* is found on wet bog-iron substrates that remain in early successional stages due to erosional forces from nearby streams. The species is also found on human-disturbed wet sites that exhibit similar early successional stages due to water fluctuation or periodic disturbance from vehicles, fire, or mowing.

**Recovery Objective:** To assure the long-range viability of *R. knieskernii* in the wild, thereby enabling its removal from the Federal list of endangered and threatened wildlife and plants.

**Recovery Criteria:** Delisting will be initiated when: (1) Nine populations and their habitat are permanently protected, (2) the species is shown to be an efficient colonizer of newly disturbed sites and/or introduction of the species to suitable habitat is proven to be a feasible technique for species maintenance, (3) a post-delisting strategy for monitoring the species' population trends and/or supplementing natural colonization through introductions to suitable habitat is in place, and (4) no evidence of decline in the species' status is seen by 1996.

**Actions Needed:**

1. Provide protection to populations and their habitat at a level needed to achieve recovery objectives.
2. Monitor the species' rangewide status.
3. Determine the capacity of the plant to colonize new sites and establish populations.
4. Develop a post-delisting strategy for maintaining the species in suitable habitats.

**Estimated Costs (\$000):**

	<u>NEED 1</u>	<u>NEED 2</u>	<u>NEED 3</u>	<u>NEED 4</u>	<u>TOTAL</u>
FY 1	6	13	11		30
FY 2	6	10	14		30
FY 3	3	9	4	2	18
TOTAL	15	<u>32</u>	<u>29</u>	<u>2</u>	<u>78</u>

**Estimated Time Frame:** Delisting of *R. knieskernii* will be considered in 1997.

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This recovery plan delineates reasonable actions needed to recover and/or protect Knieskern's beaked-rush, a threatened species. Attainment of recovery objectives and availability of funds are subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities.

Recovery plans do not necessarily represent the views or official position of any individuals or agencies involved in plan formulation, other than the U.S. Fish and Wildlife Service. Approved recovery plans may be modified as dictated by new findings, changes in species status, and the completion of recovery tasks.

Literature citations for this plan should read as follows:

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

Copies of this plan can be purchased from:

Fish and Wildlife Reference Service  
5430 Grosvenor Lane, Suite 110  
Bethesda, Maryland 20814  
301-492-6403 or 1-800-582-3421

Fees vary according to number of pages.

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## PART I: INTRODUCTION

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Knieskern's beaked-rush (*Rhynchospora knieskernii*) is a plant of the sedge family (Cyperaceae) endemic to the Pinelands region of New Jersey. The species was listed as threatened pursuant to the Endangered Species Act of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*) on July 18, 1991 (U.S. Fish and Wildlife Service 1991). Currently, 34 extant occurrences of *R. knieskernii* are known from the following five counties in New Jersey: Atlantic, Burlington, Camden, Monmouth, and Ocean. Potential threats to this species include habitat alteration due to vegetative succession, loss of habitat through development activities such as residential construction, loss of fire-maintained habitat, and possibly excessive off-road vehicle use. The recovery priority number for this species is 14 (on a scale ranging from a low of 18 to a high of 1), based on: (1) low degree of threat; (2) a high potential for achieving recovery; and, (3) the plant's taxonomic ranking as a species.

### DESCRIPTION

The *Rhynchospora* genus includes approximately 200 species that occur primarily in the warm regions of both hemispheres. Most of the North American species of this genus are confined to the Atlantic coastal plain from eastern Massachusetts southward (Gleason 1952). In New Jersey the genus is represented by 17 species. The genus name *Rhynchospora* is from the Greek *rhynchos*, meaning beak and *spora*, meaning seed, which refers to the beaked seed or fruit (achene) that is characteristic of the genus.

*R. knieskernii* was first discovered by Peter D. Knieskern, M.D., in Ocean County, New Jersey in 1843 (Stone 1911). Dr. Knieskern originally labeled specimens of the plant as *Rhynchospora grayana*. However, a description of the species was not published until John Carey did so in 1847 (Carey 1847), renaming the species in honor of Dr. Knieskern. This grass-like plant has been considered an annual; however, recent information suggests that the plant may be a perennial or semi-perennial (W. Brumback, New England Wild Flower Society, pers. comm. 1993). *R. knieskernii* grows from 1.5 to 60 centimeters high (0.6 to 24 inches), has slender culms (stems) branching from the base, and short, narrowly linear leaves. Small spikelets (flower clusters) are numerous and occur at distant intervals along the entire length of the culm. The achene (fruit) is obovate, narrow at the base, 1.1 to 1.3 millimeters long (0.04 to 0.05 inches), and equal in length to the six downwardly-barbed, or rarely, upwardly-barbed attached bristles. A tubercle (beak), which is the persistent base of the two-cleft style on top of the achene, is about one-half the length of the achene (Figure 1).

## ECOLOGY AND LIFE HISTORY

### Habitat Characteristics

*R. knieskernii* is an obligate hydrophyte that occurs in groundwater-influenced, constantly fluctuating, successional habitats. An early successional species and colonizer, this species is intolerant of competition, especially from woody species. It is generally found on relatively bare substrates with sparse vegetation and limited duff.<sup>1</sup> Periodic disturbance, either natural or human-induced, which maintains a damp-to-wet site in an early seral stage may be necessary for the successful colonization, establishment, recruitment, and maintenance of *R. knieskernii*.

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<sup>1</sup> The substrates *R. knieskernii* is found on are continually moist to wet, and are described as various combinations of sand, clay, bog ore, gravel, and peat (e.g., sandy clay, gravelly sand with clay inclusions and traces of bog iron (Kolaga and Schuyler 1993); clayey sand mixed with gravel, peaty sand (Gordon 1993); and sandy peat (New Jersey Heritage Program 1991).

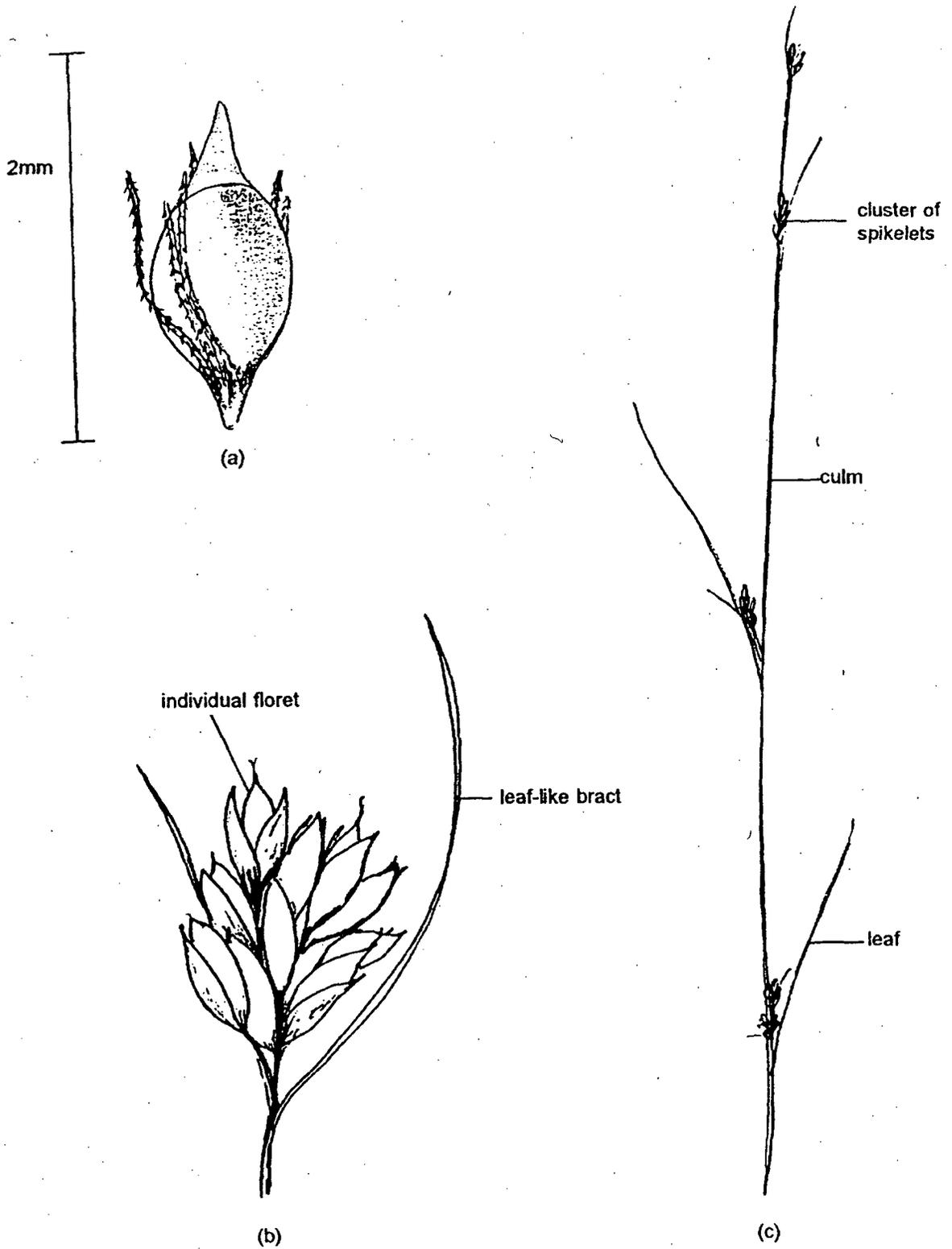


Figure 1. *Rhynchospora knieskernii*, (a) achene (fruit) with six barbed bristles, (b) cluster of spikelets, (c) flowering / fruiting culm. Illustration by Dana Peters.

The habitat originally thought to be required for the species is associated with bog-iron deposits (Robinson and Fernald 1908, Stone 1911); these areas are generally found adjacent to slow-moving streams in the New Jersey Pinelands region. Not many species have adapted to survival in this microhabitat (James Stasz, *in litt.*<sup>2</sup>, 1989). Boyd (1991) describes bog-iron deposits as being formed by the chemical action of slowly moving acid stream waters with the iron laden soils of stream beds. The soluble iron, which is oxidized by the aerated water system and oxidizing bacteria, precipitates as red flocculent and sludge. This precipitate settles and is deposited in the beds and adjacent wetland bogs of slow-moving streams, mixing with sand, mud, and decayed vegetation and hardening into thick, rocky "ironstone" ore beds. These bog-iron deposits are subject to the erosional forces of the stream system, which, combined with the durability of the bog-iron, allows the habitat to remain essentially unchanged and in an early seral stage. Bog-iron sites are therefore considered to be a naturally-maintained and long-lasting habitat for the species.

In the past, fire may have played an important role in creating and maintaining suitable habitat for *R. knieskernii*. Fires historically promoted the dominant pitch pine forests and open savannah areas, where characteristic Pinelands flora adapted to open, early-successional habitats. Occurrence records for *R. knieskernii* indicate that this plant is found in wet open areas within fire-dependent open pitch pine forests. Fire suppression during the past century has certainly changed the floral composition of the Pinelands region and may have eliminated, or certainly altered, a component of the ecosystem that naturally maintained habitat for this species.

In addition to these habitats that are created and maintained by natural forces, later records for *R. knieskernii* document that the species occurs in human-created early-successional wet habitats created by human disturbances to the landscape. These sites include: the edges of abandoned clay, sand, and gravel pits; borrow pits that are functioning as vernal ponds; ditches; unimproved roads; and railroad and powerline

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<sup>2</sup> Note: *in litt.* references refer to information received through correspondence, following style guidelines in the Endangered Species Listing Handbook, U.S. Fish and Wildlife Service, Division of Endangered Species and Habitat Conservation, January 1989.

rights-of-way. Although these human-disturbed sites are not associated with bog-iron deposits, they do exhibit some of the same characteristics as bog-iron sites, including a high water table, temporary inundation, and open, early-successional habitat with relatively bare substrate. Yearly hydrodynamics, and competition from native and introduced species, affect the long-term stability of these human-created habitats for *R. knieskernii*. In general, most of these sites require periodic human-induced disturbance to maintain their early-successional character. A few of the sand, gravel, and clay pit sites may persist without further intervention for decades due to the slow vegetative succession of these areas.

### **Biology and Population Demography**

*R. knieskernii* was generally considered to be an annual species; however, it is currently suspected to be a perennial, possibly in locations where habitat conditions are stable enough to allow uninterrupted growth year after year. Most extant populations exist in human-created habitats that experience yearly changes in habitat suitability due to drought, flooding, and vegetative succession. In these locations the populations are more variable from year to year, and the species most likely acts as an annual, germinating yearly from a seed bank. Although not all plants produce culms each year, flowering and seed production have been observed in very young plants. Fruiting typically occurs from July to September. Seed dispersal mechanisms are not documented; however, bristles on the achenes could assist in animal dispersal.

Information is lacking on reproductive biology, seed bank longevity and viability, seed dormancy mechanisms, conditions necessary for germination and seedling establishment, and level and distribution of genetic variability for this species. This information is needed in order to aid in the management of the species at extant sites, understand the colonization potential of the species, and aid in the possible establishment of the species at new or historical sites.

To date, *R. knieskernii* population sizes have been reported in areal cover by square yards, and by roughly estimating the number of individuals at a site. According to cursory estimates, the extant populations vary in size of areal cover from one square

yard to approximately 150 square yards. These population size estimates do not consider actual numbers or sizes of individuals or density within populations.

### **Associated Species**

The species in Table 1 are documented as vegetative associates of *R. knieskernii*. Due to the peculiar bog-iron habitat occupied by *R. knieskernii*, many of these associates are also rare; the State and Federal status of these species is noted.

### **DISTRIBUTION AND STATUS**

*Rhynchospora knieskernii* has always been considered rare (Knieskern 1857, Robinson and Fernald 1908, Stone 1911). Historically, the species was known to occur in Atlantic, Burlington, Camden, Monmouth, and Ocean Counties in New Jersey. With the discovery of a population in Camden County in 1992, extant populations of *R. knieskernii* are again documented from these five counties in New Jersey (Figure 2). Historically, there are also two documented occurrences from Sussex County, Delaware, known from 1874 and 1875 herbarium records. Although some knowledgeable field botanists consider it possible that the specimens from Delaware were actually collected from New Jersey and somehow mislabeled, this has not been proven to date; therefore, the species is still considered historical for Delaware, and searches for the species in Delaware continue. To date, no extant populations have been found in Delaware (William McAvoy, Delaware Natural Heritage Inventory, pers. comm. 1993).

The total number of documented occurrences of *R. knieskernii* is 48, which includes 14 historical populations and 34 extant populations. General information for the 34 extant populations of *R. knieskernii* is provided in Table 2. Historical occurrence records are summarized in Table 3.

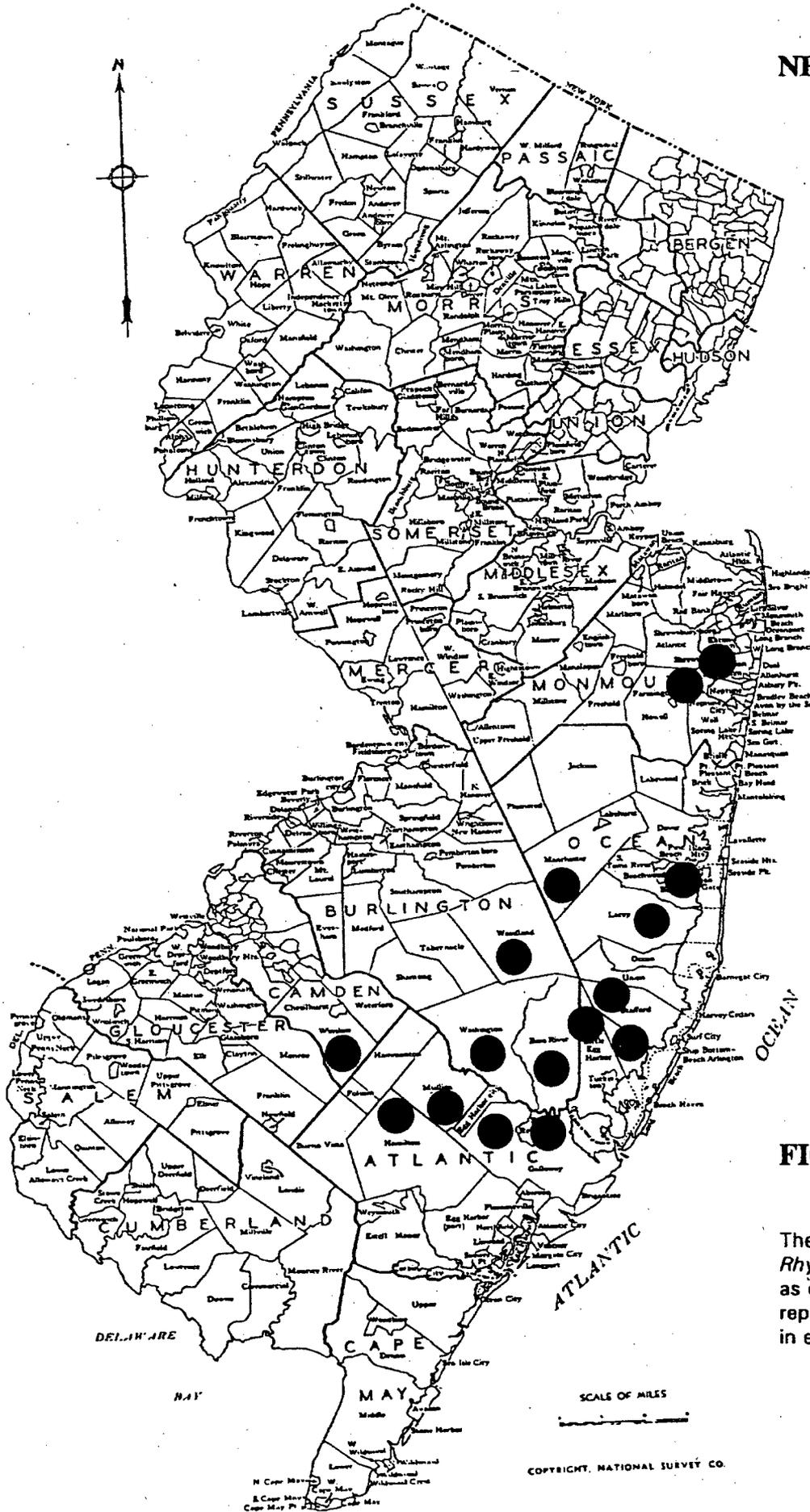
**Table 1. Vegetative Associates of *R. knieskernii***

(from Gordon 1993; species marked with \* from New Jersey Natural Heritage Program 1991)

Scientific Name	Common Name	Status
<i>Aletis farinosa</i>	White colic-root	
<i>Amphicarpum purshii</i>	Goobergrass	
<i>Andropogon glomeratus</i>	Bushy bluestem	
<i>Andropogon virginicus</i>		
<i>Aristida longispica</i>	Three-awned grass	
<i>Bartonia virginica</i>	Yellow screwstem	
<i>Calamagrostis cinnoides</i>	Nuttall's small-reedgrass	
<i>Calamovilfa brevipilis</i>	Pine barren reedgrass	S3
<i>Carex livida</i>	Livid sedge	S3
<i>Comptonia peregrina</i>	Sweet fern	
<i>Crotonopsis elliptica</i>	Rushfoil	S2
<i>Cyperus dentatus</i>	Flatsedge	
<i>Drosera intermedia</i>	Spoon-leaf sundew	
<i>Drosera filiformis</i>	Thread-leaf sundew	
<i>Eleocharis microcarpa</i>	Small-fruit spikerush	
<i>Eleocharis olivacea</i>	Bright-green spikerush	
<i>Eleocharis tuberculosa</i>	Long-tubercle spikerush	
<i>Epigaea repens</i>	Trailing arbutus	
<i>Eupatorium leucolepis*</i>	Boneset	
<i>Euthamia tenuifolia</i>	Fragrant golden-rod	
<i>Gentiana autumnalis</i>	Pine barren gentian	S3
<i>Hudsonia ericoides</i>	Golden heather	
<i>Hypericum canadense</i>	Canadian St. John's-wort	
<i>Hypericum gentianoides</i>	Orange-grass	
<i>Juncus pelocarpus</i>	Brown-fruit rush	
<i>Juncus canadense</i>	Canada rush	
<i>Juncus caesariensis</i>	New Jersey rush	E; C2
<i>Lachnanthes carolinianum</i>	Carolina redroot	
<i>Leiophyllum buxifolium</i>	Sand-myrtle	
<i>Lobelia canbyi</i>	Canby's lobelia	S3
<i>Lobelia nuttallii</i>	Nuttall's lobelia	
<i>Lycopodium alopecuroides</i>	Fox-tail clubmoss	
<i>Lycopodium adpressum</i>	Southern bog clubmoss	
<i>Lycopodium carolinianum*</i>	Slender clubmoss	
<i>Lyonia mariana</i>	Piedmont stagger-bush	
<i>Muhlenbergia torreyana</i>	Pine barren smoke grass	S3
<i>Muhlenbergia uniflora</i>	Smoke grass	
<i>Narthecium americanum</i>	Bog asphodel	E; C1
<i>Panicum longifolium</i>	Panic grass	
<i>Panicum verrucosum</i>	Warty panic grass	
<i>Panicum virgatum</i>	Switchgrass	
<i>Paspalum ciliatifolium</i>		
<i>Phragmites australis</i>	Common reed	
<i>Polygala cruciata</i>	Cross-leaf milkwort	
<i>Polygala nuttallii</i>	Nuttall's milkwort	
<i>Rhexia virginica</i>	Meadow beauty	
<i>Rhynchospora alba</i>	White beaked-rush	
<i>Rhynchospora capitellata</i>	Brownish beaked-rush	
<i>Rhynchospora cephalantha</i>	Clustered beaked-rush	S3
<i>Rhynchospora chalarocephala</i>	Loosehead beaked-rush	
<i>Rhynchospora fusca</i>	Brown beaked-rush	
<i>Rhynchospora gracilentia</i>	Slender beaked-rush	
<i>Rhynchospora pallida</i>	Pale beaked-rush	S3
<i>Rhynchospora torreyana*</i>	Torrey's beaked-rush	
<i>Sabatia difformis</i>	Lance-leaf rose gentian	
<i>Schizachyrium scoparium</i>	Little bluestem	
<i>Schizaea pusilla</i>	Curly grass fern	S3
<i>Scirpus cyperinus</i>	Wool-grass	
<i>Scleria minor</i>	Slender nut rush	S3
<i>Scleria reticularis var. pubescens</i>	Nut rush	
<i>Spiranthes cernua</i>	Nodding ladies-tresses	
<i>Vaccinium macrocarpon</i>	Cranberry	
<i>Viola lanceolata</i>	Lance-leaf violet	
<i>Viola primulifolia</i>	Primrose-leaf violet	
<i>Xyris difformis</i>	Common yellow-eyed grass	

E = New Jersey Endangered Plant list  
 S2= Ranking in New Jersey - Imperiled  
 S3= Ranking in New Jersey - Rare or Uncommon  
 C1= Federal Candidate - Category 1  
 C2= Federal Candidate - Category 2

# NEW JERSEY



**FIGURE 2.**

The general distribution of *Rhynchospora knieskernii* as of July 1993. The numbers represent the extant occurrences in each municipality.

Table 2. Extant Occurrences of *Rhynchospora knieskernii* (New Jersey Natural Heritage Program 1993, Gordon 1993, U.S. Fish and Wildlife Service files)

COUNTY	EO #* Site Name	MUNICIPALITY	USGS QUAD	SITE OWN**	FIRST OBS.	LAST OBS.	RANK ***	DESCRIPTION	SIZE	THREATS
Atlantic	002 Reega	Hamilton Township	Mays Landing	P	1985	1985 1992+	C	Inactive sand pits functioning as vernal pond; substrate gravel, sand, fine mud	Dense patches scattered over 2 acre area	Trash dumping; possible development
	003 Mackenzie Swales	Mullica Township	Egg Harbor City	P	1906	1985 1991+	C	Low grassy area in damp sandy peat on mowed powerline right-of-way	Scattered small patches	Succession
	006 Berlin Avenue Bogs	Galloway Township	Egg Harbor City	P		1984	C	Borrow pit functioning as a vernal pond	Large patch	Succession
	020 Cologne Road RR West	Galloway Township	Green Bank	P	1985	1985	D	Muddy vehicle ruts in powerline right-of-way through pitch pine lowland	Small population	Succession
	022 Big Doughnut	Mullica Township	Atsion	SF		1985 1993+	A	Low circular mound of bog ore in flooded savannah	Several thousand plants over Ca. 100 square yards	
	024 Reading at Darmstadt	Mullica Township	Egg Harbor City	P		1984	C	Cleared area in pitch pine lowland; bare muddy sand	Ca. 40 square yards	Succession
	025 Frankfurt Avenue Bog	Galloway Township	Green Bank	P	1984	1984	C	Borrow pit; once a cranberry bog; functioning as vernal pond; bare muddy sand	Locally abundant in patches over Ca. 30 square yards	Succession
	026 Reega NW	Hamilton Township	Mays Landing	P	1985	1985	B	Muddy vehicle ruts under powerline through pitch pine lowland	Dense patches over Ca. 65 square yards	Succession
	033 Drosera Street	Hamilton Township	Egg Harbor City	P		1985 1993+	C	Roadside ditch in pitch pine lowland; bare muddy sand		Succession; drought
	039 Parkway Gravel Pits	Port Republic	Green Bank	P	1992	1992	D	Abandoned gravel pit functioning as vernal pond	Several hundred plants	
	043 Laurel Street	Hamilton Township	Mays Landing	P	1991	1992	C	Vehicle ruts in sand road	Ca. 1,500 plants in 3 subpopulations	Development; succession
-- Greenberg	Hamilton Township	Mays Landing	P	1993	1993+		Abandoned area cleared for cranberry bogs; large ponds	Large, dense patches over 10-acre area		

Table 2. (continued) Extant Occurrences of *Rhynchospora knieskernii*

COUNTY	EO #* Site Name	MUNICIPALITY	USGS QUAD	SITE OWN**	FIRST OBS.	LAST OBS.	RANK ***	DESCRIPTION	SIZE	THREATS
Burlington	007 Hawkins Bridge	Washington Township	Jenkins	SF		1992	B	Bank of Wading River; mostly bare ground	Ca. 2,000 plants	
	023 Evans Bridge	Washington Township	Jenkins	SF		1985	C	Bank of Wading River; old oxbow with exposed bog ore	Ca. 25 square yards	
	027 Hawkins Bridge NW	Washington Township	Jenkins	SF		1985	C	Burned pitch pine lowland; bare sand patches	Ca. 9 square yards	Succession; drought
	032 Sacred River	Washington Township	Jenkins	SF		1985	A	Exposed bog ore in pitch pine lowland swale; pristine habitat	Locally dense; Ca. 150 square yards	
	-- Plains Branch Headwaters	Woodland Township	Woodmansie	SNA	1992	1992	D	Intermittent stream corridor in frequently burned pitch pine plains; sandy clay	15 culms over Ca. 12 square yards	
	-- Sykes Branch Headwaters	Woodland Township	Woodmansie	SNA	1992	1992	C	Vehicle ruts in intermittent stream corridor in open pitch pine lowland	90 fruiting plants over 27 square yards	
	-- FAA	Bass River Township (also partly in Ocean County/Little Egg Harbor Township)	Woodmansie and Oswego Lake	FAA	1987	1993	C	Grassy open area with vehicle ruts near communications towers through pitch pine lowland; sandy clay loam	Ca. 3,000 plants widely dispersed; 6 subpopulations	Succession
Ocean	014 Roosevelt City	Manchester Township	Whiting	P		1984	D	Bare muddy sand in clearing	Small population	Succession
	021 Pond 74	Little Egg Harbor Township	West Creek	SW	1974	1992	C	Old borrow pits in pine upland; clayey substrate	Thousands of plants	
	028 Fox Run	Manchester Township	Keswick Grove	P		1985	C	Abandoned clay pits; pitch pine lowland in housing development; pond edge, ditch, and right-of-way	Locally dense patches	Development, succession, drought
	029 Whiting Clay Pits	Manchester Township	Keswick Grove	P		1985	C	Abandoned clay pits, exposed muddy shoreline, muddy areas in paths	Ca. 100 square yards; thousands of plants	Development

Table 2. (continued) Extant Occurrences of *Rhynchospora knieskernii*

COUNTY	EO #* Site Name	MUNICIPALITY	USGS QUAD	SITE OWN**	FIRST OBS.	LAST OBS.	RANK ***	DESCRIPTION	SIZE	THREATS
	030 Harry Wright Lake	Manchester Township	Keswick Grove	P		1985	D	Small muddy swale	Ca. 2 square yards	Succession
	031 Crossley	Berkeley Township	Keswick Grove	P		1985	B	Abandoned clay pits; muddy sand	Locally dense patches	Succession
	034 Pits and Pond	Lacey Township	Forked River	P		1985	D	Old clay pits in pitch pine lowland	Very small population	Heavy disturbance by off-road vehicles; drought
	044 Stafford Forge: Rail Branch	Eagleswood Township	West Creek	SW		1992	D	Cleared patch of moist gravelly sand / clay along dike trail	Ca. 100 fruiting plants; 52 square yards	Succession; vehicles
	041 Lazarus	Stafford Township	West Creek	P	1992	1992	D	Abandoned sand pit; upper edges	Ca. 50 plants	
	042 North of Lazarus	Stafford Township	West Creek	P	1992	1992	D	Abandoned sand pit; wet tire ruts	Ca. 100 plants	Off-road vehicles
	-- Ocean Acres	Stafford/Barnegat Townships	Brookville	P		1992		Old sand roads cut for development purposes	Locally very dense patches; 8 subpopulations	Development, vehicles, succession
Camden	005	Winslow Township	Hammonton	P		1992	C	Shallow abandoned clay pit; sparsely vegetated sandy, clay substrate	Ca. 500 plants; 5 square yards	
Monmouth	037 Hockhockson	Colts Neck Township	Marlboro	N		1991+	D	Damp open area in pitch pine lowland	Ca. 40 culms	Succession
	038 Shark River	Wall Township	Farmingdale	P		1988	C	Moist sandy vehicle ruts on powerline access road	Ca. 1 square yard	Vehicles; succession
	-- Earle	Colts Neck Township	Marlboro	N		1988		Open damp grassy area	Ca. 10 square yards	Succession

\* Element occurrence number (assigned by New Jersey Natural Heritage Program)

\*\* Site ownership: P=Private land; SF=State Forest; SNA=State Natural Area; SW=State Wildlife Management Area; FAA=Federal Aviation Administration; N=U.S. Navy

\*\*\* Rankings assigned by the New Jersey Natural Heritage Program according to specifications in Appendix A.

+ Observation by the U.S. Fish and Wildlife Service

**Table 3. Historical Occurrences of *Rhynchospora knieskernii* (New Jersey Natural Heritage Program 1993)**

COUNTY	*EO#	MUNICIPALITY	USGS QUAD	LAST OBSERVED	DESCRIPTION
Atlantic	001	Mullica Township	Green Bank	1946	In damp sand ruts of deserted timber road passing through a savannah
	008	Galloway Township	Egg Harbor City	1906	In shallow water; probably along railroad right-of-way
	019	Port Republic	New Gretna	1961	Clay hole
	035	Hamilton Township	Mays Landing	1957	Old gravel pit
Burlington	004	Shamong Township	Atsion	1881	Iron ore banks
	009	Washington Township	Atsion	1887	Bog iron swamp
	010	Washington Township	Atsion	1879	Wet places
	011	Bass River Township	Oswego Lake	1939	Sandy and peaty bog
	012	Eaglewood Township	West Creek	1903	Pinelands region
	013	Manchester Township	Whiting	1907	Probably damp sandy roadside
Ocean	016	Lacey Township	Keswick Grove	1909	On iron ore
	018	Jackson Township	Lakehurst	1843?	Probably moist open Pinelands
Camden	017	Waterford Township	Hammonton	1916	Moist humus
Monmouth	036	Neptune Township	Asbury Park	1865	None given

\* Element occurrence number (assigned by New Jersey Natural Heritage Program)

Six of the extant populations occur on sites that are considered to be naturally-maintained in an early successional vegetative stage and therefore, should not require active management. Three of these six naturally-maintained extant populations (EO #'s 022, 023, and 032) occur on bog-iron deposits within Wharton State Forest. These populations are relatively secure since the habitat and much of the watershed is protected by State ownership. The habitat appears to be naturally-maintained in an early successional stage due to the erosional forces of streams and the durability of the bog-iron.

Another of the naturally-maintained extant populations (EO# 007) occurs along a hard-packed bank comprised of clay, peat, and iron-rich deposits along the Wading River. This population is also relatively secure since the site and much of the watershed are within Wharton State Forest, and the erosional forces of the Wading River maintain the early-successional character of the site. A potential threat to this population was reported by Gordon (1993) who indicated that the density of *Muhlenbergia torreyana* at the Wading River site appears to be increasing, possibly usurping space formerly occupied by *R. knieskernii*. Continued monitoring of this site will be necessary to determine the long-term viability of this population.

The remaining two naturally-maintained populations, recently discovered in the West Pine Plains Natural Area (Plains Branch Headwaters and Sykes Branch Headwaters occurrences) (Gordon 1993), are located in intermittent stream corridors in pitch pine lowlands. These two populations, although small, appear to be fairly secure due to the protected status of the sites by State ownership and the early-successional condition of the habitat, which is naturally maintained by intermittent streams.

The remaining 28 known extant occurrences of *R. knieskernii* occur on early successional sites created as the result of sand, clay, and gravel mining; borrow pit excavation; cranberry bog construction; and road, powerline, and ditch construction through wetland areas. It is presumed that since these sites exist due to human disturbance, some level of human intervention will be required to retain their suitability as habitat for *R. knieskernii*. Some of the larger abandoned sand, clay, gravel, borrow, and cranberry pits are now functioning as vernal ponds (e.g., EO#'s 002, 021, and the

Greenberg site); barring any significant changes in land use or groundwater hydrology, these sites will probably continue to remain suitable for *R. knieskernii* for several more decades. Similarly, a few of the larger populations occurring on seepage areas on unimproved sand roads (Ocean Acres population) could remain viable without management for many years if further development along the roads does not occur. The majority of the populations on human-disturbed sites, however, are relatively small and susceptible to vegetative succession and subtle changes in hydrology, possibly within the next decade. As indicated in Table 2, many of the small populations are located in extremely vulnerable locations, such as in ditches and tire ruts along roadways. These types of populations could persist for some time without management, but it is likely that extensive management would be needed to perpetuate viable populations on such sites.

Of the 28 extant populations occurring on human-disturbed sites, three are on Federal property, four are on State property, and 21 are on private property or on roadway or powerline rights-of-way. Sites in Federal or State ownership are afforded some protection from development, although it doesn't necessarily follow that management will be implemented to perpetuate the species on the site. The sites in private ownership are more susceptible to development or other permanent changes in land use that could eliminate the *R. knieskernii* habitat on those sites.

Rankings for most of the known extant occurrences have been determined by the New Jersey Natural Heritage Program (Table 2). Ranking criteria for *R. knieskernii* were developed by D.B. Snyder of the New Jersey Natural Heritage Program, following The Nature Conservancy's protocol, and are provided in Appendix A.

## THREATS

As noted above, 28 of the 34 extant *R. knieskernii* populations occur in early-successional, human-disturbed environments. While some of these sites have remained suitable for *R. knieskernii* without specific management for over 20 years, New Jersey Natural Heritage Program records (1993) indicate that approximately 19 of the 28 sites are currently undergoing vegetative succession that could eliminate *R. knieskernii* (refer to

Table 2). Without periodic intervention to reverse successional trends, these sites will most likely become unsuitable for the species in the future.

Since *R. knieskernii* appears to be able to readily colonize specific disturbed sites in the Pinelands region of New Jersey, but can persist on these sites only with continued habitat disturbance, an overall decline in either naturally-maintained, early-successional sites or human-induced disturbances could limit adequate availability of new sites for colonization. While this trend is unlikely on a rangewide basis, local distribution patterns of the species could be affected.

*R. knieskernii* appears to require relatively constant damp- to-wet soil conditions throughout most of the growing season. Human activities that alter site hydrology, or natural events such as drought, could eliminate site suitability for *R. knieskernii*. In addition, subtle changes that result in drier site conditions could promote vegetative succession, thereby eliminating *R. knieskernii*.

Fire can create suitable conditions for the species; however, Gordon (1993) noted that a previously unreported occurrence of the species within a burned pitch pine lowland was no longer extant due to invasion by other plant species following a subsequent fire. Fire can, therefore, be beneficial or detrimental to the establishment and maintenance of *R. knieskernii* depending on the timing, duration, and intensity of the burn.

Although some disturbance is necessary to maintain *R. knieskernii* on a site, excessive disturbances caused by off-road vehicles, trash dumping, and possibly roadside grading can cause local extirpations of the species. Current records indicate that four extant occurrences on private land are currently threatened by excessive or uncontrolled vehicle use of the site, and five extant occurrences are threatened by residential development (refer to Table 2).

## CONSERVATION MEASURES

### Searches and Studies

The New Jersey Natural Heritage Program conducted a survey of historical sites and *de novo* searches for *R. knieskernii* using a soil/habitat predictive method in 1984 and 1985. This method consisted of searching sparsely vegetated open seepage areas of sandy loam or clay on soil types known to support other occurrences of *R. knieskernii*. During the 1984 and 1985 surveys, several additional populations of *R. knieskernii* were discovered employing this strategy. Searches of Pocomoke sandy soils in Atlantic County were particularly productive in locating new populations.

Supplemented by Section 6 (Endangered Species Act) funding from Region 5 of the U.S. Fish and Wildlife Service, the New Jersey Office of Natural Lands Management contracted for a field survey of *R. knieskernii* sites in 1992 and 1993. During the field survey conducted in 1992, three documented extant populations (EO#'s 032, 007, and 021) were monitored to evaluate the current population size and the impact of succession and disturbance to the sites (Gordon 1993). These three sites, which had not been monitored since 1985, were still extant; however, the populations at all three sites were reported to be less extensive than in previous years. Gordon (1993) noted that EO# 021 experiences radical population fluctuations depending on the drought or flooding conditions at the site.

During the 1992 survey, five previously reported but undocumented populations (Laurel Street Site, FAA Tower Site, Ocean Acres Site, Winslow Junction Site, and Stafford Forge-Rail Branch Site) were verified, and two new populations were discovered (Sykes Branch Headwaters Site and Plains Branch Headwaters Site). For the 1993 survey, approximately 20 sites are being investigated, including extant populations and historical locations.

In 1991, W.E. Brumback of the New England Wild Flower Society, Garden in the Woods, began germination tests on seeds from *R. knieskernii* collected by D.B. Snyder of the New Jersey Natural Heritage Program. Based on these trial germination tests, it

appears that the species responds favorably to desiccation of the seeds before germination, which would aid in the plant's seed-banking abilities in the wild. These tests also verify that *R. knieskernii* has a perennial nature. The Center for Plant Conservation (CPC) has indicated that the Garden in the Woods, which is a participating institution for the CPC, will continue to determine the conditions and techniques required to germinate, establish, and grow *R. knieskernii* in cultivation (P. Olwell, Center for Plant Conservation, *in litt.* 1992). Additionally, the Garden in the Woods is willing to assist in describing the life history and investigating the existing seed bank and seed viability of *R. knieskernii*.

### **Habitat Protection**

The Nature Conservancy has made some initial landowner contacts to discuss conservation easements for some of the populations on private land. These contacts will continue on sites where landowner cooperation is considered feasible.

The U.S. Fish and Wildlife Service contacted the Department of the Navy (Navy) regarding the *R. knieskernii* populations occurring on the Naval Weapons Station-Earle in Monmouth County. Informal Section 7 consultation pursuant to the Endangered Species Act was conducted for one of the populations on this property that had the potential to be affected by remedial actions necessary for the clean-up of a hazardous waste site. The Service and a consulting botanist provided recommendations to the Navy for protection of this population, and also provided management recommendations for conserving both populations known to occur on the Naval Station. The Navy has indicated that these recommendations have been and will continue to be implemented.

The U.S. Fish and Wildlife Service also contacted the Federal Aviation Administration (FAA) regarding proposed projects at the communications Facility at Barnegat that could potentially affect the *R. knieskernii* population located at the facility. The FAA has revised its proposed project plans to avoid impacts to the species.

The New Jersey Division of Fish, Game and Wildlife has indicated (R. Porutski, New Jersey Division of Fish, Game and Wildlife, *in litt.* 1992) that it is willing to work in

developing a more specific plan for management of the *R. knieskernii* population that occurs on the Stafford Forge State Wildlife Management Area.

### **Regulatory Protection**

*R. knieskernii* is afforded some Federal and State protection in New Jersey pursuant to the following authorities:

Endangered Species Act of 1973 (ESA) (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.).

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to carry out conservation and recovery activities for listed species, thus allowing management and monitoring of *R. knieskernii* populations on Federal lands. Section 7(a)(2) of the ESA requires Federal agencies, through consultation with the U.S. Fish and Wildlife Service, to assess potential direct, indirect, and cumulative impacts for all Federal actions that may affect Federally-listed endangered and threatened species. Any Federal actions, including those that are permitted, funded, or authorized by a Federal agency, are subject to the provisions of Section 7, and are generally modified to avoid adverse impact to listed species, including *R. knieskernii*.

Section 9 of the ESA prohibits the import and export, transport in the course of commercial activity, or sale of endangered or threatened plants; the removal of endangered or threatened plants from areas under Federal jurisdiction; and the removal, cutting, digging, damaging, or destruction of such plants on other areas in knowing violation of State regulations or laws or in the course of violating State criminal trespass laws. This provision of the ESA provides some protection to populations on private lands.

Clean Water Act of 1977 (CWA) (86 Stat. 884, 33 U.S.C. 1344).

The CWA regulates the discharge of dredged or fill material and effluent in waters (including wetlands) of the United States. The applications of individual permits and many nationwide permits that authorize activities pursuant to the CWA receive review by the U.S. Fish and Wildlife Service to determine if the activities will adversely affect Federally-listed threatened or endangered species. No activities are authorized under CWA permits that are likely to jeopardize the continued existence of listed species. Some occurrences of *R. knieskernii*

may be in locations that are jurisdictional wetlands pursuant to the CWA and, therefore, receive protection from certain regulated activities that would be detrimental to the species.

(New Jersey) Pinelands Protection Act of 1979 (N.J.S.A. 13:18-1 et seq.). This Act prohibits all development that would impact the habitats of threatened and endangered species within the boundaries of the Pinelands National Reserve in New Jersey. Pursuant to its policy to preserve, protect, and enhance the diversity of plant communities through the regulation of development, the Pinelands Protection Act states that no development within the Pinelands shall be carried out unless it is designed to avoid irreversible adverse impacts to the survival of populations of threatened or endangered plants listed therein and allows for a maximum 300-foot buffer to wetlands supporting endangered and threatened species. *R. knieskernii* is listed as "endangered" by the Pinelands Commission. Since most of the extant occurrences of *R. knieskernii* are within the area regulated by the Pinelands Protection Act, application of the regulatory mechanisms provided by this Act can provide significant protection to habitats that support *R. knieskernii*.

(New Jersey) Freshwater Wetlands Protection Act (N.J.S.A. 13:19B-1 et seq.). This Act regulates activities in and adjacent to freshwater wetlands of New Jersey that are not regulated by the Pinelands Protection Act. Regulated activities must not jeopardize a threatened or endangered species or local population, or jeopardize or adversely modify their present or documented habitat. Present or documented wetland habitats of endangered or threatened species are classified as being of exceptional resource value and require a buffer of 150 feet adjacent to the wetlands. Federally-listed endangered or threatened plants are protected under this statute.

(New Jersey) Coastal Area Facility Review Act of 1973 (N.J.S.A. 13:19-1 et seq.). This Act regulates development in designated coastal regions of New Jersey. Development in habitat of species listed by the State as endangered, or those species on the Pinelands list, is prohibited unless it can be demonstrated that endangered or threatened species habitat would not be directly or indirectly adversely affected. The area regulated includes sufficient buffer to ensure the continued survival of endangered species. Currently, one population of *R. knieskernii* occurs within the jurisdiction of this legislation.

New Jersey Flood Hazard Area Control Act (N.J.S.A. 58: 16A-50 et seq.). This Act regulates development within the 100-year floodplain. Projects that may adversely affect endangered species' habitat in streams, wetlands, or through the deposition of dredged spoil are considered to be of special concern.

## RECOVERY STRATEGY

The recovery strategy for *R. knieskernii* is predicated upon a concept of species management, with habitat protection as a secondary aim. By all accounts, this species appears to be an efficient colonizer of human-disturbed sites. Although populations on naturally-disturbed habitats such as bog-iron sites appear to be largely self-sustaining, most of the populations found in human-altered habitats are small and unlikely to persist without intensive management. A course of action that recognizes the ephemeral quality of these populations and habitats, along with the apparent capacity of the plant to disperse and colonize new sites, is called for.

Recovery of this species will, therefore, focus on the core of naturally-maintained and large human-created sites, all of which, with the exception of one or possibly two populations, already occur on public lands. Priority will be given to ensuring the continued viability of these highly ranked populations (i.e., A- and B-ranked occurrences; see Table 2 and Appendix A) through formal commitments to long-range monitoring and management.

For the remaining populations, which occur for the most part on highly disturbed, and in several cases, highly degraded areas, recovery will rely on a strategy of monitoring colonization patterns, and, if deemed appropriate, facilitating the movement of this species through introductions to suitable habitats, rather than attempting to permanently protect current habitat in situ. This approach should ensure that the species persists over time, although not strictly in place. In the unlikely event of a pervasive decline in available suitable habitat, the natural or facilitated spread of the plant into conservation areas that are being managed as early successional habitats can be investigated. In any event, the two-pronged approach of protecting self-sustaining populations and facilitating continued

colonization of disturbed sites appears to be a feasible and effective means of ensuring the species' long-range viability.

## PART II: RECOVERY

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### RECOVERY OBJECTIVE

The objective of this recovery plan is to assure long-term viability of *R. knieskernii* in the wild, allowing removal of this plant from the Federal List of Endangered and Threatened Wildlife and Plants (50 CFR 17.11 and 17.12). Delisting of the species will be considered when the following conditions have been met:

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-range 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 (see Appendix A, "B" ranking).

- c. The occurrence is key to maintaining the species' historical range limits or genetic variability.
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.
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.
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 two years ago.

## RECOVERY TASKS

1. Provide the species and its habitat a level of protection commensurate to achieving recovery objectives.
  - 1.1 Ensure long-range protection for habitat on public lands. Sites on public lands should be designated, at least informally, as protected areas for the maintenance and management of *R. knieskernii* and, if appropriate, other rare plants or compatible values. These sites should be permanently exempted from management practices, development, and uses that could adversely affect this species. Particular emphasis should be given to self-sustaining populations on naturally-maintained habitats.
  - 1.2 As needed, make recommendations for best management practices. Using information gained in Task 3, develop management techniques applicable to maintaining a suitable disturbance regime, if and when needed, for viable populations on public lands. This could include techniques such as burning, mowing, water management, and soil scarification.

**Table 4. Stepdown Recovery Outline**

1.	Provide the species and its habitat a level of protection commensurate to achieving recovery objectives.
1.1	Ensure long-range protection for habitat on public lands.
1.2	As needed, make recommendations for best management practices.
1.3	Secure commitments from land managing agencies for long-range monitoring and management of the species on public lands.
1.4	Assess the feasibility and benefits of obtaining permanent protection for highly ranked sites that are <i>not currently found on public lands</i> .
1.5	As opportunities arise, seek landowner cooperation for protection of extant occurrences on private lands.
1.6	Ensure compliance with statutes protecting the species.
2.	Monitor the species' rangewide status.
2.1	As warranted, conduct searches for additional populations.
2.2	Update information on extant occurrences.
2.3	Determine overall trends over a three-year period.
3.	Determine the capacity of the plant to colonize new sites and establish populations.
3.1	Complete those life history studies that address this question.
3.2	Investigate seed-banking characteristics.
3.3	Characterize the species' habitat.
3.4	As needed, conduct experiments to determine the potential for introducing the species to suitable habitat.
4.	Develop a post-delisting strategy for maintaining the species in suitable habitats.
5.	Review recovery progress and revise the recovery plan as necessary.

- 1.3 Secure commitments from land managing agencies for long-range monitoring and management of the species on public lands. The commitment to ensure continued viability of *R. knieskernii* populations on public lands, as shown by development of management plans or strategies that incorporate the techniques defined in Task 1.2 and/or appropriate monitoring protocols (including "self-correcting" provisions), will be sought. In concert, these management commitments will comprise a comprehensive strategy for maintaining key populations in perpetuity.
- 1.4 Assess the feasibility and benefits of obtaining permanent protection for highly ranked sites that are not currently found on public lands. All known naturally-maintained sites occur on public lands. Those human-disturbed sites that appear to support viable populations of *R. knieskernii* (e.g., B-ranked occurrences) should be assessed in terms of their potential to be self-sustaining with little or no management, their biological significance, and the potential and costs for acquisition or conservation easement. Recommendations for obtaining permanent protection for such sites will be evaluated against priorities for those sites already on public lands, in terms of their relative contribution toward meeting recovery objectives.
- 1.5 As opportunities arise, seek landowner cooperation for protection of extant occurrences on private lands. The cooperation and active support of landowners in protecting and managing known occurrences of the species will be enlisted through landowner contacts and, when feasible, voluntary landowner agreements. Landowner agreements could include allowance of management activities to maintain the disturbance regime necessary for the plant's continued existence.
- 1.6 Ensure compliance with statutes protecting the species. The U.S. Fish and Wildlife Service will continue to coordinate with the U.S. Army Corps of Engineers and other appropriate Federal and State agencies to ensure that permits issued or enforcement actions initiated pursuant to the Clean Water Act avoid direct and indirect adverse impacts to *R. knieskernii*. Section

7(a)(1) of the Endangered Species Act, which directs Federal agencies to utilize their authorities in furtherance of the purposes of the Act by carrying out programs for the conservation and recovery of listed species, will also be emphasized.

Further coordination with all regulatory agencies that review and/or issue permits for activities that may affect *R. knieskernii* will be conducted to ensure that these agencies are aware of all known extant occurrences of *R. knieskernii* in order to fully implement the protection capabilities of the regulatory statutes that they are mandated to implement.

2. Monitor the species' rangewide status.

The primary purpose of this task is to determine overall status trends for *R. knieskernii*. At the present time, it appears that this species is at least stable, and possibly improving. It is possible, for instance, that its range may actually be expanding as it colonizes newly disturbed sites. Trend analysis should take into account the wide fluctuations in numbers that may occur from year to year, the dynamics of colonization and persistence, and past survey results.

2.1 As warranted, conduct searches for additional populations. For recovery purposes, these searches should be conducted in order to accurately characterize the species' status; for instance, to determine whether new colonies are being established to balance losses in extant occurrences. It should be noted that while discovery of significant additional populations could result in the re-focusing of habitat protection efforts, it would not in and of itself affect the numerical recovery objective.

2.2 Update information on extant occurrences. Due to the dynamic, opportunistic character of this species, the more tenuous populations may experience yearly size fluctuations as well as years of complete dormancy, and the status of a given population may change significantly over a short period. The implications of such changes need to be determined within the context of the species' survival strategies. Extant occurrences should thus

be checked to update information about population size, habitat conditions, and potential threats to the population,

- 2.3 Determine overall trends over a three-year period. Given what is known about the species' status to date along with information gained from Task 4, it should be evident within a short time whether the species is experiencing a demonstrable decline. Because there is now a preponderance of evidence showing that the species is not in decline, recovery will proceed on the assumption that *R. knieskernii* is stable or improving unless information is obtained to the contrary.
3. Determine the capacity of the plant to colonize new sites and establish populations.
  - 3.1 Complete those life history studies that address this question. Information on the breeding system, seed production and dispersal ability, germination behavior, phenotypic variations, mortality, growth, and population demographics of *R. knieskernii* should lead to an adequate understanding of the species. This task is likely to be accomplished through observations made in the course of monitoring known populations as well as specific studies.
  - 3.2 Investigate seed-banking characteristics. Conduct investigations to determine extent, viability, dormancy mechanisms, germination rates, longevity of seed banks, and management schemes that would promote germination and re-establishment of the species from seed banks.
  - 3.3 Characterize the species' habitat. This task will involve investigating hydrologic and edaphic conditions required for germination, seedling establishment, and maintenance of the species. This should help in identifying available habitat for possible colonization and/or suitable habitat for possible introductions. It may also help in determining limiting factors for colonization of new sites.

- 3.4 As needed, conduct experiments to determine the potential for introducing the species to suitable habitat. This activity should elucidate the capacity of the species' to occupy new sites, with and without facilitation. If it is determined, as a result of monitoring activities and life history studies, that introductions to suitable habitat may complement the species' ability to colonize new sites on its own, the results of these experiments can be used in developing a post-listing species management strategy.
4. Develop a post-delisting strategy for maintaining the species in suitable habitats. To ensure the long-range maintenance of *R. knieskernii*, a strategy should be formulated for monitoring the species and introducing the plant, as needed and appropriate, to suitable habitats within its historical range. This strategy should be developed as a cooperative effort among all those concerned with the species' continuing existence.
5. Review recovery progress and revise recovery plan as necessary. Periodically assess the overall success of the recovery program and recommend appropriate changes in recovery objectives or tasks as suggested by research, studies, or monitoring.

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## PART III: IMPLEMENTATION

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The following Implementation Schedule outlines actions and estimated costs of the recovery program. The Implementation Schedule is a guide for meeting the objectives discussed in Part II of this plan. This Schedule indicates task priorities, task numbers, task descriptions, duration of tasks, responsible agencies, and estimated costs. These actions, when accomplished, should bring about the recovery of the species and protect its habitat.

### KEY TO IMPLEMENTATION SCHEDULE PRIORITIES (COLUMN 1)

Priority 1 - An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

Priority 2 - An action that must be taken to prevent a significant decline in the species population / habitat quality or some other significant negative impact short of extinction.

Priority 3 - All other actions necessary to provide for full recovery of the species.

### KEY TO AGENCY ABBREVIATIONS (COLUMNS 5 and 6)

R5 ES = U.S. Fish and Wildlife Service, Region 5  
FA = Other Federal agencies  
SA = State Natural Heritage Programs or other natural resource agencies  
CO = Conservation organizations such as The Nature Conservancy  
PI = Private institutions such as universities and horticultural facilities

## IMPLEMENTATION SCHEDULE Knieskern's Beaked-Rush Recovery Plan

September 1993

Priority	Task Description	Task Number	Duration	Responsible Agency		Cost Estimates (\$000)			Comments
				USFWS	Other	FY1	FY2	FY3	
2	Ensure long-range protection for habitat on public lands.	1.1	2 years	R5 ES	FA, SA	1	1		
2	Make recommendations for best management practices.	1.2	1 year		SA, CO		2		
2	Secure commitments for long-range monitoring and management of the species on public lands.	1.3	1 year	R5 ES	FA, SA			2	
2	Update information on extant occurrences.	2.2	3 years	R5 ES	SA	8	8	8	This task should also address the questions in Tasks 3.1 and 3.3.
2	Determine status trends over a three-year period.	2.3	1 year	R5 ES	SA			1	Assessment based on results of Task 2.2.
2	Complete pertinent life history studies.	3.1	2 years		SA, PI	4	4		
2	Characterize the species' habitat.	3.3	1 year	R5 ES	SA, CO, PI		3		
3	Assess the feasibility of obtaining permanent protection for highly ranked sites not currently found on public lands.	1.4	1 year	R5 ES	SA, CO	2			Will assess extant occurrences, including any found in 1993 survey.
3	Seek landowner cooperation.	1.5	3 years	R5 ES	SA, ES	1	1	1	
3	Ensure compliance with statutes protecting the species.	1.6	3 years	R5 ES	FA, SA	2	2	2	

Krieskern's Beaked-Rush Recovery Plan, Implementation Schedule (continued), September 1993

Priority	Task Description	Task Number	Duration	Responsible Agency		Cost Estimates (\$000)			Comments
				USFWS	Other	FY1	FY2	FY3	
3	Conduct searches for additional populations.	2.1	2 years		SA	5	2		
3	Investigate seed-banking characteristics.	3.2	2 years		PI	3	3		
3	Conduct experiments to determine the potential for introducing the species to suitable habitat.	3.4	3 years	R5 ES	SA, CO	4	4	4	
3	Develop a post-delisting strategy for maintaining the species in suitable habitat.	4.	1 year	R5 ES	SA, CO			2	
3	Review recovery progress and revise recovery plan as necessary.	5.	Ongoing	R5 ES	SA				No funding allocation.

## APPENDIX A

### *Rhynchospora knieskernii* Element Occurrence Ranking Specifications

The following specifications were developed by David B. Snyder of the New Jersey Natural Heritage Program, following The Nature Conservancy's protocol.

#### "A" RANKING

**Habitat:** Pristine or near pristine pitch pine lowland forest complexes with no or minimal hydrological impacts and stable conditions. No or minimal management necessary to maintain long-term viability. Off road vehicles and other incompatible human uses minimal or easily controlled. Occurrence located within a viable fireshed or in area where natural disturbance has not been disrupted. Aggressive exotic plant species none or easily controlled. Surrounding land in sufficient wooded or other compatible buffer to assure long-term viability.

**Population Size and Vigor:** 5,000 or more plants in contiguous habitat.

**Exemplary Occurrence:** Greater than 10,000 plants.

#### "B" RANKING

**Habitat:** Habitat in excellent condition with only minor impacts or disturbance, none of which are directly impacting or significantly degrading habitat. Site may have trails or be bisected by road. May be adjacent to agricultural or cleared lands, or low density development, but no direct or significant long term impacts observable or anticipated. Natural cycle of wild fires may be disrupted and may require controlled burn to manage woody succession. Exotics present but not significantly impacting habitat. All impacts can be mitigated with minimal effort and expense. Reasonable amount of wooded or other buffer present to insure long-term viability.

**Population size and vigor:** Any size population of 1,000 or more plants in contiguous habitat.

## **"C" RANKING**

**Habitat:** Habitat significantly disturbed and fragmented, often with declining conditions. Portions of habitat occupied by element, ditched, dammed, or cleared (including powerline, railroad, and road rights-of-ways) or in some other way impacted. Remaining buffer less than optimal. Fire ecology or other natural disturbances strongly compromised. Occurrence recoverable with substantial effort or expense.

**Population Size and Vigor:** Any size population over 100 plants.

## **"D" Ranking**

**Habitat:** Heavily, and possibly irreversibly, disturbed or altered. Impacts significant, ongoing, and directly impacting population. Little or no remaining buffer. Population with little or no potential for recovery, at least not without an extraordinary expenditure of time and money.

**Population Size and Vigor:** Any population regardless of size or numbers.

## APPENDIX B

### List of Reviewers

Following is the list of individuals/agencies that received a copy of the Technical/Agency Draft recovery plan. An asterisk (\*) indicates the reviewers who submitted comments. All comments were reviewed and incorporated, as appropriate, into the recovery plan. Comments are on file in the Service's New Jersey Field Office, Pleasantville, New Jersey.

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