2014

Resource Recovery Plan for Parker's Pipewort (*Eriocaulon parkeri* B.L. Rob) in Pennsylvania

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An independent study project report by The John J. Willaman and Martha Haas Valentine Endowed Plant Protection Intern (2013-2014)

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Disciplines
Botany | Horticulture

Comments
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Date: **April 2014**

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CLASSIFICATION

Eriocaulon parkeri (Parker's pipewort), in the family Eriocaulaceae (pipewort family), was recognized as a distinct species and described by Benjamin Lincoln Robinson in the fifth volume of *Rhodora* in 1903 based on specimens collected along the Delaware River near Camden, NJ (Robinson, 1903). It was previously collected and included as *E. septangulare* by T.P. James in September 1858, and C.F. Parker in October 1877. Robinson dedicated the species to the late Charles F. Parker, curator of the Philadelphia Academy of Natural Sciences.

Synonyms
Eriocaulon pellucidum f. *rollandii* (J.Rousseau) Moldenke (1979)
Eriocaulon rollandii J.Rousseau (1957)
Eriocaulon septangulare var. *parkeri* (B.L.Rob) B. Boivin & J. Cay (1967)
Eriocaulon septangulare f. *rollandii* (J.Rousseau) Lepage (1974)

(The Plant List, 2013)

DESCRIPTION

Morphology

Eriocaulon parkeri is a small, erect, annual aquatic herb composed of 1-4 straight, unbranched, leafless flower stalks, referred to as scapes, 1-20 cm long with 4-5 longitudinal ridges, surrounded by a dense rosette of thin, pliant, basal, grass-like leaves, 1-6 cm long (Figure 1). The leaves have 3-9 nerves with numerous cross-veinlets, creating a net-like appearance. At the top of the scape sits a small (3-4 mm wide), button-like, grayish-white flower head (or capitulum) comprised of unisexual flowers, ~2 mm long. A small, receptacle bract supports each flower of the capitulum. Each flower contains two sepals and two petals, with a nectary gland located on the petal just below the apex. Short, white hairs can often be seen on the receptacle bracts, sepal, and petals with magnification. The staminate flowers contain four pollen-bearing stamens protruding from a short stalk, referred to as an androphore. The carpellate flowers have a single, two-chambered ovary on a short stalk, called the gynophore (Figure 2). The diminutive, capsulated fruit encloses two minute (0.5-0.7 mm long and 0.3-0.5 mm in diameter), ovate to elliptic, reddish-brown seeds with a delicate network of horizontally orientated rectangles (Figure 3). *Eriocaulon parkeri* has been reported to have a chromosome number of 2n=48 (Schuyler, 1990).

REPRODUCTION

Eriocaulon parkeri is monoecious, meaning it has separate staminate and carpellate flowers within the same inflorescence. Male flowers tend to congregate towards the center of the capitulum, surrounded by the female flowers on the outside (Sawyer et al., 2005). The inflorescences of Parker's pipewort are protandrous, meaning the male flowers mature before the female flowers. In 1875 Eichler referred to the Eriocaulaceae family as the 'compositae amongst

the monocotyledons' due to the similarity to Asteraceae (Stützel and Trovó, 2013). In his 1981 and 1984 papers, Stützel stated that the arrangement of male and female flowers within a capitulum has an effect on the reproduction of the species, and might result in autogamy (geitonogamy), despite the flowers being unisexual (Stützel and Trovó, 2013). There is a large range in the number of seeds produced in a single capitulum. I collected as little as three seeds, and as many as 56 seeds from one capitulum from specimens collected at Riverview Park in Millville, NJ on 16. October 2013.

Pollination and Seed Dispersal

There is dispute among authors as to the method of pollination in the Eriocaulaceae. *Eriocaulon parkeri* flowers from July to October (Fernald, 1950). Pollination most likely occurs between flowers on the same capitulum, rather than between flowers on separate heads (Uphof, 1927). Uphof described the presence of mites, which did not move from one flower head to another, but instead transferred pollen from male to female flowers on the same capitulum. He discovered that mites were more prevalent than flying insects. Haines (2001) stated that other methods of pollination have been described as autogamous (self-pollinated) or entomophilous (insect-pollinated) by Cook (1996), and as anemophilous (wind-pollinated) or entomophilous by Gleason and Cronquist (1991). Due to the type of habitat in which *E. parkeri* is found, Schuyler (1990) determined that most reproduction is from seeds, which may be dispersed by wind, water, and/or waterfowl.

A Connecticut field and greenhouse study completed by Sawyer et al. (2005) suggests that *E. parkeri* depends heavily on self-pollination for seed production. Bagged plants in the greenhouse produced the highest amount of seeds, and field observations showed limited insect visitation.

Seed Germination and Seed Banking

Very little research has been done on the germination requirements of *Eriocaulon parkeri*. For this reason, W.C. Muenscher's methods for storage and germination of *E. septangulare* seeds were followed (Muenscher, 1936). Alexandra Seglias, Ann Rhoads, and Cynthia Skema collected Parker's pipewort in mid-October 2013 at low tide from Riverview Park along the Maurice River in Millville, NJ (GPS: 39.39961N, 75.05370W). The plants were taken back to the Morris Arboretum greenhouse and placed in the 20˚C room. When the flower heads reached maturity the seeds were extracted under a microscope, stored in vials of water (seeds from one capitulum/vial), and placed in a cold chamber at 5˚C. After four months in the cold chamber, a portion of the seeds were moved to the greenhouse at ~19˚C in petri dishes filled with water. The seeds exhibited strong germination rates in water, with 92.1% of the seeds germinating.

A second germination study was conducted in sediment from sites where *Eriocaulon parkeri* historically occurred. Sediment was collected from the tidal marshes at Bristol Marsh, and Neshaminy Creek. Both sites are located in Bucks County, PA. The sediment was collected in containers (~22 cm x 15 cm x 4 cm), and brought back to the Morris Arboretum. Seeds extracted from specimens of Parker's pipewort from Riverview Park were sown in the sediment, and the containers were placed in the growth chamber at 14-21˚C with day and night conditions.

The seeds have germinated in the sediment from both sites, but it is too early to determine if there is a statistical significance between the two sites.

ECOLOGY

Range

Eriocaulon parkeri is native to tidal rivers and estuaries of eastern North America. The species occurs in the Ottawa River and Saint Lawrence River estuaries of Quebec and the Miramichi River estuary of New Brunswick in Canada, south to North Carolina, excluding New Hampshire, Vermont, and Rhode Island (Figure 4). Parker's pipewort is presumed extirpated in New York, Pennsylvania, and the District of Columbia (NatureServe, 2013).

Habitat

Parker's pipewort is usually found in fresh to slightly brackish (< 5.0 parts per thousand) intertidal zones of rivers and estuaries; on mudflats (Figure 5), or in tidal marshes; and occasionally in coastal ponds (NatureServe, 2013). Species previously associated with *Eriocaulon parkeri* in New Jersey include *Elatine americana, Elatine minima, I*soetes *riparia, Limosella subulata, Micranthemum micranthemoides, Sagittaria subulata, Zizania aquatic*, and occasionally *Spartina alterniflora* where conditions are somewhat brackish (Schuyler, 1990). Ann Rhoads (14. September 2013) identified *Eleocharis flavescens* var. *olivacea, Cyperus bipartitus, Orontium aquaticum*, *Nuphar advena*, and *Peltandra virginica* growing alongside *Eriocaulon parkeri* on the Maurice River mudflats in Millville, NJ.

CONSERVATION STATUS

Eriocaulon parkeri is ranked as vulnerable at the global (G3), and the national (N3) levels (NatureServe 2013). It is ranked as vulnerable (S3) in Quebec and Maine, imperiled (S2) in New Brunswick, New Jersey, Delaware, Maryland, and Virginia, critically imperiled (S1) in Massachusetts, Connecticut, and North Carolina, possibly extirpated (SH) in District of Columbia, and presumed extirpated (SX) in New York and Pennsylvania (Figure 6).

ERIOCAULON PARKERI IN PENNSYLVANIA

Early Herbarium Records

The earliest Pennsylvania records of *Eriocaulon parkeri* come from Tinicum in Delaware County (1864, 1874). The last recorded collection in Pennsylvania comes from Bucks County in 1932 (Table 1). These herbarium specimens are housed at the Academy of Natural Sciences in Philadelphia, PA.

Eriocaulon parkeri is known from three counties in eastern Pennsylvania from tidal mudflats along the Delaware River (Figure 7). All populations in Pennsylvania are presumed extirpated.

The last collection of *E. parkeri* in Pennsylvania was above Philadelphia near the mouth of Neshaminy Creek in 1932 (Schuyler, 1986).

STATUS OF *ERIOCAULON PARKERI* IN OTHER STATES

Connecticut

Eriocaulon parkeri is ranked critically imperiled or imperiled (S1S2) in Connecticut. There are extant populations in Middlesex County and New London County. Historically the species also occurred in Fairfield County and New Haven County, but these populations are now possibly extirpated (NatureServe 2013). According to Haines, there were five current populations and 7 historic occurrences in Connecticut as of 2001.

Delaware

Eriocaulon parkeri is ranked imperiled (S2) in Delaware. There are extant populations of the species in New Castle County and Sussex County (NatureServe 2013).

Massachusetts

Parker's pipewort is ranked critically imperiled (S1) in Massachusetts. There are four current, and three historic occurrences in the state (Haines, 2001). The species exists in Essex County and Plymouth County (NatureServe 2013).

Maryland

Eriocaulon parkeri is ranked imperiled (S2) in Maryland. Populations can be found in Baltimore County, Caroline County, Cecil County, Dorchester County, Harford County, Wicomico County, and Worcester County. There is a historic occurrence of the species in Charles County, but the population is presumed extirpated (NatureServe 2013).

Maine

The species is ranked as vulnerable (S3) in Maine. There are 31 current populations in the state and three historic occurrences (Haines, 2001). Extant populations are located in Kennebec County, Lincoln County, Penobscot County, Sagadahoc County, and York County. Historic populations occurred in Cumberland County, Hancock County, and Waldo County (NatureServe 2013). Dates of documented observations are: 1924, 1937 (2), 1979, 1983 (2), 1985 (3), 1986, 1990 (4), 1992, 1994, 1995 (2), 1996 (2), 1998 (11), 1999 (2), 2000, 2001, and 2002 (5) (Maine Department of Conservation, 2004).

North Carolina

North Carolina is the southern extent of the range of *E. parkeri*. The species is listed as critically imperiled (S1), and can be found in two counties in the state: Hyde County and Tyrrell County (NatureServe 2013).

New Jersey

Eriocaulon parkeri is ranked imperiled (S2) in New Jersey. According to Haines (2001) there are eight occurrences of Parker's pipewort in the state. The species can be found in the following counties: Atlantic, Burlington, Cape May, and Cumberland. The species historically existed in Camden County, Gloucester County, Mercer County, Monmouth County, Ocean County, and

Salem County, but is now presumed extirpated at all those locations (NatureServe 2013). The extant populations of *E. parkeri* in New Jersey occur along tidal portions of tributaries of the Delaware River and coastal rivers in the Pine Barrens, as well as in a few coastal ponds. Based on the number of extant populations, Schuyler (1990) determined that *E. parkeri* had a high element occurrence (EO) in the Mullica and Great Egg Harbor systems. *Eriocaulon parkeri* has been restricted to a few scattered sites along three tributaries of the Delaware River: Rancocas Creek, Deep Run near the junction with Alloway Creek, and the Maurice River. It is additionally found in a tributary of the Maurice River, Menantico Creek. The species historically occurred at many more sites in the Delaware system, but now populations are few and small, indicating a lower EO quality.

New York

Eriocaulon parkeri historically existed along the Hudson River in New York, but is now presumed extirpated (SX). Counties in which the species historically existed are: Albany, Columbia, Dutchess, Greene, Orange, Rockland, and Ulster (NatureServe 2013).

Virginia

Parker's pipewort is ranked imperiled (S2) in Virginia. Current populations can be found in the following counties: Charles City, James City, King William, King and Queen, New Kent, and Stafford. Populations that are now presumed extirpated were recorded from the following counties: Caroline, Essex, Fairfax, Gloucester, King George, Middlesex, Prince George, Southampton, and Suffolk (NatureServe 2013).

CRITICAL MANAGEMENT ISSUES

Population Decline

There are approximately 130 extant occurrences of *Eriocaulon parkeri*, 88 historical occurrences, and 22 occurrences that are now considered extirpated (NatureServe 2013). The species has faced population declines in most states and provinces from which it has been documented, especially in the southern part of its range. Parker's pipewort was once quite abundant in the Delaware River Estuary, but has disappeared from all known sites along the River's main channel, and is now limited to only a few sites along tributaries in New Jersey. The species also historically existed in the Hudson River Estuary, but is now listed as extirpated in New York State. The Chesapeake Estuary has additionally seen population decline, and the species is considered historical or extirpated in the District of Columbia.

There are an estimated 40,000-120,000 individuals of *Eriocaulon parkeri* remaining, according to the most recent occurrence counts. The species has experienced a long-term decline of 30-70% (NatureServe, 2013). Haines (2001) states that populations of Parker's pipewort can be exceedingly variable in both number and locations of plants from year to year, and dramatic differences can be seen in as little as three years. Some populations can contain extensive colonies, whereas others may have only a few plants. These dramatic fluctuations are typical of an annual species, and suggest that *E. parkeri* may have a strong relationship with environmental

conditions. Most current occurrences are small, with less than 50 individuals. About 41-125 current occurrences are considered to have good viability (NatureServe, 2013).

Contributing Factors

Habitat loss/degradation – Increase in development along major rivers has been, and continues to be a major threat to *Eriocaulon parkeri*. In the Delaware Estuary, an estimated 50 percent of the natural marshes have been lost due to development, conversion, and degradation (State of the Delaware River Basin Report 2008). Wetland losses have been most severe in urban areas, where only about five percent of freshwater tidal marsh remains. This degradation of freshwater tidal marsh may have had detrimental effects on populations of Parker's pipewort along the Delaware River.

Habitat loss can occur as a result of other processes, such as inundation, dredging, and pollution. Pier and dock construction may be responsible for population decline (Haines, 2001). The construction itself can result in toxicity and disturbance, and following establishment, a dock may prevent direct sun from reaching populations. Changes in wake patterns as a result of increased boat traffic along the Delaware River may have also contributed to population declines of *Eriocaulon parkeri*. Once habitat destruction occurs, whether it is from dredging, construction, or pollution, the ability of the original intertidal flora to re-vegetate the area will be extremely limited due to reduced dispersal mechanisms (Ferren and Schuyler, 1980).

Climate change – *Eriocaulon parkeri* is exposed twice daily during low tide, suggesting that prolonged periods of inundation are likely detrimental (Haines, 2001). Higher water levels as a result of global climate change (Figure 8) may be having a harmful effect on populations of Parker's pipewort. The rate of sea level increase at Philadelphia from 1900 through 1999 was 0.108 inches/year, or about one inch every nine years (State of the Delaware River Basin Report 2008). As sea levels rise, freshwater areas will face the intrusion of salt water. Freshwater flows from the rivers and streams in the Delaware estuary prevent salinity intrusion into freshwater areas. A combination of rising sea levels and decreasing fresh water flows could have a negative effect on the ability to take in fresh water and prevent intrusion of salt water. *Eriocaulon parkeri* is confined to fresh to slightly brackish habitats (less than 5.0 parts per thousand). The distribution of the species seems to be restricted by the limits of tidal influence upstream and by salinity flows downstream (NatureServe, 2013). According to Steve Eisenhauer of Natural Lands Trust at Peek Preserve, NJ, increase of salinity in the Maurice River area has led to population declines of Parker's pipewort (personal communication, 2014). Eisenhauer expects that salinity levels fluctuate with the tides and the seasons, but he has noticed that just downstream from the former *E. parkeri* habitat, salt tolerant emergent wetland plant species have started to appear. This may be a good indicator of the changing salinity levels in the area surrounding Peek Preserve in the Maurice River.

Water pollution – Increased toxicity of water was, and continues to be a major threat to populations of *Eriocaulon parkeri*. According to Schuyler (1990), poor water quality in the vicinity of Philadelphia during the mid-20th century most likely contributed to declines in occurrences of Parker's pipewort along the Delaware River. Water quality has improved in the latter half of the 20th century, but there still exist areas that have poor nutrient quality. Factors

that contribute to the pollution of the River and subsequent extirpations and reductions of intertidal plant populations include the dumping of dredging spoil, landfills, and refuse (Ferren and Schuyler, 1980). Eisenhauer hypothesizes that the location of a sewage treatment plant upstream of the *E. parkeri* habitat at Peek Preserve has degraded the area and affected the ability of the species to subsist (personal communication, 2014). Discharge from the treatment plant – potentially containing chlorine, or other contaminants – has affected subaquatic vegetative growth, and has increased water levels downstream.

CONCLUSIONS

Stabilization of Existing Populations

The existing populations of *Eriocaulon parkeri* in New Jersey, and other states, should be monitored from year to year. Increasing salinity in freshwater areas may be a reason for decline in populations in some tributaries of the Delaware River in New Jersey.

Tidal wetlands are vulnerable to pollution, and rising sea levels, and as a result are facing increased degradation and destruction. It is imperative that these areas, and adjacent land, are protected from further damage in order to conserve species that rely on the resources and habitat for survival, and to allow for up-slope migration with increased sea level.

Establishment of New Populations

An attempt should be made to restore populations of *Eriocaulon parkeri* to historical sites where suitable habitat remains. Potential sites and environmental factors should be evaluated for the likelihood of establishment of new populations. Initial results show that Neshaminy Creek may be a possible site for reintroduction, but more research still needs to be conducted to determine the probability of the species to subsist at this location. Seeds from the closest existing, and natural population should be propagated off site to generate plants for the purpose of establishing new populations.

Measures of Success

- Closest populations in NJ stable or increasing
- Clear and established propagation methods

Research Needs

- What are the effects of increased salinity on populations of *Eriocaulon parkeri?*
- What are the critical environmental factors that limit where *E. parkeri* grows?
- How can new populations be established following off-site propagation?
- How long does viable seed remain in the soil? What is the seed banking potential for the species?

FIGURES AND TABLES

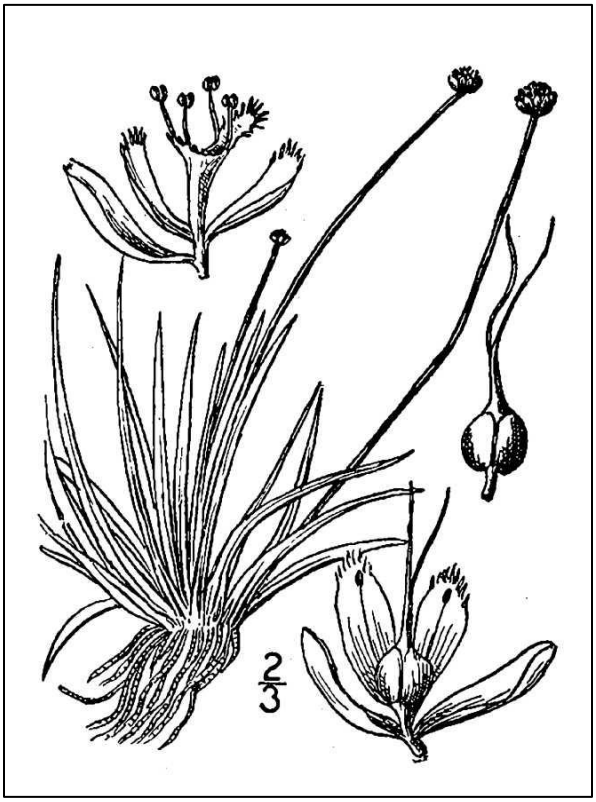

Figure 1. Morphology of *Eriocaulon parkeri*. Source: USDA Plants Database

Figure 2. Microscopic image of female flower. Photographed 21. October 2013.

Figure 3. Microscopic image of two mature seeds, ~0.7 mm. Photographed 21. October 2013.

Figure 4. Range of *Eriocaulon parkeri* in North America. Source: Plants Database

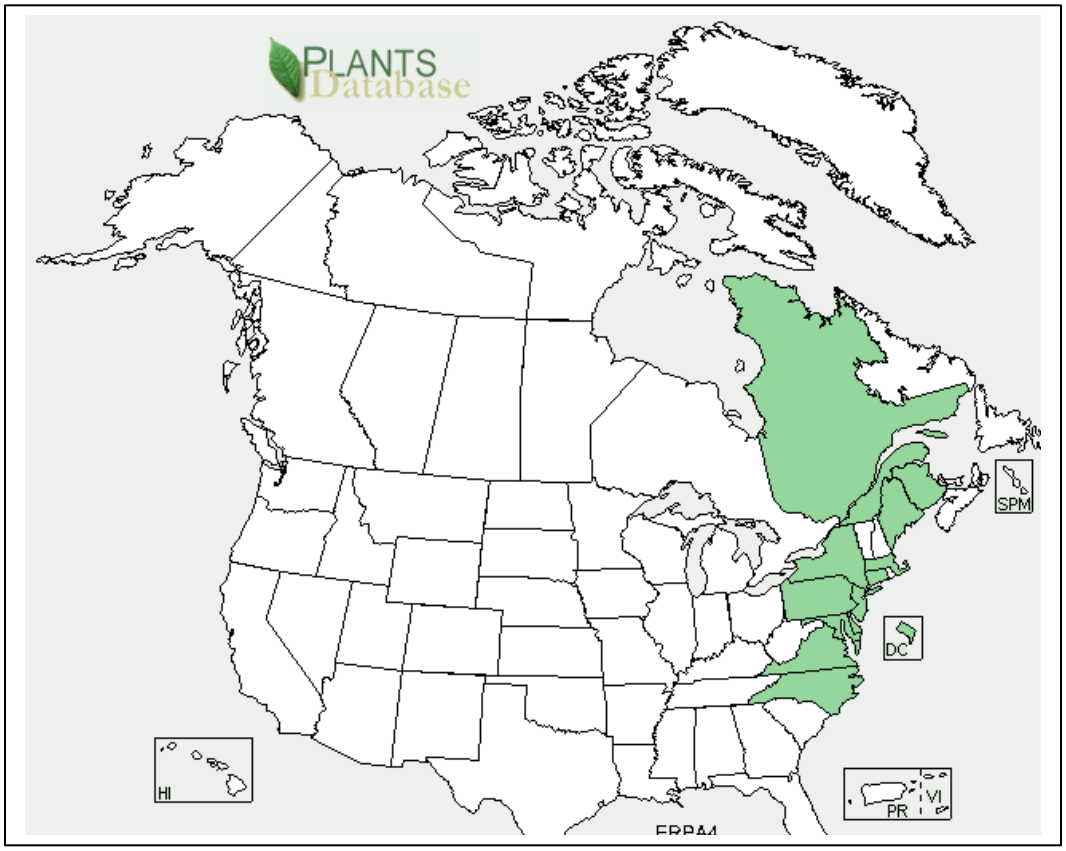

Figure 5. Tidal freshwater mudflat with *Eriocaulon parkeri* at low tide on the Maurice River in Millville, NJ. Photographed by Ann Rhoads October 16, 2013.

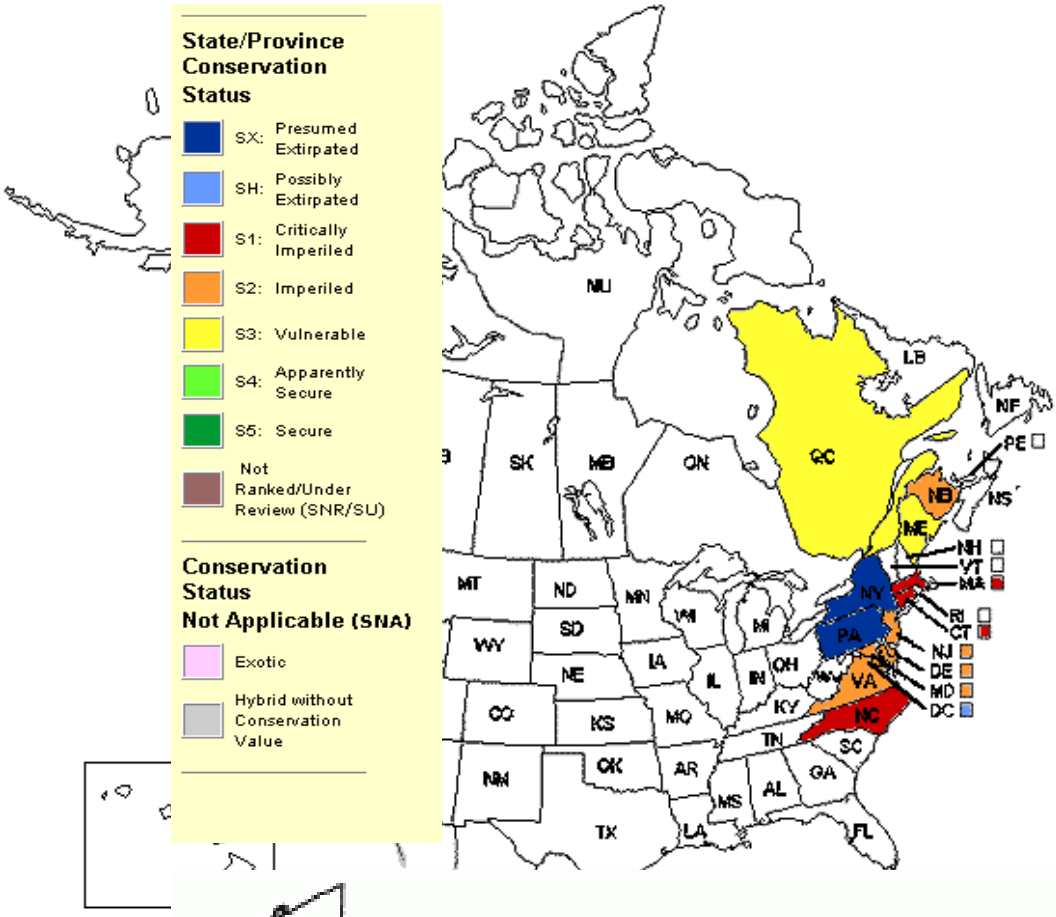

Figure 6. Conservation status of *Eriocaulon parkeri*. Source: NatureServe 2013.

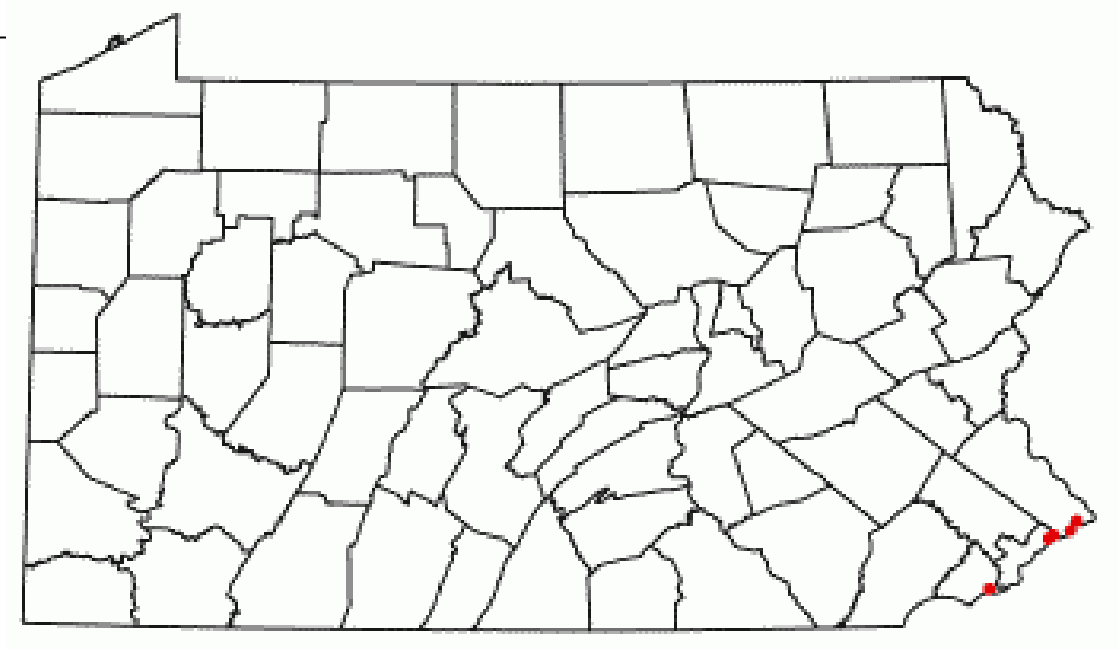

Figure 7. Map of historical occurrences of *Eriocaulon parkeri* in Pennsylvania. Source: The Pennsylvania Flora Project

Figure 8. 2001 aerial photograph of Maurice River Cove depicting a receding shoreline since 1890. Photo courtesy of J. Gebert, U.S. Army Corps of Engineers, Philadelphia District. Source: State of the Delaware River Basin Report 2008

Table 1. *Eriocaulon parkeri* specimen records from Pennsylvania.
Source: Herbarium of the Academy of Natural Sciences of Philadelphia

Year	County	Location	Location Detail	Collector
not given		not given		not given
not given	Delaware	Tinicum		not given
1864	Delaware	Tinicum	Shores of Delaware River	Geo. Smith
1864	Delaware	Tinicum		A.H. Smith
1874	Delaware	Tinicum	Along the Delaware River	J.W. Eckfeldt
1874	Delaware	Tinicum	Tide water	J.W. Eckfeldt
1904	Philadelphia?	Torresdale		Stewardson Brown
1923	Bucks	Torresdale Manor	Andalusia	Bayard Long
1926	Bucks	Bristol	Tidal mudflats	Walter M. Benner
1927	Bucks	Tullytown	Wet, sandy tidal shores along Common Creek	Bayard Long
1932	Bucks	Edington	Tidal shore of Neshaminy Creek	Walter M. Benner

			near its mouth on Bensalem Twp. side	

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ACKNOWLEDGMENTS

I would like to thank my supervisor, Tim Block, as well as Ann Rhoads, and Cindy Skema for their assistance throughout this project. Steve Eisenhauer of Natural Lands Trust provided me with helpful information regarding the status of *E. parkeri* at Peek Preserve. I would also like to thank Shelley Dillard for use of greenhouse space, Jan McFarlan, and the endowers of the Plant Protection internship.