New England Plant Conservation Program

Saururus cernuus L.
Lizard's Tail

Conservation and Research Plan for New England

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SUMMARY

Saururus cernuus L. (Saururaceae) is a perennial herbaceous plant, found in forested and open wetlands in saturated soils and in periodically inundated conditions. *Saururus cernuus* is found from Ontario and Quebec, through southern New England and New York, into the southern and Midwestern United States. It is abundant throughout most of this range, but appears to be on the edge of its range in New England, Kansas (S1), Ontario (S3), and Quebec (S2). *Saururus cernuus* is ranked as G5 (Globally secure) and is a NEPCoP Division 2 (Regionally Rare) species. In New England, it is found at one site in Rhode Island (S1), at one undocumented site in Massachusetts where it is considered extirpated (SX), and at two sites in Connecticut (S1, E). Herbarium records indicate greater abundance in Connecticut prior to the 20th century. The largest Connecticut population contains over 50,000 plants. The second Connecticut population has over 1,000 plants, and the Rhode Island population has 100-1,000 plants. Threats include alteration of natural hydrologic regimes, shading by native and non-native species, and competition by invasive species.

The overall objective for *Saururus cernuus* in New England is to maintain one large population of 25,000 to 50,000 plants within natural communities along the Saugatuck River (CT .004) and two populations of at least 1,000 plants at existing sites in Connecticut (CT .002) and Rhode Island (RI .001). Target population sizes for existing populations are based on current estimates from Natural Heritage biologists. These estimates should be revisited once the results of research and monitoring are available. Additional populations would be protected and managed if discovered through further inventory or if suitable habitat is found that could be used to re-establish new populations in areas where they existed historically. Implementation of the following actions would accomplish the objectives:

- Develop capabilities in management and restoration of habitat for *Saururus cernuus*.
- Develop and implement monitoring protocols to characterize and track the status of populations, habitat conditions, and identified threats.
- Develop capabilities in seed collection, germination and propagation of plants, within both the greenhouse and the wild.
- Investigate both the unconfirmed and historic occurrences in Massachusetts and develop cooperative management strategies with the landowner(s) to enhance any population(s) that may exist.
- Inventory sites identified through herbarium records in Connecticut along the Housatonic and Shetucket Rivers both for the presence of *Saururus cernuus* and for potential habitat (both currently protected and unprotected sites).
- Depending on inventory results, investigate the possibility of enhancing existing or establishing new populations along the Housatonic and Shetucket Rivers in Connecticut and in Massachusetts if the unconfirmed population does not exist.

PREFACE

This document is an excerpt of a New England Plant Conservation Program (NEPCoP) Conservation and Research Plan. Full plans with complete and sensitive information are made available to conservation organizations, government agencies, and individuals with responsibility for rare plant conservation. This excerpt contains general information on the species biology, ecology, and distribution of rare plant species in New England.

The New England Plant Conservation Program (NEPCoP) of the New England Wild Flower Society is a voluntary association of private organizations and government agencies in each of the six states of New England, interested in working together to protect from extirpation, and promote the recovery of the endangered flora of the region.

In 1996, NEPCoP published "*Flora Conservanda*: New England." which listed the plants in need of conservation in the region. NEPCoP regional plant Conservation Plans recommend actions that should lead to the conservation of *Flora Conservanda* species. These recommendations derive from a voluntary collaboration of planning partners, and their implementation is contingent on the commitment of federal, state, local, and private conservation organizations.

NEPCoP Conservation Plans do not necessarily represent the official position or approval of all state task forces or NEPCoP member organizations; they do, however, represent a consensus of NEPCoP's Regional Advisory Council. NEPCoP Conservation Plans are subject to modification as dictated by new findings, changes in species status, and the accomplishment of conservation actions.

Completion of the NEPCoP Conservation and Research Plans was made possible by generous funding from an anonymous source, and data were provided by state Natural Heritage Programs. NEPCoP gratefully acknowledges the permission and cooperation of many private and public landowners who granted access to their land for plant monitoring and data collection.

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I. BACKGROUND

INTRODUCTION

This document summarizes existing information on the biology, ecology, conservation status, and uses of *Saururus cernuus* L. (Saururaceae), Lizard's tail. Information on biology and ecology was used to develop an overall conservation objective for *Saururus cernuus* in New England and objectives for existing and potential populations to increase the number and range of populations to historical levels formerly documented in New England. This plan identifies conservation actions, including research, inventory and the development of restoration skills and capacity for the species in New England. The plan also identifies actions for existing sites to assure continued viability of those populations. These conservation actions are needed to assure the long-term viability of *Saururus cernuus* in New England.

Recommended actions are based on the best available information. However, further work is needed on how existing populations vary, seed bank dynamics, habitat characteristics and propagation techniques. The target population sizes recommended for existing sites are based on current numbers, but should be considered interim targets until further information has been collected and analyzed. At that point, more specific objectives for population size and spatial distribution and habitat characteristics should be developed, and this plan amended accordingly.

This plan is also strategic in focus. While site-specific recommendations have been developed, further planning is needed, particularly regarding invasive species control, habitat management, habitat creation or enhancement or reintroduction at specific sites.

DESCRIPTION

Saururus cernuus is a perennial, herbaceous plant. It is branched and 5-12 dm in height. The leaves (4-25 cm) have long, basally sheathing petioles (1-10 cm) and cordate to ovate blades (2-17 cm long and 1-10 cm wide) (Buddell and Thieret 1997). There can be one or two spikes, often surpassed by axillary branches that can be 6-15 cm in length and nodding at the tip before anthesis (Gleason and Cronquist 1991).

Saururus cernuus has small, white flowers aggregated in spikes, with 175-350 flowers on a spike (Buddell and Thieret 1997). The inflorescence (5-35 cm) is terminal, dense, slender, and peduncled, borne opposite the leaves (Magee and Ahles 1999). The flower-bract stalk bears both the flower and a subtending bract, distally, to the inflorescence axis (Han-Xing and Tucker 1990). These bracts are acute and ovate (Han-Xing and Tucker 1990). The flowers are perfect and hypogynous (perianth and stamens attached directly to the receptacle, generally below the gynoecium). The ovary is superior to half-inferior. The stamens can number from 4-8 and are arranged in two whorls (Raju 1961). The filaments are white, 3-4 mm, and surpass the pistils (Gleason and Cronquist 1991). The flowers emit a sweet odor, which may be strong where plants are dense (Thien et al. 1994).

The three to five carpels are united at the base only, each with a short, outcurved style. One author has described the carpels as very close together, but not united (Raju 1961), though most authors describe the carpels as united, but separate and distinct above the connate base. There are two to four ovules that are orthotropous (straight with funiculus at one end and micropyle at the other) and laminal-lateral (Gleason and Cronquist 1991). Both stamens and carpels are initiated in pairs, so that floral symmetry is bilateral from the beginning of the formation of these organs. This is considered rare in primitive angiosperms (Tucker 1975, Tucker 1976).

The fruits are schizocarps, approximately 1.5-3.0 mm thick, and rugose. Fruits consist of 3-4 indehiscent carpels (with one seed per mericarp). This type of fruit is common in aquatic macrophytes (Sculthorpe 1967). Seeds are brown, smooth and 1.0-1.3 x 0.7-1.0 mm (Montgomery 1977, Gleason and Cronquist 1991, Buddell and Thieret 1997, Magee and Ahles 1999).

Baldwin and Speese (1949) reported that the chromosome number for *Saururus cernuus* is 2*n*=22, *n*=11, based on plant material collected from eleven sites throughout the range. They also report a previous study in which a chromosome number of *n*=10 was reported, but provide no other details (Baldwin and Speese 1949).

TAXONOMIC RELATIONSHIPS, HISTORY, AND SYNONYMY

Saururus cernuus is a member of the Saururaceae or Lizard's tail family, which is considered a primitive plant family in the order Piperales (Raju 1961). The Saururaceae is a small family, with four genera and six species in the order Piperales: *Saururus cernuus* L., *Saururus chinensis* Lour., *Houttuynia cordata* Thunb., *Anemopsis californica* Hook. and Arn., *Gymnotheca chinense* Decaisne, and *Gymnotheca involucrata* S.J.Pei (Xia and Brach 1999). *Saururus cernuus* and *Anemopsis californica* are native to North America, while the others are Asian (Buddell and Thieret 1997). The native ranges of *Saururus cernuus* and *Anemopsis californica* overlap in Kansas, Oklahoma and Texas. *Houttuynia cordata* is found in Louisiana and is sold in nurseries, as is *Anemopsis californica*, and both may be used by gardeners anywhere in the United States and beyond. The native and naturalized ranges of *Saururus cernuus*, *Saururus chinensis* and *Gymnotheca* spp. do not overlap at this time (U. S. Department of Agriculture 2001).

All members of this family are perennial, aromatic herbs that inhabit areas where soil moisture is high (Raju 1961). The family is characterized by flowers arranged in a terminal spike or raceme. The flowers are simple, lack a perianth and have six or fewer stamens and four or fewer carpels (Han-Xing and Tucker, 1990) and spirally arranged, simple leaves with stipules (Raju 1961). Unlike *Saururus cernuus,* both *Houttuynia cordata* and *Anemopsis californica* have large, showy bracts below the inflorescence (Raju 1961, Xia and Brach 1999).

SPECIES BIOLOGY

Saururus cernuus overwinters by dormant perennating organs. However, in Alabama, it was observed to put out leaves continually, although periodic frosts prevented extensive growth (Penfound et al. 1945).

Saururus cernuus flowers from June to August in New England (Magee and Ahles 1999). Surveyors at both the Rhode Island and Connecticut sites observed both flowering and fruiting plants during July and August visits. Further south in its range, flowers have been observed as early as late May in the Tennessee Valley (Hall 1940). Anthesis proceeds from the base of the flower spike to the tip, so that an individual flower spike has a gradient of degree of flowering and fruit maturation (Thien et al. 1994). In Louisiana, anthesis proceeded at approximately 1.52 cm per day, and the inflorescence changed from the characteristics “tail” of a lizard to an upright spike as the axis sclerified (Thien et al. 1994).

Saururus cernuus sets seed from July through September (Hall 1940). Plants flowering on July 1 produced fruit three weeks later and held the fruit until September (Hall 1940). Observations of the standing crop of a stand near Aiken, South Carolina in 1970 indicated that 79% of the peak standing crop (roots and shoots) was reached by May 29th and the peak was reached on June 24th (Boyd and Walley 1972).

Thien et al. (1994) attempted to discern pollination mode for *Saururus cernuus* at sites in Louisiana based on observations of potential pollinators. Diptera and Coleoptera were observed eating pollen. Wasps visited flowers, seeking insect larvae that fed on leaves. Species of Odonata sometimes landed on pollen spikes. When struck, a flower spike would send off a cloud of pollen. Based on these observations, Thien et al. (1994) concluded that wind and insect-mediated wind pollination were the primary methods of pollinations. Coursol (2000) reported similar findings and hypothesized wind as the dominant mode based on the structure of the flower.

Saururus cernuus propagates both vegetatively and by seed. Vegetative reproduction may be more important to population persistence, as seedlings have not been reported from field studies (Hall 1940, Penfound et al. 1945). *Saururus cernuus* forms extensive rhizomes (Hall 1940). In one stand, Hall measured 13 feet (3.9 m) of rhizome for each square foot of soil surface (Hall 1940). Hall (1940) also noted that these fragments can break off, float and take root in other locations, and this may be an important dispersal mechanism. Following cutting of a stand and water drawdown, fallen stem fragments rotted, but rhizomes emerged and put out new shoots within 20 days of cutting. In a plot that was also cut, but not subjected to drawdown, the floating fragments of stems produced adventitious roots within 14 days of cutting and became rooted if stranded on the surface (Hall 1940). Plants have also been grown successfully from cuttings in water, wet sand and sphagnum (Shannon 1953).

The rhizomes contain aerenchyma tissue that allows them to store oxygen and to float (Sculthorpe 1967). Hall (1940) determined that young rhizomes contain approximately 5% air space while older rhizomes contain 60% aerenchyma. Aerial stems also transmit oxygen to the rhizomes, which otherwise exist in anaerobic conditions (Hall 1940). Roots were confined to the upper 15 cm of soil in 25 sites studied in Mississippi, Alabama, Georgia and South Carolina (Boyd and Walley 1972).

Typical of many large, perennial wetland species, *Saururus cernuus* has a high standing biomass (Mitsch and Gosselink 1993). Total, average standing crop of roots and shoots ranges from 445 to 2,250 g dry wt/m^2. Shoot standing crop varies from 184 to 1,199 g dry wt/m^2 , while root standing crop varies from 261 to 1,051 g dry wt/m^2 . (Boyd and Walley 1972). The shoot:root ratio varies from 0.58 to 2.48, while the average shoot standing crop is 54.9% of the total standing crop. By comparison, the aboveground shoot biomass of *Pontedaria cordata*, a comparable wetland plant in Connecticut sites, averages 524 g/m^2 ,while belowground biomass averages 688 g/m^2 (Heisey and Damman 1982).

Seeds planted in January in different media, provided with light and moisture and kept at a temperature of 25^0C, did not germinate until April (Johnson 1900). Johnson (1900) concluded that a period of dormancy was needed prior to germination. Hall (1940) concluded that a period of dormancy was required for seed germination, based on a study of seeds collected from 100 fruit. Baskin and Baskin (1998) report that the optimal temperature for germination of *Saururus cernuus* requires is 25^0C. Pretreatment was not required, so they concluded that *Saururus cernuus* did not require a dormant period, pending further studies (Baskin and Baskin 1998).

Schneider and Sharitz (1986) found that *Saururus cernuus* was present in the standing seed bank of both a cypress-tupelo and a hardwood community in South Carolina. Soil samples were stratified in the dark at 5^0 C for three weeks, spread over potting medium, and kept in sunlight supplemented by grow lights at an average temperature of 30^0C for twelve weeks. *Saururus cernuus* germinated in an average of 14 out of 90 samples from three sampling periods. In a seed bank study in New York, soil was transported from a cleared, but previously forested peatland (with *Saururus cernuus* in the standing flora) to a newly-created wetland to establish native vegetation. However, only three wetland species, *Boehmeria cylindrica*, *Eupatorium perfoliatum* and *Onoclea sensibilis*, emerged from the samples (O'Reilly 1997). *Saururus cernuus* seeds, collected in the wild for wetland planting, can be kept in cold, dry conditions for up to seven years before planting (L. Hunter, Environmental Concern, St. Michaels, Maryland, personal communication). In Louisiana, seeds began germinating after being placed in water for 17 days; 75% of seeds had germinated by 94 days. Young seedlings grew floating and submerged and were difficult to distinguish from other aquatic plants, such as *Lemna* sp. (Thien et al. 1994). Together, these studies indicate that *Saururus cernuus* is capable of remaining dormant in the seed bank, but that the proportion of seeds remaining viable may be low. Further research is needed on this subject.

The New England Wildflower Society has undertaken several germination studies of *Saururus cernuus* and also has noted low germination rates (unpublished data of Christopher Mattrick, New England Wild Flower Society, Framingham, Massachusetts). By contrast, germination rates of 85-90% are generally obtained through a process used by the Octoraro Native Plant Nursery, Kirkwood, Pennsylvania (Bennett 2001). Seeds are collected in the fall and refrigerated through the winter at 2^0C. Seeds are then soaked in water for two weeks, then mixed with damp sand and again refrigerated at 2^0C for another two weeks. Seeds are then planted on open flats in a mix of sphagnum, vermiculite, perlite and sand and kept at a temperature of 21-23^0C. Flats are also misted at regular intervals. Germination occurs in about three weeks (Bennett 2001). Environmental Concern, Inc., a nonprofit wetlands research and restoration organization, also has had good success with germination of seed collected in the fall. Seed is kept in cold, dry storage until planted in greenhouses in the spring. Seed has been sown on the surface for planting on site with approximately 40% germinating (L. Hunter, personal communication).

Based on structural analyses of cross and self pollen tube growth, *Saururus cernuus* shows stigmatic self-incompatibility (Pontieri and Sage 1999). Within clones, the density of pollen transfer between ramets would be high, leading to reduced seed set. However, since there is often substantial genetic variation within vegetatively spreading plant species, there may still be some viable seeds set, even within clonal populations (Cook 1985, Silander 1985, Thien et al. 1994).

Saururus cernuus contains volatile oils consisting of several lignoid compounds (Tutupalli et al. 1974, Rao and Alvarez 1982, Rao and Alvarez 1985, Rao and Reddy 1990, Rao and Rao 1990). Some of these chemicals appear to deter herbivory by some organisms (Bolser et al. 1998, Kubanek et al 2000).

HABITAT/ECOLOGY

Saururus cernuus is found in freshwater wetlands, including hardwood swamps and floodplains, stream margins, muddy pond shores, freshwater tidal wetlands and floating mats (Tiner 1987, Crow and Hellquist 2000). It is classified as an obligate wetland plant and is a wetland indicator plant (Silberhorn 1993). *Saururus cernuus* may be found in a range of conditions, from saturated soils that are periodically inundated to frequently and permanently inundated conditions (Theriot 1993).

In northeastern North America (see Appendix 3), *Saururus cernuus* is found in forested swamps dominated by *Acer rubrum, Nyssa sylvatica, Fraxinus pennsylvanica,* and other species typical of red maple-hardwood swamps and floodplain forests (NatureServe 2001). According to field forms supplied by Connecticut Natural Diversity Data Base, at the largest site in New England, *Acer rubrum* dominates the canopy (though the observer noted many dead trees), with *Ilex verticillata* and *Cephalanthus occidentalis* in the shrub layer, and *Carex stricta, Carex lupulina, Osmunda regalis, Pontedaria cordata*, and *Peltandra virginica* in the herbaceous layer. (Nancy Murray, Connecticut Natural Diversity Data Base, personal communication).

In Ohio, *Saururus cernuus* has been associated with communities in relatively advanced states of succession and little disturbance (Andreas and Lichvar 1995). Also in Ohio, Aldrich (1943) found *Saururus cernuus* as a subdominant in the *Cephalanthus-Alnus* (shrub swamp) and *Larix-Betula* (forested bog/peat soil), and *Ulmus-Fraxinus-Acer* (forested wetland) associations. Soils ranged from organic within the *Larix-Betula* association to silt in the shrub swamp and forested wetlands. Soil pH ranged from 3.0-4.7 in the *Larix-Betula* association to 4.7-5.8 in the *Ulmus-Fraxinus-Acer* association.

In Quebec, *Saururus cernuus* is found in areas of limestone deposits that are open to the sun. Sites are located within embayments of the St. Lawrence River. Associated species include *Acer saccharinum, Fraxinus pennsylvanica, Cornus stolonifera, Cephalanthus occidentalis, Boehmeria cylindrica, Impatiens capensis, Lobelia cardinalis, Lysimachia terrestris, Lythrum salicaria, Onoclea sensibilis, Osmunda regalis, Phalaris arundincacea, Polygonum amphibum, Pontedaria cordata,* and *Sparganium eurycarpum* (Coursol 2000).

In the southern United States, *Saururus cernuus* is a dominant in eight associations described as part of the National Vegetation Classification (NatureServe 2001). Appendix 3 provides the descriptions of each of those associations, which are found in the southeastern and southern United States. The environmental characteristics of these associations provide some insight into the habitat and ecology of *Saururus cernuus,* especially in areas where it dominates. These associations tend to be seasonally to semipermanently flooded stream channels, floodplains, sloughs and backwaters. Water levels fluctuate both during the growing season and between years. Several associations have unique microtopographic and hydrologic characteristics. The Small Blackwater Stream Swamp association, found in Maryland, Virginia and South Carolina, occurs in intermittent streams. The Upper Tidal Gum Swamp Forest association is characterized by hummock/hollow topography. The Floodplain Pools association is an herbaceous community that receives water from periodic flooding and rainfall.

Rienhardt (1992) found *Saururus cernuus* within Ash-black-gum (*Fraxinus* sp.-*Nyssa biflora-Acer rubrum, Fraxinus* sp.-*Nyssa biflora-Acer rubrum-Taxodium distichum*) and

Maple-Sweetgum (*Acer rubrum-Liquidambar styraciflua*) associations in a tidal, freshwater wetland in the Chesapeake Bay. *Saururus cernuus* was a dominant herb in both associations, though the associations differed in organic content and calcium levels in the soil. Both communities contain hollows and hummocks. The hummocks are elevated, steep-sided, flat-topped mounds generally 1-10 m^2 in area with the tops 14-16 cm above the adjacent low-lying hollows. The tops are at approximately the same elevation and consist of large and small roots. During spring tides, the hollows were often flooded twice a day and the upper root zone (upper 15 cm) remained saturated for many days. During the growing season, the upper 15 cm of the hummocks flooded 5-10% of the time, while that of the hollows flooded 20-100%. *Saururus cernuus* and *Peltandra virginica* were found more often in hollow microsites than hummocks (Reinhardt 1992).

In another study of freshwater tidal wetlands on the Chesapeake Bay, *Saururus cernuus* was associated with the following species in order of decreasing abundance: *Typha latifolia, Polygonum puctatum, Leersia oryzoides, Cuscuta gronovii, Sagittaria latifolia, Boehmeria cylindrica, Phragmites australis, Carex lurida, Polygonum arifolium,* and *Mikania scandens*. This association was found primarily in upper stream portions in the supratidal zone, in the higher elevations of the study site (Pasternack et al. 2000).

Cypress heads are symmetrical domes of variable sizes in which pond cypress (*Taxodium ascendens*), black gum (*Nyssa biflora*), slash pine (*Pinus elliottii*), red maple (*Acer rubrum*), and wax myrtle (*Myrica cerifera*) are important species. These cypress heads are interspersed within pine flatwoods of Florida. The communities have a pond at the center with a depth of 1-4 feet (0.3 to 1.2 m). Water depth decreases toward the edge of the pond. *Saururus cernuus* is generally found along the pond edges. Associated species include *Woodwardia virginica, Lachnanthes tinctoria, Cephalanthus occidentalis, Lyonia lucida, Magnolia virginiana, Acer rubrum, Persea palustris, and Liquidambar styraciflua. Saururus cernuus* abundance increases with increasing calcium and pH at these sites (Monk and Brown 1965).

In tupelo-gum communities (which include *Taxodium distichum, Acer drummondii, Nyssa biflora, Fraxinus profunda*, and *Fraxinus carolina*), *Saururus cernuus* occurs in localized patches, in somewhat elevated areas, and within old-growth tupelo gum swamp with a poorly developed herbaceous layer. Associated herbaceous species include *Ceratophyllum dermersum, Didiplis diandra, Isnardia palustris, Lemna minor, Proserpinaca palustris,* and *Sisymbrium nasturtium-aquaticum*. The canopy cover in these communities has been measured as 75% and pH as 7.1. This community is inundated throughout the year except in August, September and October with maximum water level in March (30 inches or 0.75 m in depth) (Penfound and Hall 1943).

Productivity of *Saururus cernuus* has been correlated with the availability of light and soil phosphorus and with neutral pH. According to Boyd and Walley (1972), shoot standing crop of *Saururus cernuus* has also been correlated positively with increasing pH (r=0.68;

p<0.01), dilute-acid-soluble phosphorus (r=0.72; p<0.01) and base saturation (r=0.58; p<0.05). Soil phosphorus availability increases to a maximum value where pH is neutral (Boyd et al. 1972). Based on this study, one would expect *Saururus cernuus* to reach highest standing crops in areas with moderate-to-high light, high phosphorus, and moderate-to-high pH. White (1983) found that *Saururus cernuus* was most abundant in areas of high organic matter, low salt (0.1-0.2%) and high pH (>6.0) in areas where the water table was at or above the surface. One grower of *Saururus cernuus* for home aquariums states the plant does best in high to very high light and pH of 6 to 9 (Tropica Aquarium Plants 2002). *Saururus cernuus* is found in some freshwater tidal wetlands, such as the Upper Tidal Gum Swamp Forest (NatureServe 2001), and has been reported in slightly brackish water (Buddell and Thieret 1997). Thunhorst (1993) states that it can tolerate salinity up to 1.5 ppt.

Thunhorst (1993) recommends planting in up to one foot (30 cm) of water. However, *Saururus cernuus* may not be able to tolerate complete inundation during the growing season. Penfound et al. (1945) report that *Saururus cernuus* was confined to the upper foot (30 cm) of the fluctuation zone in reservoirs in Alabama. Plants were inundated to the same depths twice, first in April and again in July of 1941 for two weeks. Plants inundated to a depth of four feet (1.2 m) were killed, those inundated three feet (1.1 m) were defoliated and those inundated less than 1.1 m were unaffected. This indicates that *Saururus cernuus* can tolerate being inundated, but perhaps not completely and not during the summer.

In summary, *Saururus cernuus* forms large stands and can dominate the herbaceous layer. *Saururus cernuus* is adapted to periodic and frequent inundation. In North America, most freshwater wetlands are inundated during the fall, following senescence of vegetation and lower evapotranspiration and again in the spring, following snow melt and increased spring precipitation. Some may be inundated throughout the winter. In such conditions, soils are anaerobic. Water levels tend to drop during the growing season as plants take up water and evapotranspiration is increased (Mitsch and Gosselink 1993). *Saururus cernuus* appears to do best in conditions of periodic and frequent inundation, followed by lowering of water levels in the summer. While tolerant of some shading, *Saururus cernuus* does best in moderate to full sun. While tolerant of a wide range of pH, *Saururus cernuus* does best in moderate to high pH and in conditions of high Ca and P and with soils that have some organic component.

USES

Saururus cernuus is sold in nurseries that specialize in aquatic and native plants for ponds, aquatic gardens and aquariums. Generally, root stock or small plants are sold rather than seed (Cherry Hill Nurseries 2002, Maryland Native Nurseries 2002, Tropica Aquarium Plants 2002, Waterloo Gardens 2002). *Saururus cernuus* has been used in restored and created wetlands and for stormwater retention ponds and wetlands (Mitsch and Gosselink 1993), and is recommended for creating and restoring wetlands for agricultural wastewater, domestic wastewater, stormwater and coal mine drainage (Davis 1995). Environmental

Concern, Inc. both uses and sells rhizomes, bare-root plants, and small plants in quart containers for wetland restoration and enhancement (Thunhorst 1993). There is no information on use of *Saururus cernuus* in wetlands creation or restoration projects in New England.

Saururus cernuus has been used as a sedative and a poultice for tumors by early settlers in North America, and for various wounds and ailments by different Native American tribes (Phytochemical Database 2002), so it may still be used as a folk or herbal remedy. *Saururus cernuus* contains lignans and neolignans, which have been shown to inhibit growth of tumors, to suppress the central nervous system and to exert other physiological effects of medical interest (Tutupalli et al. 1974, Rao and Alvarez 1982, Rao and Alvarez 1985, Rao and Reddy 1990, Rao and Rao 1990), though chemicals derived from *Saururus cernuus* are not currently being used for medical treatment. However, it was reported that *Saururus cernuus* is the only natural product discovered since the 1950's with neuroleptic properties (i.e., a substance used to treat psychosis). Reserpine, synthesized from *Rauwolfia serpentina* in the 1950's is used to treat hypertension and for the synthesis of antipsychotic agents (Alvarez 1981).

THREATS TO TAXON

Saururus cernuus can be highly competitive due to its ability to form dense rhizomes. However, vegetation succession, in the form of increasing dominance by shrubs and trees, can reduce available light for *Saururus cernuus*. Reduction in light caused by shading from trees, shrubs and vines has been noted as a potential threat by surveyors at RI .001 (Little Compton). The causes of such succession may be alteration in the hydrologic regime or in frequency of disturbance. Areas where *Saururus cernuus* is currently found may have been previously disturbed by grazing, logging or other land use, allowing *Saururus cernuus* to become more predominant, as in the site studied by Hall (1940). Therefore, plant community succession from open wetlands to shrub and forested wetlands will reduce the size of *Saururus cernuus* populations and their ability to reproduce.

Increased sedimentation due to changes in adjacent land use may increase the rate of vegetation succession or, in extreme cases, bury plants in silt. For example, along the Raritan River in New Jersey, Westendahl (1958) noted that siltation along a river edge had favored formation of a virtual monoculture of *Phalaris arundincacea*. In areas where the water velocity was higher and siltation was not occurring, he found *Saururus cernuus* within a diverse, herbaceous, wetland community.

Road runoff may include road salt used to melt snow and ice. The extent to which this may influence *Saururus cernuus* is unknown. Runoff from roads and adjacent lands may include increased nutrients from fertilizers, compost, waste (such as the waste treatment plant near CT .002 [Stratford]), herbicides, and other substances. These can all affect the composition and structure of natural communities. They may directly or indirectly influence the abundance of *Saururus cernuus* by increasing cover of competitive species, including invasive species.

Invasive wetland species such as *Lythrum salicaria* may outcompete and reduce the available habitat of *Saururus cernuus*. For example, surveyors have identified *Lythrum salicaria* as a threat at CT .002 (Stratford). If *Lythrum salicaria* is able to outcompete *Saururus cernuus* in areas that are either not inundated or infrequently inundated, *Saururus cernuus* would be restricted to areas that are more frequently inundated, where it would be more vulnerable to flooding during high-water years.

Alteration of the flow regime may affect *Saururus cernuus* by either inundating the plant for periods longer than it can tolerate, inundating it at critical points of the life cycle, or stranding the plant in dry conditions. The surface and groundwater flow regime is a major determinant of the physical structure of aquatic systems and, hence, the structure and composition of aquatic communities. Alteration in the flow regime directly affects water level fluctuation in wetlands. Alteration in the flow regime can also facilitate invasion by exotic species (Bunn and Arthington 2002). Water level fluctuation has been identified by surveyors as a possible threat at CT .004 (Redding), for example. In Connecticut, occurrences were documented in herbarium records on the Shetucket and Housatonic Rivers in the late 1800's and early 1900's. During this same period, a number of dams were constructed on the main stems of both of these rivers (U.S. Environmental Protection Agency 1999). Dams can alter timing and magnitude of maximum and minimum flows, water temperature (both upstream and downstream), sediment flows (deposition and transport), nutrient movement, and movement by organisms (Poff et al. 1997). Research is needed on the effects of these changing flow regimes on existing and potential habitat for *Saururus cernuus*.

DISTRIBUTION AND STATUS

General Status

NatureServe (2001), U.S. Department of Agriculture Plants Database (2001), Buddell and Thieret (1997) and Natural Heritage Programs throughout the United States and Canada were consulted on the distribution and status of *Saururus cernuus*. In the United States, *Saururus cernuus* is found in 27 states and the District of Columbia. In New England, the species occurs in Rhode Island, Connecticut and Massachusetts. In Massachusetts, it is considered extirpated, but there is an unconfirmed report of an extant population. In Canada, *Saururus cernuus* is found in Ontario and Quebec. New England, Quebec (Coursol 2000), and Ontario represent the eastern and northern limits respectively (see Table 1, Figure 1). The central range of *Saururus cernuus* appears to be from the mid-Atlantic states to Florida, the Gulf States and most of the Midwest, except Kansas where it is rare (ranked S1). *Saururus cernuus* is designated a Division 2 (Regionally Rare) species by the *Flora Conservanda* of the New England Plant Conservation Program (Brumback and Mehrhoff et al. 1986).

Figure 1. Occurrences of *Saururus cernuus* in North America. States and provinces shaded in black have more than five confirmed, extant occurrences of the taxon. States shaded in gray have one to five (or an unspecified number of) occurrences. Diagonal hatching indicates a state (Massachusetts) in which the taxon is considered "historic" or "presumed extirpated." Stippling indicates areas in which the taxon is ranked "SR" ("status reported"), with little additional information. See Appendix 4 for explanation of conservation ranks.

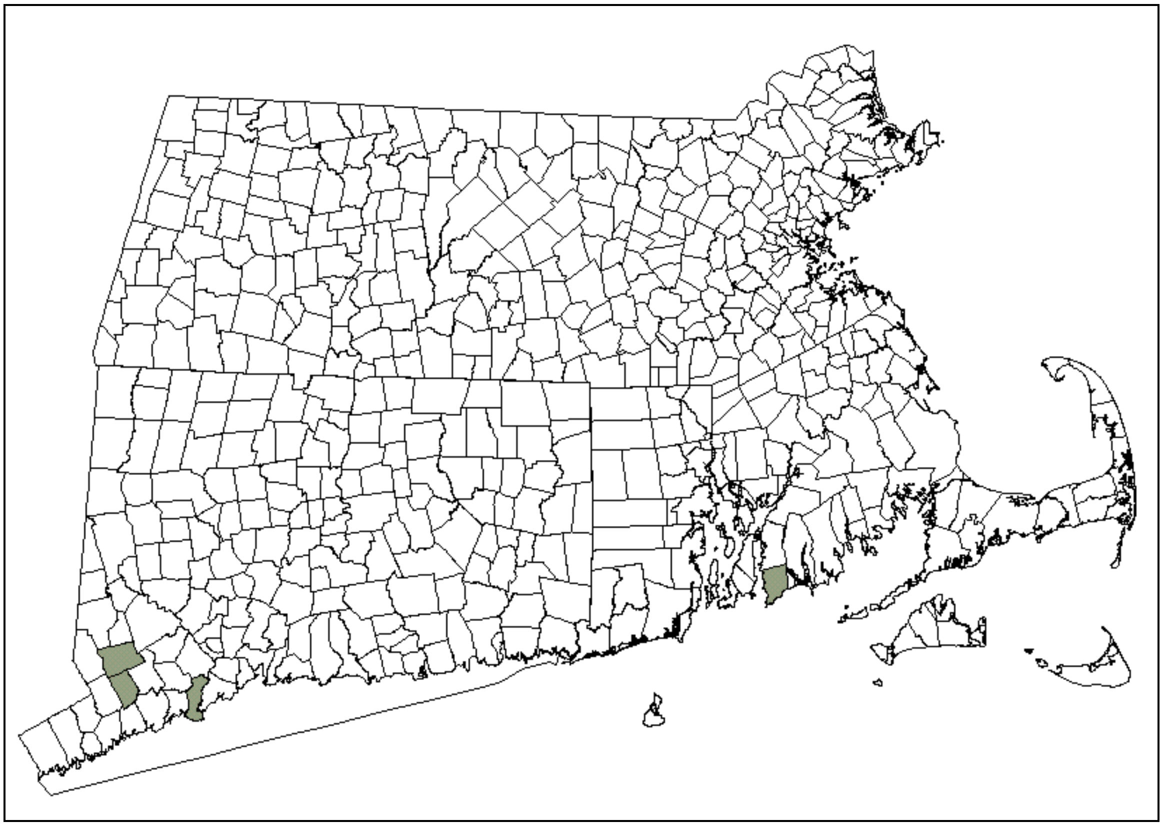

Figure 2. Extant occurrences of *Saururus cernuus* in New England. Town boundaries for Massachusetts, Connecticut, and Rhode Island are shown. Towns shaded in gray have one to five confirmed, extant occurrences of the taxon.

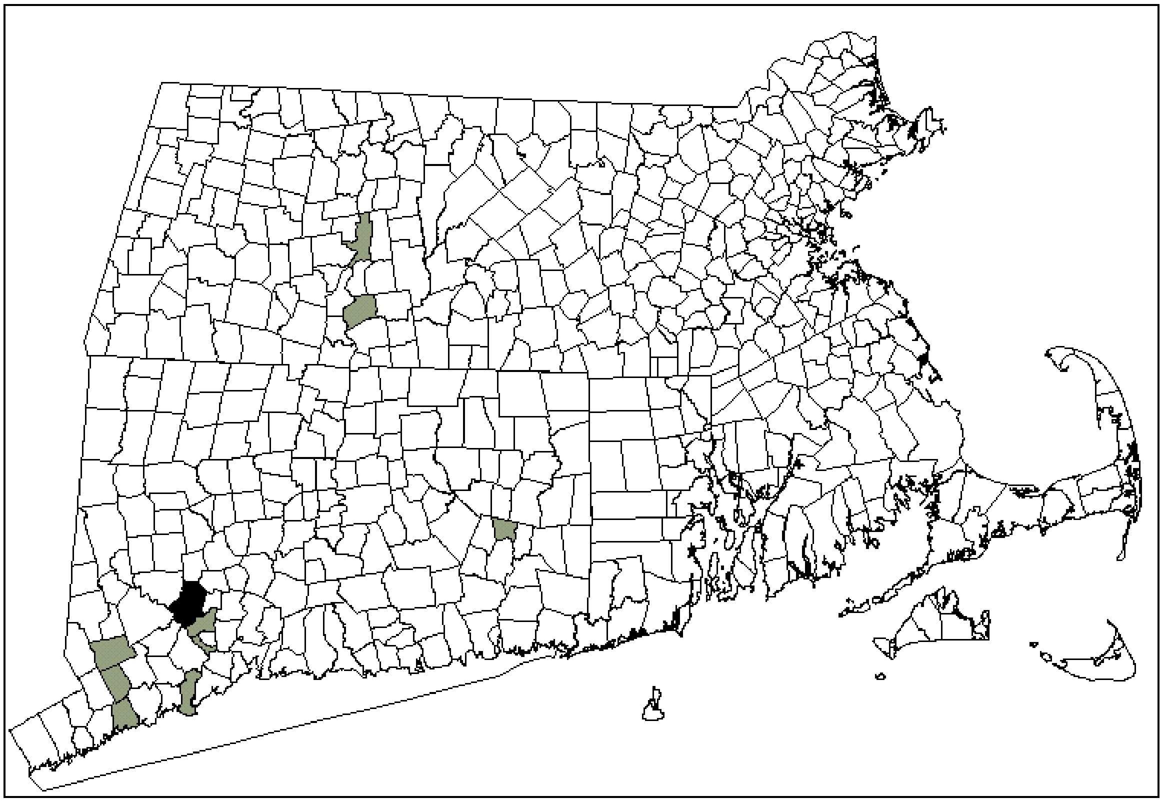

Figure 3. Historical occurrences of *Saururus cernuus* in New England. Towns shaded in gray have one to five historic records of the taxon. Towns shaded in black have more than five historic records.

Table 1. Occurrence and status of *Saururus cernuus* in the United States and Canada based on information from Natural Heritage Programs (Source: NatureServe 2002) and the U.S. Department of Agriculture (Source: U.S. Department of Agriculture, PLANTS National Database 2002).			
OCCURS & LISTED (AS S1, S2, OR T &E)	**OCCURS & NOT LISTED (AS S1, S2, OR T & E)**	**OCCURRENCE REPORTED OR UNVERIFIED**	**HISTORIC (LIKELY EXTIRPATED)**
Connecticut (S1, E): 2 extant occurrences	Illinois (S3S4): not tracked (Bill Mcclain, Illinois Natural Heritage Program, personal communication)	Alabama (SR)	Massachusetts (SX): two undocumented records
Kansas (S1): 2 counties; 5 extant occurrences	North Carolina (S5): 60 counties	Arkansas (SR): 48 counties	
Rhode Island (S1): 1 extant occurrence	District of Columbia (S?): no records (Ellen Gray, DC Natural Heritage Program, personal communication)	Delaware (SR)	
Ontario (S3): approximately 40 records	Kentucky (S?): 41 counties	Florida (SR): not tracked, 54 counties	
Quebec (S2): 8 occurrences	Pennsylvania (S?): 26 counties	Georgia (SR): 26 counties	
	Michigan (S?): 25 counties	Louisiana (SR)	
	West Virginia (S?): 13 counties	Maryland (SR)	
		Minnesota (SR)	
		Mississippi (SR)	
		Missouri (SR): 55 counties	
		New Jersey (SR)	
		New York (SR)	
		Ohio (SR)	
		South Carolina (SR): 38 counties	

Table 1. Occurrence and status of *Saururus cernuus* in the United States and Canada based on information from Natural Heritage Programs (Source: NatureServe 2002) and the U.S. Department of Agriculture (Source: U.S. Department of Agriculture, PLANTS National Database 2002).			
OCCURS & LISTED (AS S1, S2, OR T &E)	**OCCURS & NOT LISTED (AS S1, S2, OR T & E)**	**OCCURRENCE REPORTED OR UNVERIFIED**	**HISTORIC (LIKELY EXTIRPATED)**
		Tennessee (SR): 46 counties	
		Texas (SR)	
		Virginia (SR): 63 counties	

Table 2. New England Occurrence Records for *Saururus cernuus.* Shaded and bold occurrences are considered extant.			
State	**EO #**	**County**	**Town**
MA	.001	Hampshire	Hadley
MA	No EO number	Hampden	Chicopee
RI	**.001**	**Newport**	**Little Compton**
CT	**.002**	**Fairfield**	**Stratford**
CT	**.004**	**Fairfield**	**Redding; Weston**

II. CONSERVATION

CONSERVATION OBJECTIVES FOR THE TAXON IN NEW ENGLAND

Currently, there is one large occurrence of *Saururus cernuus* in New England, located in Redding and Weston, Connecticut (CT .004). This occurrence has over 50,000 plants, spread over a mile of river. The other occurrences are much smaller (100-1000 plants) and fairly localized.

Historically, based on herbarium records, there were populations along the Housatonic, Saugatuck and Shetucket rivers in Connecticut. The current Rhode Island occurrence is the only one from that state and there was one historic occurrence from Massachusetts, apparently extirpated. The putative population at Chicopee needs to be documented.

In natural settings, *Saururus cernuus* forms large stands and can be the dominant species in the herbaceous layer. Therefore, enhancement of existing populations or creation of new populations of *Saururus cernuus* could reduce the abundance of other native species.

It is important to maintain populations, whether they be continuous or spatially distributed in patches or subpopulations, where appropriate water levels may be found during the range of variation for the specific site, along with moderate to high light, neutral pH and available nutrients. Generally, in wetlands, water level controls the availability of nutrients, oxygen, temperature and other key variables (Sculthorpe 1967). These patches or subpopulations should be close enough to one another to allow for genetic interchange.

The species is secure throughout most of its range in North America. Therefore, it may not be wise to direct resources for the conservation of *Saururus cernuus* that might take resources from other, more imperiled species in New England. By integrating conservation of *Saururus cernuus* into existing programs, the species can be made secure while minimizing the allocation of scarce conservation resources.

The overall objective for *Saururus cernuus* in New England is to maintain one large population of 25,000 to 50,000 plants within natural communities at CT .004 (Redding and Weston) and two populations of at least 1,000 plants at existing sites in Connecticut (CT .002 [Stratford]) and Rhode Island (RI .001 [Little Compton]). Additional populations should be protected and managed if discovered through further inventory or if suitable habitat is found that could be used to establish new populations in areas where they existed historically.

This objective would require the following actions:

- **Maintain one large population of 25,000 to 50,000 plants** within natural communities in Weston and Redding, Connecticut (CT .004) and two populations of at least 1,000 plants at existing sites in Connecticut (CT .002 [Stratford]) and Rhode Island (RI .001 [Little Compton]).
- **Investigate the possible extant occurrence in Massachusetts** (MA .No EO Number [Chicopee]) and develop cooperative management strategies with the landowner to enhance the population if it is extant.
- **Inventory for the historic Massachusetts occurrence reported in 1932 in Hadley.**
- **Inventory sites identified through herbarium records in Connecticut** along the Housatonic and Shetucket Rivers both for the presence of *Saururus cernuus* and for potential habitat (both currently protected and unprotected sites).
- **Develop and implement monitoring protocols** to characterize and track the status of existing populations (and new populations, if established), habitat conditions, and identified threats.
- **Develop capabilities in seed collection, germination and propagation of plants,** within both the greenhouse and the wild.
- **Depending on inventory results, investigate the possibility of enhancing existing or establishing new populations** along the Housatonic and Shetucket Rivers in Connecticut and in Massachusetts if the unconfirmed population does not exist.

Meeting the above conservation objectives would result in the maintenance of existing populations and provide for expanding the number of populations to the historic range of *Saururus cernuus* in New England.

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IV. APPENDICES

1. **Historic Occurrences of *Saururus cernuus* in Connecticut. Source: Connecticut Natural Heritage Program.**

2. **Plant Associations Described in NatureServe with *Saururus cernuus* as a Dominant Component Species.**

3. **An Explanation of Conservation Ranks Used by The Nature Conservancy and NatureServe**

1. Historic occurrences of *Saururus cernuus* in Connecticut. Source: Natural Diversity Data Base (NDDB) of the Connecticut Department of Environmental Protection.

Town	County	Collector	Herbarium	Date
Derby	New Haven	F.W. Hall	University of Connecticut	26 July 1873
Derby	New Haven	G.W. Hawes	Yale University	24 July 1873
Oxford	New Haven	C.H. Bissell	Connecticut Botanical Society	6 August 1901
Oxford	New Haven	L. Andrews	Not listed	6 August 1901
Oxford	New Haven	E.B. Harger	Connecticut Botanical Society	5 September 1901
Oxford	New Haven	E.B. Harger	Connecticut Botanical Society	25 August 1903
Oxford	New Haven	C.A. Weatherby	Connecticut Botanical Society	11 September 1907
Oxford	New Haven	A.E. Blewitt	Connecticut Botanical Society	11 September 1907
Oxford	New Haven	H.S. Clark	University of Connecticut	11 September 1907
Oxford	New Haven	A.E. Blewitt	Connecticut Botanical Society	15 August 1908
Redding (2 vouchers)	Fairfield	G.E. Nichols	Yale University University of Connecticut	31 July 1919
Redding	Fairfield	E.B. Harger	Connecticut Botanical Society	7 September 1931
Seymour	New Haven	C.H. Bissell	Connecticut Botanical Society	1901
Sprague	New London	Gerald Waldo	Connecticut Botanical Society	20 August 1880
Sprague	New London	C.H. Bissell	Connecticut Botanical Society	1 September 1915
Sprague	New London	R.W. Woodward	Connecticut Botanical Society	6 September 1915
Sprague	New London	C.W. Vibert	Connecticut Botanical Society	6 September 1915
Stratford	Fairfield	E.H. Eames	University of Connecticut	31 July 1893
Weston	Fairfield	A.L. Winton	Yale University	July 1882
Weston	Fairfield	E.H. Eames	University of Connecticut	14 July 1904
Westport	Fairfield	E.H. Eames	Missouri Botanical Garden	7 August 1929

2. Plant associations described in NatureServe with *Saururus cernuus* as a dominant component species.

Source: NatureServe Explorer: An online encyclopedia of life [web application]. 2001. Version 1.6 . Arlington, Virginia, USA: NatureServe. Available: http://www.natureserve.org/explorer. (Accessed: April 9, 2002).

Name (Common Name in Parentheses)	Distribution (TNC Ecoregions in Parentheses)	Environmental Setting	Description
Acer rubrum - Fraxinus pennsylvanica / Saururus cernuus Forest - G? (Red Maple Swamp)	DE, MD, NJ, VA:? (Chesapeake Bay Lowlands)		This red maple swamp community of the Coastal Plain of the Chesapeake Bay region occurs on poorly drained to very poorly drained soils that are seasonally to semipermanently flooded. A thin organic horizon overlies sandy or silt clay loam soils. The tree canopy is closed to partially open and dominated by *Acer rubrum*, *Fraxinus pennsylvanica*, *Fraxinus profunda*, and *Quercus lyrata*. Associated canopy species may include *Nyssa sylvatica*, *Quercus phellos*, and *Populus heterophylla*. The shrub layer includes *Lindera benzoin*, *Leucothoe racemosa*, *Ilex verticillata*, and *Viburnum* spp. The herbaceous layer is characterized by *Saururus cernuus*, *Peltandra virginica*, *Boehmeria cylindrica*, *Triadenum walteri*, *Cinna arundinacea*, *Pilea pumila*, and *Polygonum arifolium.*
Acer rubrum var. trilobum/ Viburnum nudum var. nudum / Osmunda cinnamomea - Saururus cernuus - Impatiens capensis Forest – G3?(Piedmont Low Elevation Headwater Seepage Swamp)	GA:?, NC, SC, VA (Piedmont; Mid-Atlantic Coastal Plain)	This saturated vegetation is found in seepage areas, often on edges of floodplains or in headwaters of small streams in the upper Coastal Plain and Piedmont of North Carolina, South Carolina, Virginia, and likely other states.	This saturated vegetation is found in seepage areas, often on edges of floodplains or in headwaters of small streams, in the upper Coastal Plain and Piedmont of North Carolina, South Carolina, Virginia, and likely other states. The canopy includes *Acer rubrum*, *Quercus phellos*, and possibly other wetland trees. Some herbs found in this association include *Saururus cernuus*, *Impatiens capensis*, *Osmunda cinnamomea*, *Osmunda regalis var. spectabilis*, *Boehmeria cylindrica*, *Rudbeckia laciniata*, *Ranunculus recurvatus*, and *Juncus* spp. Some more western examples may contain *Chelone glabra* and *Saxifraga micranthidifolia*. Occurrences in South Carolina's Savannah River drainage are dominated by *Carex atlantica ssp. capillacea*, *Carex debilis var. pubera*, *Carex debilis var. debilis*, and *Carex leptalea*.

2. Plant associations described in NatureServe with *Saururus cernuus* as a dominant component species.

Source: NatureServe Explorer: An online encyclopedia of life [web application]. 2001. Version 1.6 . Arlington, Virginia, USA: NatureServe. Available: http://www.natureserve.org/explorer. (Accessed: April 9, 2002).

Name (Common Name in Parentheses)	Distribution (TNC Ecoregions in Parentheses)	Environmental Setting	Description
Nyssa biflora - (Liquidambar styraciflua) / Itea virginica / Saururus cernuus Forest -G4? (Small Blackwater Stream Swamp)	GA:?, MD, NC:?, SC, VA (South Atlantic Coastal Plain; Mid-Atlantic Coastal Plain)	This community occurs in seasonally flooded low areas (stream channels) along small streams with intermittent flow in regions of very subdued topographic relief in the Outer Coastal Plain of South Carolina, Virginia, Maryland, and likely North Carolina and Georgia.	This community occurs in seasonally flooded low areas (stream channels) along small streams with intermittent flow in regions of very subdued topographic relief in the Outer Coastal Plain of South Carolina, Virginia, Maryland, and likely North Carolina and Georgia. The canopy consists of *Nyssa biflora*, sometimes with admixture of *Liquidambar styraciflua*. Herbs and shrubs are few, and these strata are poorly developed. *Itea virginica, Leucothoe racemosa*, and *Clethra alnifolia* are characteristic of the shrub layer. *Saururus cernuus* can be a common herb.

2. Plant associations described in NatureServe with *Saururus cernuus* as a dominant component species.

Source: NatureServe Explorer: An online encyclopedia of life [web application]. 2001. Version 1.6 . Arlington, Virginia, USA: NatureServe. Available: http://www.natureserve.org/explorer. (Accessed: April 9, 2002).

Name (Common Name in Parentheses)	Distribution (TNC Ecoregions in Parentheses)	Environmental Setting	Description
Nyssa biflora - Nyssa aquatica - Taxodium distichum / Saururus cernuus Forest - G? (Upper Tidal Gum Swamp Forest)	NC, SC, VA (South Atlantic Coastal Plain; Mid-Atlantic Coastal Plain)	This community may occur in ecotones between tidal marshes and non-tidal backswamps or uplands. Pronounced hummock/hollow microtopography is usually a prominent feature of this type, with the hollows filled with deep, soupy peat and muck substrates. Nutrient regimes may be enhanced in some examples by rare, wind-tidal inputs.	This association represents swamp forests along upper tidal reaches of rivers in portions of the outer Atlantic Coastal Plain ranging from southeastern Virginia and North Carolina to South Carolina, in which *Nyssa biflora, Nyssa aquatica*, and *Taxodium distichum* may dominate singly, codominate in various combinations, or share dominance with *Acer rubrum, Fraxinus pennsylvanica*, and/or *Liquidambar styraciflua*. Typical subcanopy trees are *Nyssa biflora, Acer rubrum, Fraxinus pennsylvanica, Liquidambar styraciflua, Ulmus americana*, and *Quercus laurifolia*. Woody vines are frequent and climb into the canopy; they include *Decumaria barbara, Toxicodendron radicans ssp. radicans, Campsis radicans, Smilax walteri*, and *Berchemia scandens.* Shrub and herb layers are variable but generally contain a mixture of species characteristic of both marshes and swamps. Typical shrubs are *Fraxinus caroliniana, Itea virginica, Amelanchier canadensis, Leucothoe racemosa, Lyonia ligustrina var. foliosiflora, Alnus serrulata*, and *Morella cerifera (= Myrica cerifera var. cerifera)*. Characteristic herbaceous species include *Saururus cernuus, Peltandra virginica, Triadenum walteri, Boehmeria cylindrica, Lycopus rubellus, Bidens discoidea, Carex seorsa, Carex stipata var. maxima, Cicuta maculata, Glyceria septentrionalis, Ranunculus sceleratus, Lobelia cardinalis, Sphenopholis pensylvanica, Decodon verticillatus, Galium obtusum, Polygonum setaceum, Osmunda regalis var. spectabilis, Scutellaria lateriflora, Hydrocotyle verticillata, Cinna arundinacea*, and *Pilea pumila*. Substrates are mucky peats and mucks; nutrient regimes may be enhanced in some examples by rare, wind-tidal inputs. Because of higher nutrient status, this type is more diverse than non-tidal cypress-gum forests. Pronounced hummock/hollow microtopography is usually a prominent feature of this type, with the hollows filled with deep, soupy muck.

2. Plant associations described in NatureServe with *Saururus cernuus* as a dominant component species.

Source: NatureServe Explorer: An online encyclopedia of life [web application]. 2001. Version 1.6 . Arlington, Virginia, USA: NatureServe. Available: http://www.natureserve.org/explorer. (Accessed: April 9, 2002).

Name (Common Name in Parentheses)	Distribution (TNC Ecoregions in Parentheses)	Environmental Setting	Description
Quercus lyrata - Quercus laurifolia - Taxodium distichum / Saururus cernuus Forest – G4 (Overcup Oak - Diamondleaf Oak - Bald-cypress Blackwater Bottomland Forest)	NC, SC (South Atlantic Coastal Plain; Mid-Atlantic Coastal Plain)	This vegetation is found in sloughs and edges of backswamps.	This vegetation of sloughs and edges of backswamps in the Atlantic Coastal Plain has a mixture of cypress - gum swamp and bottomland hardwoods species, generally *Quercus lyrata, Quercus laurifolia, Taxodium distichum, Populus heterophylla, Fraxinus profunda, Quercus phellos, Ulmus americana, Acer rubrum, Liquidambar styraciflua, Carya aquatica, Planera aquatica,* and *Fraxinus pennsylvanica*. Along with the canopy species, other species that may be present in the subcanopy are *Ulmus alata, Ilex decidua, Carpinus caroliniana,* and *Diospyros virginiana*. The shrub layer ranges from sparse to a moderate coverage by species of the canopy and subcanopy layers with *Sabal minor* and *Arundinaria gigantea*. Herbaceous coverage usually is well-developed, and dominant species include *Carex joorii, Carex intumescens, Carex lupulina, Boehmeria cylindrica, Justicia ovata, Saururus cernuus,* and *Leersia lenticularis*. Other herbaceous species that occur include *Commelina virginica, Lobelia cardinalis, Ludwigia palustris, Diodia virginiana, Gratiola virginiana*, and others. The undergrowth (especially the prevalence of *Saururus cernuus*) is typical of cypress - gum swamps. This forest has well-developed canopy, subcanopy, and herbaceous strata.

2. Plant associations described in NatureServe with *Saururus cernuus* as a dominant component species.

Source: NatureServe Explorer: An online encyclopedia of life [web application]. 2001. Version 1.6 . Arlington, Virginia, USA: NatureServe. Available: http://www.natureserve.org/explorer. (Accessed: April 9, 2002).

Name (Common Name in Parentheses)	Distribution (TNC Ecoregions in Parentheses)	Environmental Setting	Description
Taxodium distichum - Fraxinus pennsylvanica - Quercus laurifolia / Acer rubrum / Saururus cernuus Forest – G3G4	LA:?, NC, SC, VA:? (Mid-Atlantic Coastal Plain)	These forests occur in sloughs and on alluvial flats on soils with a percentage of silt.	These forests occur in sloughs and on alluvial flats on soils with a percentage of silt. This association is dominated by *Taxodium distichum* and *Fraxinus pennsylvanica*. *Quercus laurifolia, Quercus lyrata, Acer rubrum, Liquidambar styraciflua, Planera aquatica*, and *Fraxinus caroliniana* are usually present, as are other tree species of generally higher bottomland communities including *Celtis laevigata, Ulmus americana, Platanus occidentalis*, and *Acer negundo*. The canopy is closed and the subcanopy layer generally is well-developed. The shrub layer is sparse and the herbaceous layer ranges from sparse to moderately dense depending upon duration of flooding. *Acer rubrum* is the strong dominant in the subcanopy with *Planera aquatica, Carpinus caroliniana, Ulmus alata, Ilex decidua*, and *Celtis laevigata* typical in this stratum as well. *Itea virginica* and *Cephalanthus occidentalis* are typical in the shrub layer. A variety of vines are possible within occurrences of this community. These include *Vitis rotundifolia, Vitis aestivalis, Bignonia capreolata, Campsis radicans, Berchemia scandens, Trachelospermum difforme*, and *Mikania scandens.* The most commonly occurring herbs are *Asclepias perennis, Boehmeria cylindrica, Pilea pumila, Saururus cernuus, Commelina virginica, Justicia ovata, Phanopyrum gymnocarpon, Carex lupulina, Leersia lenticularis, Ludwigia alternifolia*, and *Chasmanthium latifolium.* This forest type is documented in North Carolina and South Carolina; global distribution needs assessment.
Taxodium distichum - Nyssa aquatica - Acer rubrum / Saururus cernuus Forest – G5?	AL, KY, SC (East Gulf Coastal Plain; South Atlantic Coastal Plain)		This association includes swamps dominated by *Taxodium distichum* with *Nyssa aquatica* and other hardwood species, especially *Acer rubrum* and *Ulmus americana*. Shrub species which may be present include *Itea virginica* and *Clethra alnifolia*. *Saururus cernuus* is prominent in the herbaceous stratum, which may also include *Boehmeria cylindrica, Sagittaria latifolia*, and *Smilax* spp.

2. Plant associations described in NatureServe with *Saururus cernuus* as a dominant component species.

Source: NatureServe Explorer: An online encyclopedia of life [web application]. 2001. Version 1.6 . Arlington, Virginia, USA: NatureServe. Available: http://www.natureserve.org/explorer. (Accessed: April 9, 2002).

Name (Common Name in Parentheses)	Distribution (TNC Ecoregions in Parentheses)	Environmental Setting	Description
Peltandra virginica - Saururus cernuus - Carex crinita / Climacium americanum Herbaceous Vegetation – G2? (Floodplain pool)	DE:?, MD:?, NC, NJ:?, TN:?, VA (Southern Blue Ridge: Piedmont; Mid-Atlantic Coastal Plain; Lower New England/Northern Piedmont)		This vegetation occupies depressions of Piedmont and mountain floodplains. Vegetative cover is generally low and may be confined to edges or shallower portions that dry out during the growing season. The vascular plant species vary widely among examples. Emergent vegetation may include *Peltandra virginica*, *Dulichium arundinaceum*, and *Polygonum* spp. *Carex crinita* or some other wetland *Carex* species are almost always present, and *Climacium americanum* is often abundant on the landward side. Larger examples may have pad-leaved aquatic species such as *Brasenia schreberi* or *Nymphaea odorata*. Piedmont examples may also have *Saururus cernuus* and *Boehmeria cylindrica*. Some examples have wetland shrubs on edges or in shallow portions, including *Cornus amomum* and *Cephalanthus occidentalis*. These depressions are usually abandoned channel segments or swales behind natural levees in which water is ponded for all or much of the year. Water may be supplied primarily by stream flooding or by rainfall.

3. An Explanation of Conservation Ranks Used by The Nature Conservancy and NatureServe

The conservation rank of an element known or assumed to exist within a jurisdiction is designated by a whole number from 1 to 5, preceded by a G (Global), N (National), or S (Subnational) as appropriate. The numbers have the following meaning:

1 = critically imperiled
2 = imperiled
3 = vulnerable to extirpation or extinction
4 = apparently secure
5 = demonstrably widespread, abundant, and secure.

G1, for example, indicates critical imperilment on a range-wide basis — that is, a great risk of extinction. S1 indicates critical imperilment within a particular state, province, or other subnational jurisdiction — i.e., a great risk of extirpation of the element from that subnation, regardless of its status elsewhere. Species known in an area only from historical records are ranked as either H (possibly extirpated/possibly extinct) or X (presumed extirpated/presumed extinct). Certain other codes, rank variants, and qualifiers are also allowed in order to add information about the element or indicate uncertainty.

Elements that are imperiled or vulnerable everywhere they occur will have a global rank of G1, G2, or G3 and equally high or higher national and subnational ranks (the lower the number, the "higher" the rank, and therefore the conservation priority). On the other hand, it is possible for an element to be rarer or more vulnerable in a given nation or subnation than it is range-wide. In that case, it might be ranked N1, N2, or N3, or S1, S2, or S3 even though its global rank is G4 or G5. The three levels of the ranking system give a more complete picture of the conservation status of a species or community than either a range-wide or local rank by itself. They also make it easier to set appropriate conservation priorities in different places and at different geographic levels. In an effort to balance global and local conservation concerns, global as well as national and subnational (provincial or state) ranks are used to select the elements that should receive priority for research and conservation in a jurisdiction.

Use of standard ranking criteria and definitions makes Natural Heritage ranks comparable across element groups; thus, G1 has the same basic meaning whether applied to a salamander, a moss, or a forest community. Standardization also makes ranks comparable across jurisdictions, which in turn allows scientists to use the national and subnational ranks assigned by local data centers to determine and refine or reaffirm global ranks.

Ranking is a qualitative process: it takes into account several factors, including total number, range, and condition of element occurrences, population size, range extent and area of occupancy, short- and long-term trends in the foregoing factors, threats, environmental specificity, and fragility. These factors function as guidelines rather than arithmetic rules, and the relative weight given to the factors may differ among taxa. In some states, the taxon may receive a rank of SR (where the element is reported but has not yet been reviewed locally) or SRF (where a false, erroneous report exists and persists in the literature). A rank of S? denotes an uncertain or inexact numeric rank for the taxon at the state level.

Within states, individual occurrences of a taxon are sometimes assigned element occurrence ranks. Element occurrence (EO) ranks, which are an average of four separate evaluations of quality (size and productivity), condition, viability, and defensibility, are included in site descriptions to provide a general indication of site quality. Ranks range from: A (excellent) to D (poor); a rank of E is provided for element occurrences that are extant, but for which information is inadequate to provide a qualitative score. An EO rank of H is provided for sites for which no observations have made for more than 20 years. An X rank is utilized for sites that are known to be extirpated. Not all EO's have received such ranks in all states, and ranks are not necessarily consistent among states as yet.