PRODUCTION NOTE

University of Illinois at
Urbana-Champaign Library
Conservation Assessment

for the

Kidneyleaf Mud-plantain

(Heteranthera reniformis Ruiz & Pavón)

12 May 2006

Steven R. Hill, Ph.D.
Illinois Natural History Survey
Center for Wildlife and Plant Ecology
1816 South Oak Street
Champaign, Illinois 61820

Illinois Natural History Survey
This Conservation Assessment was prepared to compile the published and unpublished information on the subject taxon or community; or this document was prepared by another organization and provides information to serve as a Conservation Assessment for the Eastern Region of the Forest Service. It does not represent a management decision by the U.S. Forest Service. Though the best scientific information available was used and subject experts were consulted in preparation of this document, it is expected that new information will arise. In the spirit of continuous learning and adaptive management, if you have information that will assist in conserving the subject taxon, please contact the Eastern Region of the Forest Service - Threatened and Endangered Species Program at 310 Wisconsin Avenue, Suite 580 Milwaukee, Wisconsin 53203.
Table of Contents

Acknowledgments............................................................................................................................ 4
Executive Summary.......................................................................................................................... 5
Nomenclature and Taxonomy.......................................................................................................... 6
Description of Species..................................................................................................................... 7
Habitat and Ecology......................................................................................................................... 8
Distribution and Abundance............................................................................................................ 10
Protection Status............................................................................................................................ 13
Life History..................................................................................................................................... 15
Population Biology and Viability..................................................................................................... 16
Potential Threats............................................................................................................................ 17
Research and Monitoring.............................................................................................................. 18
Restoration.................................................................................................................................... 20
Summary....................................................................................................................................... 22
References..................................................................................................................................... 22
Websites Consulted.......................................................................................................................... 25
Contacts......................................................................................................................................... 26
Appendix 1. Representative specimens of *Heteranthera reniformis* in the continental United
States examined or cited in the literature...................................................................................... 27
Appendix 2. The distribution of *Heteranthera reniformis* in the continental United States.
Information from herbarium specimens and the literature.......................................................... 30
Appendix 3. Natural Diversity Database Element Ranking System............................................... 32
ACKNOWLEDGMENTS

I would like to thank the staffs of the United States Forest Service, Shawnee and Hoosier National Forests, for the opportunity to compile these conservation assessments and for their invaluable assistance with data and field opportunities. Steve Widowski, Beth Shimp, and Sarah Calloway were particularly helpful in facilitating this cost share agreement.

I would also like to thank the staff of the Illinois Natural History Survey, Champaign, for their assistance with logistics necessary to complete these reports.

Specimens were examined at several herbaria during the preparation of this report. I would like to thank the curators of the following herbaria, especially, for their help – the Missouri Botanical Garden (MO), the University of Northern Alabama (UNAF), and the University of Wisconsin (WIS).

Several people contributed additional information on this wetland herb. Among these, Charles N. Horn, the recognized expert on the genus, was most helpful. Beth Shimp supplied some recent information on Illinois populations. Mike Homoya provided information on the plant in Indiana and George Yatskievych provided information on the Missouri population.

A special thanks to my assistant Sherry Weaver for her continuing assistance in database management and processing the plant specimen vouchers.

This material is based upon work supported by the U.S.D.A. Forest Service, Eastern Region, under Cost Share Award No. AG03-CS-11090804-024. Any opinions, findings, and conclusions or recommendations expressed in this publication are those of the author and do not necessarily reflect the views of the U.S.D.A. Forest Service, Eastern Region.
EXECUTIVE SUMMARY

This Conservation Assessment is a review of the taxonomy, distribution, habitat, and ecology of the Kidneyleaf Mud-plantain, *Heteranthera reniformis* Ruiz and Pavón, throughout the United States, and in the U.S.D.A. Forest Service lands, Eastern Region (Region 9), in particular. This document also serves to update knowledge about the status, potential threats, and conservation efforts regarding the Kidneyleaf Mud-plantain to date. The Kidneyleaf Mud-plantain is a colonial, spreading, fragile [spongy-fleshy] annual herb normally found in patches and the prostrate stems may be up to 1 m long. The species is found through much of the western hemisphere, but it is limited by cold sensitivity and suitable habitat. It grows mainly on open, exposed but periodically inundated mudflats at the margins of stagnant or slow-moving bodies of water where there is little other competition. The leaves and flower stalks are erect and they can be numerous, and each plant can produce an abundance of seeds provided that the water level does not exceed about 15 cm. The seeds within the seed banks allow the plant to persist at an area, but the plants do not grow every year, instead they await suitable conditions. It has been spread as a weed in rice paddy plantings because the same growing conditions benefit both. Globally, its ranking is G5 (the species is secure world-wide). The Kidneyleaf Mud-plantain is listed as Endangered in Illinois and Ohio, and it is included on the Regional Forester Sensitive Species list (RFSS) for the Shawnee National Forest but not the Hoosier National Forest, where it has not been documented. The species is sensitive at the margins of its range where conditions are only marginally suitable for its survival. Populations may also be destroyed by means of loss of wetland habitats, loss of its seed bank, and by the excessive use of herbicides.

In addition to species listed as endangered or threatened under the Endangered Species Act (ESA), or species of Concern by U.S. Fish and Wildlife Service, the Forest Service lists species that are Sensitive within each region (RFSS). The National Forest Management Act and U.S. Forest Service policy require that National Forest System land be managed to maintain viable populations of all native plant and animal species. A viable population is one that has the estimated numbers and distribution of reproductive individuals to ensure the continued existence of the entity throughout its range within a given planning area.

The objectives of this document are to:

- Provide an overview of the current scientific knowledge on the species.

- Provide a summary of the distribution and status on the species range-wide and within the Eastern Region of the Forest Service, in particular.

- Provide the available background information needed to prepare a subsequent Conservation Approach.
NOMENCLATURE AND TAXONOMY

Scientific Name:  *Heteranthera reniformis* Ruiz-Lopéz & Pavón [1798]
Common Names:  Kidneyleaf Mud-plantain; Kidneyleaf Mudplantain; Kidney-leaf Mudplantain; Mud Plantain; Mud-plantain

Synonymy:  
- *Heterandra reniformis* P. Beauv. [1799]  
- *Heteranthera acuta* Willd. [1801]  
- *Leptanthus reniformis* (P. Beauv.) Michx. [1803]  
- *Leptanthus virginica* Persoon [1805]  
- *Buchosia aquatica* Vellozo [1825]  
- *Heteranthera virginica* (Persoon) Steudel [1841]  
- *Schollera reniformis* (P. Beauv.) Kuntze [1891]  
- *Phrynium reniforme* (P. Beauv.) Kuntze [1898]

Class:  Liliopsida (Flowering Plants - Monocotyledons)
Family:  Pontederiaceae (The Pickerel-weed Family)
Plants Code:  HERE (USDA NRCS plant database, W-1)  
http://plants.usda.gov/cgi_bin/topics.cgi

The genus *Heteranthera* contains twelve species total, with seven in North America north of Mexico, according to Horn (2002). The species are widespread to narrowly distributed and they are most common in wet habitats in the Western Hemisphere and Africa. Some occur in tropical lowlands.

Kidneyleaf Mud-plantain was named *Heteranthera reniformis* by the South American botanists Ruiz-Lopéz & Pavón [1798] who noted that the leaf shape resembled that of a kidney, hence the epithet *reniformis* [Latin - *reni* – of the kidney, *formis* – form]. In the subsequent years this and similar small genera were redefined, and selected species were treated within the genera *Eurystemon* E.J.Alexander, *Heterandra* Palisot de Beauvois, *Schollera* Schreber, and *Zosterella* Small. Kidneyleaf Mud-plantain was the first species described within *Heteranthera*, and it has been treated as a typical member of the genus ever since. The name of the genus was derived from the Greek *hetera*, *-os*, different, and *anthera*, anther, from the dissimilar anthers of the originally named species. This species is thought to be closely related to, and it is sometimes confused with, two similar species, the Many-flowered Mud-plantain, *Heteranthera multiflora* (Griseb.) C.N.Horn, a primarily Midwestern USA species, and the Peduncled Mud-plantain, *H. peduncularis* Benth., a primarily Mexican species. Most published works previous to 1986 treated the former either as typical *H. reniformis* or as *H. reniformis* var. *multiflora* Griseb., named in 1879. The current treatment by Horn (2002), accepts all three taxa as distinct species.

Most species of *Heteranthera* with a wide leaf blade are simply called Mud plantain or Mud-
plantain because of their similarity to the unrelated common plantain (genus *Plantago*). The common name listed for the plant by the Illinois Endangered Species Protection Board (2005) is simply Mud Plantain. The name used by NatureServe (W-2) is the same as that used in this report.

**DESCRIPTION OF SPECIES**

*Heteranthera reniformis*, the Kidneyleaf Mud-plantain, is a moderately delicate annual or, in the tropics, rarely a perennial herb of periodically flooded wetlands; its vegetative *stems* are either submersed with elongate sheathed internodes or they are emersed and procumbent; the tissues are somewhat spongy (aerenchymatous); the maximum stem length is about 1 meter; the flowering stem is glabrous, 1-9 cm long, the upper internode of which is 0.5-4 cm; initial *sessile leaves* are normally submersed and form a basal rosette, they are thin, whitened on the abaxial surface, linear to oblanceolate, and acuminate at the apex; the later more frequently seen and persistent *petiolate leaves* can be floating or emersed, reniform, obtuse at the apex, 1-4 cm long x 1-5 cm wide, with the length equal to or less than the width; the *petiole* is glabrous and 2-13 cm long. *Stipules* are 1-5 cm long and sheathing and conspicuous. The *spathes* are folded, and 8-55 mm long x 2-5 mm wide; the *inflorescence* is a spike with 2-8 flowers that elongates in a single day and it is usually shorter than the spathe; the *peduncle* is glabrous and 5-42 mm long. The *flower* perianth is salverform, white, and densely glandular pubescent; its tube is 5-10 mm long; there are five similar *lobes* and one dissimilar from the rest making the overall symmetry zygomorphic (bilateral), the lobes are narrowly elliptic, acuminate at the apex, 3.0-6.5 mm long, and the upper dissimilar central lobe has a yellow or green region at the base, sometimes with a brown spot above. *Stamens* are of two sizes; the lateral stamens are 0.9-2.2 mm long, the filaments are linear, white, and pubescent with white multicellular hairs toward the apex, and the anthers are rounded, yellow, and 0.2-0.8 mm long; the central stamen is yellow or blue, 2.2-4.7 mm long, with the filament linear, white, and sparsely pubescent with multicellular hairs, its anther is yellow or blue and 0.8-1.8 mm long. The style is white and pubescent with multicellular hairs. The *fruit* is an elongate thin-walled capsule, 0.5-0.8 cm long with many (50-100) *seeds*, each 0.5-0.9 mm long x 0.3–0.5 mm wide and with 8-14 longitudinal wings. The chromosome number is 2n = 48. (Adapted from Horn 2002).

This aquatic or amphibious herb may be confused with one other species in the midwestern states, namely *Heteranthera multiflora*. The differences between the two follow in an abbreviated key also adapted from Horn (2002).

Flower spikes shorter than spathe, terminal flower sometimes extending past spathe tip; filament hairs white; spathe equal to or barely longer than the internode immediately below them; 2-8 flowers/spike; leaf blade length less than or equal to the width..............................................................*Heteranthera reniformis*
Flower spikes longer than spathes, terminal flower always extended beyond spathe tip; filament hairs purple, spathes 3 or more times longer than the internode immediately below them; 3-16 flowers/spike; leaf blade length usually greater than width..............Heteranthera multiflora

The nature of many aquatic monocots and dicots is to have submersed and emergent leaves with different morphologies, as in these two Heterantheras. Therefore, the general leaf blade features of emersed (aerial, not submerged) leaves have been used in the key. Identifications should be made based on reproductively mature plants whenever possible, because the leaves are somewhat variable.

HABITAT AND ECOLOGY

The Kidneyleaf Mud-plantain is a plant of very level, naturally or artificially (human) disturbed wetland sites. It requires strong sunlight for its best development, but it can be found among open areas of shrubs and small trees. Heteranthera reniformis has a wetland indicator status of OBL, indicating that the species grows only in wetlands. [OBL = Obligate wetland species that under natural conditions occur almost always (> 99% probability) in wetlands] (Reed 1988). These habitats include roadside ditches, the margins of streams and ponds, as well as freshwater tidal mudflats, in or near sluggish, slow-moving, or stagnant water. On herbarium specimen labels, it has been said to grow at the margins of lakes, ponds, creeks, rivers, river banks, canals, ditches, sloughs, swamps, bogs, marshes, sink holes, bayous, tidal shores, and even pigpens. In its natural state, the plant appears to grow best on level floodplains of rivers and ponds that flood and dry regularly or somewhat intermittently, and where barren potholes or playa-like patches occasionally form. This is a restricted (infrequent) habitat, though it is also a very disturbed one. While specific data is not available on this, it appears that this plant can tolerate both acidic and alkaline habitats, but it does require high nutrient (rich) sites. It can often be found in wetlands associated with livestock or agriculture.

Normally the plants establish in areas with little competition from other species by means of small seeds that germinate underwater in shallow areas that are nearly barren. At these sites, small or large, the water level can fluctuate and later the surface can be exposed as moist or wet mud or sand flats. Success then depends upon a continuous water supply and, usually, partial submergence during the rest of the growing season. The species is best considered to be amphibious, and it produces the most seeds when the water is shallow (about 5-10 cm deep) and when leaves are mostly emergent so that it can make and store a quantity of nutrients for flower production. This plant requires a great deal of bright sunlight to produce enough seeds for it to persist at a site. Under ideal conditions, the procumbent stems can grow throughout the growing season, resulting in a branched patch up to 1 m in diameter that can be a single plant. However, most patches appear to contain multiple plants, or colonies (Horn, pers. comm.).

The plants usually produce many seeds, and the populations are established from these seeds that
persist in the soil seed bank. It is not known for certain how long the seeds can survive in the seed bank. However, according to Horn (pers. comm.), the germination rate of 15-year old seeds that had been kept in water in the dark for that period of time was greater than 95%. This would help to explain why the species at a particular site is typically absent and suddenly present again after spans of years elapse between sightings.

Because of its habitat preferences, certain types of agricultural practice actually seem to benefit this species. The Kidneyleaf Mud-plantain and others in the genus can become common and even noxious weeds in rice fields. The periodic draining and submergence of the seeds and the high nutrient availability (fertilizer having been added to benefit the rice) are also ideal for *Heteranthera reniformis* success (W-3). When the plant occurs as a weed, a pre-emergence herb control (Oxadiazon, or Ronstar) application has been recommended to prevent this plant from getting a start in rice fields (W-3; Ebre Delta, Spain). To remove colonies of the plant, the post emergence herbicide Cinosulfuron (Setoff) has been recommended. Looking at this from another perspective, it is clear that some herbicides can also pose a significant hazard for the survival of the species within its native range. Nevertheless, this species has been considered to be invasive in some United States rice fields by the Southern Weed Science Society (1998).

*Heteranthera reniformis* grows with a predictable assemblage of facultative or obligate wetland species. In Maryland it has been found growing with *Bidens* spp., *Nuphar luteum*, *Pontederia cordata*, *Aster* spp., *Scirpus* sp., and others (Hill 17411). It has been found in several areas growing with its close relative *Heteranthera multiflora* (Horn & Wiersema 8613). The plants’ fragile nature can allow other more vigorous plants in their vicinity to overtake them and shade them out from a site.

In Illinois, Hill (1999) found *Heteranthera reniformis* at a single site, along the margin and floodplain of a tributary of Cache Creek at Tamms, in Alexander County. At this site the associated plants overall included the **trees** *Acer negundo*, *Acer rubrum*, *Acer saccharinum*, *Betula nigra*, *Carya cordiformis*, *Celtis laevigata*, *Fraxinus pennsylvanica*, *Fraxinus profunda*, *Liquidadambar styraciflua*, *Populus heterophylla*, *Quercus palustris*, *Salix nigra*, *Taxodium distichum*, and *Ulmus americana*, the **shrubs** *Cephalanthus occidentalis*, *Cornus foemina*, *Forestiera acuminata*, and *Styrax americana*, the **vines** *Brunnichia ovata*, *Smilax rotundifolia*, *Toxicodendron radicans*, and *Vitis cinerea*, the **herbs** *Alisma plantago-aquatica*, *Asclepias incarnata*, *Aster simplex*, *Bidens* spp., *Boehmeria cylindrica*, *Ceratophyllum demersum*, *Commelina virginica*, *Diodia virginiana*, *Hibiscus lastocarpus*, *Impatiens capensis*, *Ludwigia alternifolia*, *Mimulus alatus*, *Phyla lanceolata*, *Pilea pumila*, *Polygonum punctatum*, *Polygonum sagittatum*, *Sagittaria latifolia*, *Saururus cernuus*, and *Spirodela polyrhiza*, the **grasses** *Leersia oryzoides* [dominant], and *Panicum rigidulum*, and the **sedges** *Carex crinita*, *Carex frankii*, *Carex grayi*, *Carex hyalinolepis*, *Carex lupulina*, *Carex muskingumensis*, *Carex tribuloides*, *Carex typhina*, *Carex vulpinoidea*, *Scirpus cyperinus*, and *Scirpus georgianus*. This wetland association was considered to be a relatively high-quality natural one.
Associated plants found growing with its close relative and occasional associate *Heteranthera multiflora* in the same county (Hill and Koontz 2002), near the Mississippi River and near a new rice field, included the trees *Fraxinus pennsylvanica* (seedlings) and *Salix nigra*; the shrub *Cephalanthera occidentalis*; the vines *Ampelopsis arborea* and *Ipomoea lacunosa*; the herbs *Acalypha rhomboidea*, *Alisma plantago-aquatica*, *Amaranthus tuberculatus*, *Ammannia coccinea*, *Asclepias incarnata*, *Aster simplex*, *Bacopa rotundifolia*, *Bidens spp.*, *Commelina diffusa*, *Conyza canadensis*, *Dalea leporina*, *Diodia virginiana*, *Echinodorus berteroi* var. *lanceolatus*, *Echinodorus cordifolius*, *Eclipta prostrata*, *Gratiola neglecta*, *Heteranthera limosa*, *Hibiscus laevis*, *Hibiscus lasiocarpos*, *Iva annua*, *Lindernia dubia*, *Ludwigia decurrens*, *Ludwigia palustris*, *Ludwigia peploides*, *Penthorum sedoides*, *Phyla lanceolata*, *Pluchea camphorata*, *Polygonum bicerne*, *Polygonum lapathifolium*, *Polygonum pensylvanicum*, *Polygonum persicaria*, *Portulaca oleracea*, *Ranunculus sceleratus*, *Rorippa islandica* var. *fernaldiana*, *Rotala ramosior*, *Sagittaria brevirostra*, *Sagittaria calycina*, *Senecio glabellus*, *Sida spinosa*, *Spirodela polyrhiza*, *Typha latifolia*, *Veronica peregrina*, and *Xanthium strumarium*; the grasses *Alopecurus carolinianus*, *Echinochloa muricata*, *Elymus virginicus*, *Eragrostis hypnoides*, *Leptochloa acuminata*, *Leptochloa panicoides*, and *Panicum dichotomiflorum*, and the sedges *Cyperus acuminatus*, *Cyperus erythrorhizos*, *Cyperus esculentus*, *Cyperus iria*, *Cyperus strigosus*, *Eleocharis macrostachya*, and *Eleocharis obtusa*. It should be noted that *Cyperus iria* is also generally known as a rice field weed. This association was considered to be typical of a wet disturbed site with a very good seed bank flora.

Finally, it should be mentioned that *Heteranthera reniformis* is occasionally commercially sold for use as both an aquarium plant and a water garden plant around the world.

**DISTRIBUTION AND ABUNDANCE**

*Heteranthera reniformis*, the Kidneyleaf Mud-plantain, is widespread in the Western Hemisphere, and its range is limited primarily by suitable habitat and the need for a long growing season. Its range extends from Connecticut to Missouri in the United States on the north, south to Texas and the Florida panhandle, south through Mexico to Central America, and then scattered south to Paraguay and Argentina. It is most common in wetlands in Central America. It has been naturalized in Italy and Spain in rice fields where it has become weedy. It has been reported to grow in twenty-two of the United States as well as the District of Columbia. According to Horn (2002) the species has been reported historically in Alabama, Connecticut, Delaware, District of Columbia, Florida, Georgia, Illinois, Indiana, Kentucky, Louisiana, Maryland, Mississippi, Missouri, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Texas, Virginia, and West Virginia. The USDA Plants website (W-1) includes Arkansas and Iowa within its known range. In addition, Horn (2002) indicates an outlying population in Oklahoma, but this was in error (Horn, pers. comm.). It appears that the Iowa and Arkansas reports refer to occurrences of *Heteranthera multiflora* instead. Only one
collection has been made of this plant in Texas.

It should be noted again here, that previous to 1986, most published floras included *Heteranthera multiflora* within this species, and so specimens must be individually re-evaluated to determine the true distribution of *H. reniformis*. The distribution data presented by Horn (1985, 2002 and pers. comm.) involved such a re-evaluation and is accepted here.

The closely related species *H. multiflora*, then, is distributed only in the following states: Arkansas, Delaware, Illinois, Iowa, Kansas, Louisiana, Maryland, Mississippi, Missouri, Nebraska, New Jersey, North Carolina, Oklahoma, Pennsylvania, Tennessee, Texas and Virginia. It, also, can be found from Venezuela to Argentina in South America (Horn 2002).

The distribution of the Kidneyleaf Mud-plantain suggests that it survived during the Ice Ages in warm coastal and Mississippi basin areas. It is most commonly found on the coastal plain on level flooding terraces. As a wetland plant with tiny seeds often growing in the tropics, it is likely that it has also achieved its present distribution as a hitchhiker on waterfowl frequenting these well-known bird migration routes. Its current range includes primarily unglaciated areas, but because it is not hardy and it is frost sensitive, its range appears to be more dependent on current tolerances than past glacial distribution.

The Kidneyleaf Mud-plantain in the continental United States is (or was) at its northeastern limit of distribution along the coast in Connecticut, and at its northwestern limit in southern Illinois. A single disjunct population has been reported in west Texas, its western range limit. The species reaches its southern range limits in the continental United States in Louisiana's Mississippi River delta and in the panhandle of Florida. In suitable recent years, the plant has been found to be especially common in Alabama, Louisiana, and Virginia (Horn 1985, and pers. comm.). There have been many collections of the species made in Maryland, New Jersey, North Carolina, and, especially, Pennsylvania, but most of these were collected well before 1960, suggesting that some northern US populations may have been lost since then. Representative specimens of this wetland herb have been listed in Appendix 1. A summary of the distribution of *Heteranthera reniformis* in the continental United States has been presented in Appendix 2.

Within the U.S. Forest Service Eastern Region (Region 9) *Heteranthera reniformis* is present within the Shawnee National Forest in Illinois, and it has been most recently noted at the Homberg Spring Natural Area in Pope County (in 1990) and at the La Rue - Pine Hills / Otter Pond Research Natural Area in Union County (in 1977; Shimp, pers. comm.). There are no known definite reports of the species in the Hoosier National Forest, though historic occurrences are known from Crawford and Orange Counties, and so it may yet be found on Forest Service land in Indiana. *Heteranthera reniformis* is present in the Wayne National Forest in Ohio, and while it is included on their list of Plants Prohibited from Collection, the species has not been added to the RFSS list for the forest (W-4).

*Conservation Assessment for the Kidneyleaf Mud-plantain (Heteranthera reniformis Ruiz & Pavón)*
Again in Illinois, where *Heteranthera reniformis* is listed as Endangered and where it is at its northwestern range limit, the species has been reported historically in Alexander, Lawrence, Pope, St. Clair, Union, and Wabash counties, but it is currently known to survive only in Alexander, Pope, and (probably) Union counties (Mohlenbrock & Ladd 1978, Herkert and Ebinger 2002). It probably survives at other historic sites in the other counties mentioned. The southern Illinois sites fall within the Natural Divisions and sections known as the Lower Mississippi River Bottomlands Division, Southern Section; the Shawnee Hills Division, Greater Shawnee Hills Section and Lesser Shawnee Hills Section; and the Coastal Plain Division, Bottomlands Section (Schwegman et al. 1973) just south of the former glacial boundary.

In Indiana overall, *Heteranthera reniformis* is rarely seen, though it was reported in Clark, Crawford, Harrison, Jefferson, Knox, Orange, Posey, and Putnam counties by Deam (1940). It is said to be very local in ponds in the southern counties. It has not been seen in recent years (Homoya, pers. comm.) though it likely persists. It may fit all criteria for listing as threatened or endangered in Indiana.

The Kidneyleaf Mud-plantain was included in Missouri by Steyermark (1963), who recognized three species within the state, *Heteranthera dubia*, *H. limosa*, and *H. reniformis*. In the more recent treatment of the Flora of Missouri by Yatskievych (1999) five *Heteranthera* species were recognized to occur within the state, namely *H. dubia*, *H. limosa*, *H. multiflora*, *H. reniformis*, and *H. rotundifolia*. Also in this treatment, *Heteranthera peduncularis* was included as a synonym of *H. multiflora*, whereas in Steyermark’s treatment it was considered to be a synonym of *H. reniformis*. The Missouri treatments show the history of the confusion in the taxonomy of these species very well. *Heteranthera rotundifolia* (Kunth) Griseb. has been confused with *H. limosa* in many floras, just as *H. multiflora* has been confused with *H. reniformis*. Therefore, the distribution of *H. reniformis* presented by Steyermark (1963) better reflects the distribution of *H. multiflora* in Missouri, because *H. reniformis* itself is currently and historically known only in a single county (New Madrid County). *Heteranthera peduncularis*, a primarily Mexican species, does not occur in Missouri at all (Horn 2002).

The population numbers in Illinois and other parts of the Midwest are relatively low compared to populations near the Mississippi River in Louisiana and western Tennessee. Furthermore, the populations here are isolated from one another apparently because only a few local sites are suitable at this northern margin of its range. It is likely that the species was somewhat more common in the region at the time of European settlement because some historic populations (e.g. those in the American Bottoms near St. Louis) appear to have been lost through land development.

Botanists generally believe that most native plants have reached the limits to which they can travel under present conditions of climate (that is, temperature and rainfall), substrate, dispersal
In other words, species are in balance with their environment as long as the environment is stable. Plants are very sensitive to local conditions at the margins of their ranges. In many biological simulations, the ecological extremes are more important than the means in controlling plant distribution (Webb et al. 1975). An obvious example is that of frost tolerance (temperature extremes), and another is that of drought tolerance. A plant species completely intolerant of freezing can persist in a site indefinitely until the first time extreme temperatures cause it to freeze. Likewise, a severe drought can eliminate species intolerant of complete drying. One such freeze or drought in a century may be enough to eliminate a species entirely from a wide area of its range, and, with the exception of human activities, changes in climate historically have caused the greatest changes in plant distributions.

In the case of the Kidneyleaf Mud-plantain, current distribution appears to be controlled by temperature extremes, but its distribution may be equally dependent on flooding regimes, seed transport, and the protection of the seed bank (from human perturbation). Both habitat unsuitability and colder temperatures may have prevented the establishment of colonies of this herb to the north and elsewhere in the midwestern states.

PROTECTION STATUS

The Nature Conservancy’s ranking for *Heteranthera reniformis* is G5 (Secure globally; numerous populations exist and there is no danger overall to the security of the element; W-5, Appendix 3). In the United States the species has the National Heritage status rank of N4N5 with a similar meaning. The state rankings vary, but it has been designated as Endangered in Illinois (Illinois Endangered Species Protection Board 2005, as Mud Plantain) and Ohio (W-6); it has been designated as Rare in New York, of Special Concern in South Carolina, and, though ranked as a species of Special Concern in Connecticut, it is generally considered to have been extirpated there (W-2). It exists at a single site in Missouri, but current law in that state only allows the listing of federally listed taxa as state endangered (Yatskievych, pers. comm.). *Heteranthera reniformis* has been included on the Rare, Threatened, and Endangered Plants list of the West Virginia Natural Heritage Program [in 2003] but its state category was not indicated. It is not tracked in several states where it occurs because of its greater frequency in those states.

*Heteranthera reniformis* has been included on the Regional Forester Sensitive Species List (RFSS) for the Shawnee National Forest, but not on that for the Hoosier National Forest where it has not yet been found. It has not been included on the RFSS lists for other national forests in the Eastern Region (Region 9).

Protection for this wetland herb and for so many other species is currently dependent primarily on habitat protection, and so its survival will probably depend more on this than on individual species protection. As indicated previously in this report, the species is not globally threatened,
and so most protection programs that exist for it have been instituted at the state level where it is at the margins of its range.

Table 1 lists the official state rank assigned by each state’s Natural Heritage program according to the Nature Conservancy at their Internet site (W-2). Appendix 3 explains the meanings of the acronyms used (W-5). A summary of the current official protection status for the Kidneyleaf Mud-plantain follows:

**U.S. Fish and Wildlife Service:** Not listed (None)

**U.S. Forest Service:** Sensitive (RFSS) in the Shawnee National Forest only

**Global Heritage Status Rank:** G5

**U.S. National Heritage Status Rank:** N4N5

**Table 1: S-ranks for Heteranthera reniformis** [Heritage identifier: PMPON03040; W-2]

<table>
<thead>
<tr>
<th>State/Province</th>
<th>Heritage S-rank</th>
<th>Mississippi</th>
<th>SNR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Missouri</td>
<td>SNR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>New Jersey</td>
<td>S4S5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>New York</td>
<td>S3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>North Carolina</td>
<td>S2?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ohio</td>
<td>S1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pennsylvania</td>
<td>SNR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>South Carolina</td>
<td>SNR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tennessee</td>
<td>SNR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Texas</td>
<td>SNR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Virginia</td>
<td>SNR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>West Virginia</td>
<td>S1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>State/Province</th>
<th>Heritage S-rank</th>
<th>* = likely error in the (W-1; W-2) listings, probably refers to <em>H. multiflora</em>, not <em>H. reniformis</em>; the latter is not recorded from this state.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alabama</td>
<td>SNR</td>
<td></td>
</tr>
<tr>
<td>*Arkansas</td>
<td>SNR</td>
<td></td>
</tr>
<tr>
<td>Connecticut</td>
<td>SH</td>
<td></td>
</tr>
<tr>
<td>Delaware</td>
<td>S4</td>
<td></td>
</tr>
<tr>
<td>District of Columbia</td>
<td>SNR</td>
<td></td>
</tr>
<tr>
<td>Florida</td>
<td>SNR</td>
<td></td>
</tr>
<tr>
<td>Georgia</td>
<td>S3?</td>
<td></td>
</tr>
<tr>
<td>Illinois</td>
<td>S1 [endangered]</td>
<td></td>
</tr>
<tr>
<td>Indiana</td>
<td>SNR</td>
<td></td>
</tr>
<tr>
<td>*Iowa</td>
<td>S1</td>
<td></td>
</tr>
<tr>
<td>Kentucky</td>
<td>S4?</td>
<td></td>
</tr>
<tr>
<td>Louisiana</td>
<td>SNR</td>
<td></td>
</tr>
<tr>
<td>Maryland</td>
<td>SNR</td>
<td></td>
</tr>
</tbody>
</table>

* = likely error in the (W-1; W-2) listings, probably refers to *H. multiflora*, not *H. reniformis*; the latter is not recorded from this state.
LIFE HISTORY

*Heteranthera reniformis* is, in the southern and tropical portions of its range, a perennial herb. However, in the northern portions of its range, including Illinois, it is an annual because frost and freezing temperatures kill the plants. It is a long-season (or warm-season) plant, meaning that it requires a long and warm growing season to successfully produce seeds. In warmer areas its normal flowering period is June to October. Further north, it often will not flower until late August, restricting its seed-production capability. Here, as elsewhere, its seeds will remain in the seed bank until suitable conditions allow it to germinate and become a member of the flora again. This seed dormancy capability also has allowed it to survive in disturbed agricultural areas with rice, many varieties of which require a similar periodically marshy habitat. As a rice seed contaminant, it has reached southern Europe and is there sometimes considered to be a noxious weed (W-3).

The seeds germinate from the seed bank when the soil begins to warm in the mid to late spring (in the north). The earliest leaves have no blades and form a rosette, and these may be submersed or not. The plants grow slowly until temperatures become warm in the mid-summer, whereupon the plants produce the more typical leaves with blades and can then grow more quickly.

Under suitable growing conditions, plants can grow into rather large colonies covering well over 200 square meters. According to Horn (pers. comm.) each individual plant stem does not exceed 1 m, and even this would be large for an individual plant. Large colonies, then, would tend to indicate that several to many plants are present, and this would generally permit frequent outcrossing in areas of abundance. The plants have little tough support structure and the tissues are dependent on air chambers and water to hold their shape, typical of other obligate wetland plants. In northern climates, especially at the margins of its range, plants can be small, and, in extreme years, the plants may die from cold before reproducing. The plant may appear to be vegetative during much of the year in northern regions.

The delicate emergent flowers of *Heteranthera reniformis* last less than a day; they all open in the early to mid-morning (about three hours after sunrise), and they close (wilt) by the heat of mid-afternoon. They appear to be insect pollinated and possess nectar guides, typical of the Pickerel-weed Family. During seasons when plants are common but the water level is deep (more than 15 cm), plants tend to have submerged inflorescences with cleistogamous flowers (flowers that do not open and that self-pollinate and self-fertilize). This backup method can still allow individuals to produce seeds, but without insect pollination. This mechanism suggests that self-compatibility is the typical situation within the species.

Herbarium specimens of the Kidneyleaf Mud-plantain possess invaluable data on the phenology of past and present populations of the species in the United States, and elsewhere. The earliest flowers on United States plants noted on herbarium labels were 17 June [1945] in Talbot County,
MD, 26 June [1958] in Gates County, NC, 7 July [1950] in Chowan County, NC, and 9 July [1991] in Laurens County, SC. The earliest fruits on specimens were noted on 7 August [1994] in Jefferson County, TN, and 4 August [1878] in Washington, DC. Essentially all collections made in mid-August through October had some flowers, and most in September and October were also fruiting. The latest flowering and fruiting dates noted on specimens were on plants collected in Franklin and West Feliciana Parishes, LA, on 2 and 7 November [1980, 1981].

The seeds of *Heteranthera reniformis* can either float or sink (Horn, pers. com.), and this is generally dependant on whether they developed in air or under water. It is generally believed that the seeds can be dispersed not only by water, but also in mud or detritus on birds’ feet, or in birds’ stomachs. It is likely that the seeds are also now being dispersed as a contaminant in rice seed and by agricultural machinery.

**POPULATION BIOLOGY AND VIABILITY**

As previously indicated, *Heteranthera reniformis* is not considered to be a rare species over most of its range. There is no indication that the Kidneyleaf Mud-plantain is declining very drastically in range or abundance globally, and it remains common through most of its range (W-2). There are, however, dramatic population fluctuations from year to year, and it is also difficult to track and monitor this plant because of its mucky habitat. One must be careful not to derive conclusions on its presence or absence based on just a few visits to a site. According to the Nature Conservancy (W-2) “When environmental conditions are favorable, populations may appear from unknown seedbanks or spread from only a few individual plants to dense mats of vegetation in short periods of time. Populations will disappear just as quickly when environmental conditions are not favorable. Populations will come and go quickly from an area depending on several important environmental factors: it cannot propagate in water much deeper than 15 cm, as the maturing plant will be unable to reach the water surface; it cannot withstand too much shade or competition with other wetland plants. If management and monitoring is a concern, as it may be on the edge of its range, one must keep in mind the above needs.”

The range does appear to be expanding overall because of its weedy tendency in rice growing areas. However, *Heteranthera reniformis* colonies are normally not robust or large in Illinois and at other marginal locations, and they may not flower or re-appear at a particular site for many years because of a lack of suitable climatic conditions. In occasional suitable years, however, the local colonies in Illinois may cover areas about 1 m wide and 2 m or more long (pers. obs.).

Viability of the populations of this and many other species often depends on important considerations of genetic variability. It is generally understood that fertility is reduced in inbred populations through the process of autogamy (self-fertilization). Autogamy is useful to the plant when there are small numbers of individuals per area, since the safeguarding of the success of
propagation is more important than the production of new genotypes. This is not infrequent at the margins of a species’ range. In primary habitats, those that are generally poorly vegetated, initial success is very important, and *Heteranthera reniformis* can take advantage of this situation. However, in subsequent periods of vegetation increase, pioneers are often substituted by other, more competitive species (W-7). In plants such as the Kidneyleaf Mud-plantain self-fertilization is the most likely outcome for emergent flowers because there may be little chance of fertilization by other genotypes unless suitable pollinators are present, and unless plants with other genotypes are within dispersal range. The existing populations can be very isolated from one another in time and space. Continued self-fertilization can result in severe reproductive problems. If the habitat is subject to deeper water flooding, flowers may not even be produced, leaving only the obligate self-pollinating underwater flowers to supply seeds for the next generation. One advantage that small-seeded wetland plants do have, however, is that seeds from other genetically different populations may be introduced by migrating waterfowl, instilling a hybrid vigor to an older inbred population. It may not be necessary for this to be a very frequent event for the benefits to be significant.

The Kidneyleaf Mud-plantain’s preferred habitat, while secure worldwide, has been observed to be decreasing at its northern range limits across the continental United States (see Potential Threats below). It may or may not occur at other suitable sites in Illinois and Indiana, but only a few searches have been specifically for the Kidneyleaf Mud-plantain in recent years. Suitable habitat for the species appears to exist, but it may have never been very common here. Additional searches are suggested. If individuals are relocated, or if new sites are found, they may persist with proper habitat management.

Maintaining the fluctuating open wet habitat in which it grows appears to be one of the most important means to insure the survival (or viability) of this species at the northern extreme of its range.

**POTENTIAL THREATS**

Globally, the Kidneyleaf Mud-plantain has been judged to be secure (see Protection Status above). There is no indication that it is significantly declining in range or abundance globally, and it remains common through most of its range (W-2). The range actually appears to be expanding because of its weedy tendency in rice growing areas in southern Europe.

At the margins of its natural range, however, there are several non-natural potential threats to individual populations of this species. These threats include 1) permanent alteration of the hydrology at a given site (including draining wetlands for dry land agriculture, as well as the damming of rivers), 2) toxic runoff from agricultural activities, and 3) radical alteration of areas where seed banks and populations exist (including bulldozing, road construction, channelization of streams, riverbank stabilization, and the extraction or deposition of fill soil).
The deleterious effects of permanent hydrologic changes to its habitat appear obvious, because the plant is a wetland plant with specific water depth requirements. Herbicides applied to the plant when it is growing will eliminate it, but the application of herbicides to eliminate competing vegetation while the plants lie dormant as seeds can be beneficial to this Heteranthera. However, this is to be avoided if one wishes the environment to maintain a natural biodiversity (W-2). The removal of the seeds by means of burying or removing the surface soil layers containing the seeds of this plant can also eliminate a population permanently.

The most common natural threat to Heteranthera reniformis appears to be competition and shading from other wetland plants, particularly from graminoids such as Phalaris arundinacea L. (W-2). The species prefers primary (disturbed) open sites, but then it quickly disappears with the succession of both native and exotic species. Another important periodic threat may be from physical trampling of colonies and compaction of the soil, especially early in the season, by fishermen and others utilizing riverbanks. Cattle can also have this destructive effect. On the other hand, when cattle are excluded from an area that Heteranthera reniformis grows, the competition from recovering vegetation at the site will generally crowd out the Heteranthera, causing it to disappear from the site. This makes the decision of proper management techniques for this species very difficult.

Insect predation may significantly affect populations of this species. While it is not yet known to attack H. reniformis, infestations of the waterlily aphid (Rhopalosiphon nymphaeae) are known to decimate populations of the related species Heteranthera limosa (Sw.) Willd. (Oraze and Grigarick 1992).

It is generally believed among biologists that habitat fragmentation can also have profound effects on the success and persistence of local populations. Over time, as populations become increasingly more isolated, the effects of fragmentation can potentially be observed at the molecular level by reduced genetic frequencies caused by random drift (Barrett and Kohn 1991). When one is considering populations that are already isolated, as in the case of the Illinois populations of this plant, random genetic drift may have already occurred and may have caused negative effects to the species. This drift may cause the individuals to be less adaptive to competition and environmental change.

At the current time, it appears that the populations of Heteranthera reniformis in the Shawnee National Forest are not significantly threatened with elimination from habitat change and disturbance.

RESEARCH AND MONITORING

The primary research on this species has been conducted by Charles N. Horn (1985, 2002). Much is known on the plant’s life history, distribution, habitat requirements, and other aspects.
While the species has been studied in many portions of its range, local monitoring is certainly necessary where the species is of some concern or risk to determine its status in a given area.

A review of specific population monitoring techniques has been presented by Philippi et al. (2001).

Heteranthera reniformis is so rarely seen in Illinois and Indiana that a primary emphasis should be to locate, monitor, and protect (when possible) all remaining populations. Similar habitat should be explored for the plant, but its somewhat unpredictable seasonal and variable nature must be taken into consideration. Lack of the species at a previously known location in a given year cannot be used as conclusive evidence that it is truly gone from the site. There is a rather large area of suitable habitat in extreme southern Illinois where the Kidneyleaf Mud-plantain could also exist, and continued searches for the species should be conducted. It may even increase in the state if rice production also increases. A list of associates and indicator species has been compiled as a result of field studies in Illinois and other states (see habitat section above). These indicator plants should be very useful in facilitating the discovery of additional populations of this amphibious herb.

It may be useful to point out that the closely related Heteranthera multiflora was once thought to no longer exist in Illinois. Botanical surveys by Hill (Hill and Koontz 2002) resulted in a new collection of this plant in the state, the first known collection in 124 years, the last being in August 1877 when it was found by Heinrich Eggert in the American Bottoms area of St. Clair County. A long absence of H. reniformis may yet also occur, so monitoring must be carefully interpreted. Botanical surveys conducted by scientists from the Illinois Natural History Survey have shown repeatedly that with sufficient time and funding, and an experienced eye, many plants thought to be extirpated or else threatened or endangered can be found at additional locations (Hill 2002). These sorts of investigations have been important in that they have led not only to the de-listing of species once thought to be rare, but they have also resulted in the discovery of species previously unknown in the state. The U.S. Forest Service and other related agencies have done a fine job in the effort to preserve rare species with the resources that they have available. Much of the locating and monitoring of known populations of rare species in southern Illinois has been conducted by Forest Service biologists in cooperation with Illinois Department of Natural Resources personnel. However, a continuing problem is that there is neither sufficient funding nor are there enough classically trained field botanists available to survey the immense area that needs to be covered in the monitoring of the large numbers of sensitive plants, including this one. It appears that a high priority should be given to the training and hiring of more qualified field botanists to achieve these goals.

Basic research and on-site investigations are still needed locally to determine the best management techniques to be used for this amphibious herb. Because some states have very few populations of this herb, caution is needed in field research to avoid harming the remaining fragile colonies in those states. It is generally recommended that the habitat conditions where
this plant grows should be monitored and an assessment of the specific threats to all populations should be made (W-2). Long-term monitoring of known populations should be conducted every 1-2 years in mid to late August (preferably, during peak flowering and fruiting periods of late Summer) to track their status with respect to current environmental activities. As part of the basic monitoring on current populations of this species, data such as the number of plants or the area covered, the determination of the success of yearly flowering and seed production, if any, that might occur and an assessment of recruitment rates, if any, are needed in order to monitor population dynamics and to assess the viability of the individual populations found. The effects of insect predation on this species are still unknown. It has been suggested that fire management may be a useful tool in the more vegetation-rich areas where it grows (W-8) and some controlled experiments may be useful in providing more information on this potential management tool.

RESTORATION

There are no known restoration efforts being conducted on *Heteranthera reniformis* anywhere in its range and so the restoration potential of this species is largely unknown (W-2). This is because the plant is not globally rare and because populations can even occur in artificial habitats such as rice fields. As discussed above, most fruit and seed production in this species is dependent on the lack of competition from other wetland plants (including shading), and water depth must be less than 15 cm. The plant benefits from nutrients in agricultural areas and it may not establish well in sterile soils. It also appears to benefit from, or even require, water level fluctuations from year to year. Over a period of time, abundant seeds are needed to sustain the seed bank from which the plants will arise under suitable conditions.

While small applications of herbicides may, at times, benefit these plants (Horn 1985) because of their sensitivity to competition, selected herbicides are known to seriously harm the plants (W-3). Herbicides will also lessen general biodiversity. The overall usefulness of selected herbicides in restoration efforts for this species, however, has not yet been tested.

In Ohio, which may serve as an example of restoration potential, it is possible that the damming of the Ohio River has created habitat suitable for this species as well as an avenue for the species to migrate into Ohio. It is likely that this species could become more common in Ohio in the future, especially on mudflats along the shore of the Ohio River. (W-6).

The generally recommended method to restore populations of this and other rare plants is to protect and manage their habitat. Protection of the hydrology and the seed bank soil layer of the sites may be crucial, along with the maintenance of an open habitat. Some clearing of other vegetation may help, especially if woody plants occur at a given site, but it would be difficult to eliminate native aggressive herbs from the same habitat – instead, management of the water level will do more to eliminate many competitive species.

*Conservation Assessment for the Kidneyleaf Mud-plantain (Heteranthera reniformis Ruiz & Pavón)* 20
It has been suggested with convincing historical examples from the La Rue - Pine Hills / Otter Pond Research Natural Area in the Shawnee National Forest in Union County (W-8) that some fire management may benefit this species. It is well known that the plant benefits from additional nutrients, and that it needs sunny, open wetland habitats to grow well, so this management method would appear to be beneficial in some instances. Many areas where the plant has been found have little flammable plant debris, however. Some controlled burns may be necessary to test the effectiveness of this management for this species because this appears not have been attempted as yet.

Restorations of native plant species are recommended using only propagated material grown from native, local populations to avoid mixing genotypes not adapted to the local conditions and to avoid compromising the local gene pool. If this rule is not followed, the result is generally the loss of plants because they are not competitive under local conditions or the result could be the success of a plant or plants that cannot be considered truly native. Local plants should be propagated for planting in such an effort. This herb is readily propagated and grown from seed. It may be wise to include seeds of this plant in wetland plant mixtures used at suitable mitigation sites to insure its local survival. The plant cannot be expected to re-occur at sites from which the original soils have been either excavated or covered over because of its almost complete dependence on the persistence of seeds in the local seed bank for its survival.

An additional point may be of interest. The Kidneyleaf Mud-plantain found in rice fields may not be a local genotype – some have speculated that the rice field plants in Italy may have been introduced from Brazil (W-2). It is possible that these plants may not be adapted to natural Illinois habitats, and vice versa. How this would affect restoration efforts or local populations of native plants is unknown. This cannot be determined without studies of the breeding characteristics and genetics of these plants.

In summary, the management for extant colonies of Heteranthera reniformis should include monitoring, experimental investigation of management techniques (to maintain an open wet habitat in order to maintain suitable light levels for growth and flowering), and the elimination of woody plant encroachment. Habitats need protection from destructive recreational activities, severe land development, indiscriminate herbicide application, and changes in the local hydrology (W-2). Interestingly, the species may be able to co-exist well with continuous rice cultivation provided herbicides are carefully applied. At this time, with proper management, current populations should persist and they could even increase in size, but the establishment of additional populations will be only through active human efforts. The importance of the seed bank for this and several similar wetland species should not be underestimated.
SUMMARY

The Kidneyleaf Mud-plantain, *Heteranthera reniformis* Ruiz & Pavón, is an annual delicate herb normally found growing in colonies, with creeping stems up to 1m long. The species is native in the eastern to midwestern United States south to southern South America, and it has been found in wetland habitats in twenty-two states plus the District of Columbia. It grows mainly in periodically inundated level floodplains or the margins of bodies of water on mud or in water to about 15 cm deep, and it can co-exist with some habitat disturbance. Under the right conditions of full sun, the lack of competition, and nutrient-rich shallow water it can produce numerous seeds that persist in the seed bank during unfavorable periods. The seed bank is crucial to its survival.

Globally, its ranking is G5 (the species is secure world-wide). The Kidneyleaf Mud-plantain is listed as Endangered in Illinois and Ohio; it has been designated as Rare in New York, of Special Concern in South Carolina, and it is thought to be extirpated in Connecticut. It exists at a single site in Missouri. The Kidneyleaf Mud-plantain is included on the Regional Forester Sensitive Species list (RFSS) for the Shawnee National Forest but not the Hoosier National Forest, where it has not been found.

Suggested action priorities for this wetland herb include monitoring of the local populations to determine its normal growth cycles, attempts to locate additional populations, and to determine, through controlled experimentation, the best management techniques to insure its survival and increase. Management through enforced protection of its habitat, either through enforcement of existing regulations or through the creation of new rules for restricted access to the sites (particularly recreational access) may be necessary for it to persist where it may occur, but, at the current time, the species appears secure in Illinois.

REFERENCES


Conservation Assessment for the Kidneyleaf Mud-plantain (Heteranthera reniformis Ruiz & Pavón)


Conservation Assessment for the Kidneyleaf Mud-plantain (Heteranthera reniformis Ruiz & Pavón) 24
WEBSITES CONSULTED


http://plants.usda.gov/java/profile?symbol=HERE


W-3. l'Institut Agroambiental Terres de l'Ebre (IATE), Ebre River Delta, Mediterranean Spanish coast. “Mesures de Control per a Heteranthera reniformis”, Bulletí Tècnic no. 7. http://www.iate.es/Butllet%C3%AD%20n%C2%BA7.htm


W-6. Ohio Department of Natural Resources, Division of Natural Areas and Preserves, Rare Native Ohio Plants 2004-2005 Status List. http://www.dnr.state.oh.us/dnap/Abstracts/H/hetereni.htm


Conservation Assessment for the Kidneyleaf Mud-plantain (Heteranthera reniformis Ruiz & Pavón)
CONTACTS

Shawnee National Forest, Hidden Springs Ranger District, 602 N. 1st Street, Vienna, IL 62995

Elizabeth L. Shimp  (618) 658-2071; e-mail:  eshimp@fs.fed.us

Shawnee National Forest, Mississippi Bluffs District, 521 N. Main Street, Jonesboro, IL 62952

Stephen P. Widowski  (618) 833-8576; e-mail: swidowski@fs.fed.us

Hoosier National Forest; 811 Constitution Avenue, Bedford, IN 47421 (812) 275-5987

Kirk Larson  (812) 275-5987

Steven D. Olson  (719) 553-1400; e-mail: solson01@fs.fed.us
currently: Pike-San Isabel National Forests,
Cimarron-Comanche National Grasslands,
Kachina Drive, Pueblo, CO 81008

Illinois Natural History Survey, 1816 S. Oak Street, Champaign, IL 61820-6970

Dr. Steven R. Hill  (217) 244-8452; e-mail: srhill@mail.inhs.uiuc.edu
Dr. L. Richard Phillippe  (217) 244-2181; e-mail: rickp@mail.inhs.uiuc.edu

Illinois Endangered Species Board

Dr. John E. Ebinger  (217) 345-3815; e-mail: cfjee@eiu.edu

Indiana Department of Natural Resources, 402 W. Washington St., Indianapolis, IN 46204

Michael A. Homoya  (317) 232-0208; e-mail: mhomoya@dnr.state.in.us

Biological Consultant

John E. Schwegman  (618) 543-9429; e-mail: botany@wkblue.net

Missouri Botanical Garden, P.O. Box 299, Saint Louis, MO 63166-0299

Dr. George A. Yatskievych  (314) 577-9522; e-mail: george.yatskievych@mobot.org

Biology Department, Newberry College, Newberry, SC 29108

Dr. Charles N. Horn  (803) 321-5257  e-mail: CHorn@Newberry.edu

Conservation Assessment for the Kidneyleaf Mud-plantain (Heteranthera reniformis Ruiz & Pavón)
APPENDIX 1

Representative specimens of Heteranthera reniformis from the continental United States examined or cited in the literature

Herbaria:


ALABAMA: CHOCTAW CO., Lake Coffeeville ca. 9 mi E of Silas, 2 Dec 1978, Haynes 6998 (UNA); ETOWAH CO., Gadsden at jct. US 431 & Black Creek, low field near Sansom High School, 18 Oct 1975, Whetstone & Radford 7571 (MO); HALE CO., Big Brushy Creek ca. 14 mi NW of Greensboro, 4 Aug 1980, Haynes 8066 (UNA); JACKSON CO., Lake Guntersville off US 72 near Stevenson, 2 Aug 1978, Haynes 6836 (UNA); LAUDERDALE CO., Shoals Creek, 8 Oct 1986, Reynolds s.n. (UNAF); Union Hollow, Waterloo, 9 July 1977, Watts s.n. (UNAF); LIMESTONE CO., 5 mi N Decatur on US 31, 13 Oct 1969, Kral 37861 (MO, NLU, UNA); PICKENS CO., S side Aliceville, ditch by railroad tracks by Airport, 19 Sep 1975, Kral 56587 (MO); TUSCALOOSA CO., dirt road off of Co. Rt. 79, S of Warrior River near Cypress Pond at powerline cut and stream, 18 Aug 1982, Horn & Guzman 555 (UMO, UNA).

CONNECTICUT: NEW HAVEN CO., Derby, 25 Sep 1886, Setchell s.n. (UC).

DELAWARE: NEW CASTLE CO., in creek along Rt. 459, near Rt. 25, near Townsend, 10 Aug 1958, Reed 4271 (MO); along Brandywine Creek, Hollingsworth Ford, 24 Aug 1865, Commons s.n. (NY).


Conservation Assessment for the Kidneyleaf Mud-plantain (Heteranthera reniformis Ruiz & Pavón)
ILLINOIS: ALEXANDER CO., Tamms, E side IL Rt. 127, branch of Cache River at floodgate, 13 Aug 1999, Hill 31962 (ILLS, MO); CALHOUN CO., Batchtown Waterfowl Management area, 19 Sep 1990, Miller, Brant, & Merello 5588 (MO); POPE CO., Homberg Spring Natural Area, Bay Creek, 25 Aug 1988, Taft 520 (ILLS); WABASH CO., Mt. Carmel, Sep 1877, Patterson s.n. (F).

INDIANA: HARRISON CO., sink hole 3 mi SE of DePauw, 16 Jun 1935, Hermann 6699 (NY); PUTNAM CO., exact location uncertain, 12 Sep 1889, MacDougal s.n. (NY).

KENTUCKY: CARLISLE CO., marsh along Mayfield Creek, the Memphis District, 9 Aug 1983, Heineke 3262 (MO); GRAVES CO., Casey Bottoms, 3 mi S of Kaler, 3 Aug 1973, McCoy 1973-269 (MO); Rt. 301, 3 mi E of Rt. 131, 30 Aug 1973, McCoy s.n., (MO).


MARYLAND: BALTIMORE CO., Baltimore, Aug 1880, Smith 2989 (MO); CECIL CO., Charlestown center, tidal area along upper Chesapeake Bay, 21 Sep 1986, Hill 17411 (GH, MO, NY, SMU); HARFORD CO., 0.5 mi SSW of Havre de Grace, 20 Sep 1902, Shull 404 (MO); in stream in meadow, along Little Gunpowder Falls, S of Magnolia, E of Rt. 40, 22 Aug 1957, Reed 42426 (MO); TALBOT CO., in creek just S of Skipton, 30 Sep 1951, Reed 27728 (MO); Potter Mill Creek, 0.75 mi S of Longwoods, 30 Aug 1941, Earle 3465 (PH).

MISSISSIPPI: CHICKASAW CO., 4 mi E Houston, Tombigbee National Forest, 1 Jul 1997, MacDonald & Warren 10907 (UNA); NOXUBEE CO., on hwy 388 near Tennessee-Tombigbee project, 2 mi E of Bigbee Valley, Davenport 842 (UNA).

MISSOURI: NEW MADRID CO., Portageville, 2 Oct 1955, Palmer 61628 (UMO).

NEW JERSEY: CAMDEN CO., marsh along Delaware River east of Petty’s Island, Fish House Cove off NJ 543, Pennsauken, 4 Sep 1994, Horn & Wiersema 8613 (MO); HUNTERDON CO., Raritan River I mi W of Three Bridges, 7 Jul 1937, Benner 7671 (PH); MERCER CO., Delaware River NW of Trenton, 29 Aug 1972, Dix s.n. (PH); MIDDLESEX CO., margin of pond, Milltown, 4 Aug 1907, Mackenzie 2826 (MO); SOMERSET CO., Watchung, 23 Aug 1939, Moldenke & Moldenke 11238 (MO, NY); UNION CO., Seeley’s Notch, 24 Aug 1947, Moldenke 19164 (MO, NY, PH, SMU).

NEW YORK: GREENE CO., tidal shore of the Hudson River, Catskill, 8 Sep 1937, Fassett 18718 (MO); Hudson River, Green Point, 4 mi S of Catskill, 2 Sep 1937, House 25115 (GH, NY, PH).
NORTH CAROLINA: BERTIE CO., 1.5 mi S of Lewiston, 28 Oct 1958, Ahles 52174 (NCU);
DAVIDSON CO., edge of pond on Leonard farm, off West Center Street extension, Lexington, 7 Sep 1969, Leonard 2679 (MO, NCU, NY); GATES CO., 0.3 mi W of Hobbsville, 26 Jun 1958, Ahles 44598 (NCU); WASHINGTON CO., sewage ditch opp. old RR station, Plymouth, 10 Oct 1968, Leonard 2103 (NCU, UNA, UNAF).

OHIO: MIEGS CO., along Ohio River, 1 mi SE of Letart Falls, Cusick & Ortt 26170 (MICH, OS).

PENNSYLVANIA: BERKS CO., 1 mi NE of Pine Forge, along Manatawny Creek, 12 Aug 1963, Brumbach 5007 (PH); BUCKS CO., Neshaminy Creek just N of Bensalem Pike, 15 Aug 1925, Adams 21 (PH); DAUPHIN CO., edge of river 4 mi SSE of Middletown, 2 Aug 1953, Berkheimer 15564 (GH, PH);

SOUTH CAROLINA: LAURENS CO., Co. Rt. 42 at tributary to Little River, 1.6 mi N of Co. Rt. 49, ca. 5 mi SSE of Laurens, 9 Jul 1991, Horn & Mytko 4589 (CLEMS, GH, MO, NY, SMU, UC, UNA); MCCORMICK CO., 5 mi ESE of Mount Carmel, 13 Jun 1984, Nelson 3478 (USCH); NEWBERRY CO., Rt. 83 at Beaver Dam Creek, 8 mi S of Newberry, 24 Sep 1988, Horn 3026 (NCSC).

TENNESSEE: BERKS CO., old canal bed, alt. 190 ft, 1/4 mi NW of Seifert, 13 Sep 1942, Berkheimer 3490 (MO); JEFFERSON CO., roadside marsh along Eslinger Road, 1.5 mi E of US 11E, SW of Jefferson City, 7 Aug 1994, Horn 8348 (GH, MO, NY).

TEXAS: BREWSTER CO., Leoncita Springs, Kokernot Ranch, foothills of Davis mountains, 7 Sep 1950, Warnock 9663 (SMU).

VIRGINIA: CAMPBELL CO., Curtiss s.n. (F, NY); DINFIDDE CO., 12 mi E of McKenny, 29 Aug 1960, Kral 11352b (NCU); FAIRFAX CO., Mount Vernon, 2 mi NW, head of Dogue Creek, mud flat along stream, 17 Sep 1939, Fosberg 16774 (MO); Cameron Run, New Alexandria, 13 Aug 1910, Dowell 6450 (MO); GLOUCESTER CO., dried pool, bank of salt marsh, along North End Branch, James Store, 1 Sep 1923, Wherry & Pennell 12571 (MO); HANOVER CO., Wolf Swamp 2.5 mi S of Montpelier, 21 Aug 1976, Wieboldt 2619 (NCU); JAMES CITY CO., Powhatan Creek N of Jamestown Island, 22 Aug 1939, Fernald & Long 10997 (GH, PH); SOUTHAMPTON CO., swampy woods along Nottoway River below Point Beach S of Franklin, 20 Jul 1939, Fernald & Long 10569 (GH, MO, PH, US); STAFFORD CO., Brent Marsh along the Potomac River E of Co. Rt. 633, S of Co. Rt. 611, N of Co. Rt. 658, N of Aquia Creek, 5 Sep 1994, Horn, Strong, & Kelloff 8628 (MO).

WEST VIRGINIA: FAYETTE CO., New River gorge at Gauley Station, 17 Sep 1956, Hicks & Bartley 2219 (NY, US).
APPENDIX 2.
The Historic Distribution of *Heteranthera reniformis* in the Continental United States.
Information from herbarium specimens and the literature.
(If in > 10 counties, then only number of counties included.)

[Incomplete]

<table>
<thead>
<tr>
<th>STATE</th>
<th>COUNTIES</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alabama</td>
<td>Choctaw, Clarke, Covington, Etowah, Hale, Jackson, Lauderdale, Limestone, Madison, Marengo, Pickens, Tuscaloosa</td>
<td>Horn (1985)</td>
</tr>
<tr>
<td>Connecticut</td>
<td>Fairfield, New Haven</td>
<td>Magee and Ahles (1999); Horn (1985)</td>
</tr>
<tr>
<td>Delaware</td>
<td>New Castle,</td>
<td>Herbarium specimen; Horn (1985).</td>
</tr>
<tr>
<td>Florida</td>
<td>Escambia, Santa Rosa.</td>
<td>(W-9)</td>
</tr>
<tr>
<td>Georgia</td>
<td>Burke, Morgan, Oglethorpe, Walker, Whitfield</td>
<td>(W-1)</td>
</tr>
<tr>
<td>Illinois</td>
<td>Alexander, Calhoun, Lawrence, Pope, St. Clair, Union, Wabash</td>
<td>Mohlenbrock and Ladd (1978); herbarium specimens at MO; Mohlenbrock (1986); Herkert and Ebinger (2002); includes Shawnee N.F.</td>
</tr>
<tr>
<td>Indiana</td>
<td>Clark, Crawford, Harrison, Jefferson, Knox, Orange, Posey, Putnam</td>
<td>Deam (1940)</td>
</tr>
<tr>
<td>Kentucky</td>
<td>Bullitt, Carlisle, Clark, Graves, Henry, Hickman, Lyon</td>
<td>(W-1); Horn (1985)</td>
</tr>
<tr>
<td>Louisiana</td>
<td>19 parishes, few in NW quarter of state.</td>
<td>MacRoberts (1989); Thomas and Allen (1993)</td>
</tr>
<tr>
<td>Maryland</td>
<td>Baltimore, Cecil, Charles, Harford, Queen Annes, Talbot</td>
<td>Herbarium specimens</td>
</tr>
<tr>
<td>Mississippi</td>
<td>Chickasaw, Noxubee</td>
<td>Herbarium specimens</td>
</tr>
<tr>
<td>Missouri</td>
<td>New Madrid</td>
<td>(W-1); Yatskievych (1999)</td>
</tr>
<tr>
<td>New Jersey</td>
<td>Burlington, Camden, Cumberland, Essex, Gloucester, Hunterdon, Mercer, Middlesex, Morris, Passaic, Somerset, Union</td>
<td>Herbarium specimens</td>
</tr>
</tbody>
</table>

*Conservation Assessment for the Kidneyleaf Mud-plantain (Heteranthera reniformis Ruiz & Pavón)*
<table>
<thead>
<tr>
<th>State</th>
<th>Counties/Location</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>New York</td>
<td>Albany, Greene, Ulster; Reported for Dutchess County</td>
<td>Magee and Ahles (1999); Herbarium specimens</td>
</tr>
<tr>
<td>North Carolina</td>
<td>12 counties, mostly NE coastal plain</td>
<td>Radford et al. (1964)</td>
</tr>
<tr>
<td>Ohio</td>
<td>Lawrence, Miegs “The species was collected in Hamilton Co. in 1837 and was thought until recently to be extirpated from Ohio. However, the species was rediscovered in 1986 and is now known to grow along the banks of the Ohio River in Lawrence and Meigs Counties”</td>
<td>(W-2; W-6)</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>&gt;15 counties, southeastern ¼ of state</td>
<td>Wherry et al. (1979); Rhoads and Block (2000); Herbarium specimens</td>
</tr>
<tr>
<td>South Carolina</td>
<td>Calhoun, Laurens, McCormick, Newberry</td>
<td>(W-2); Herbarium specimens</td>
</tr>
<tr>
<td>Tennessee</td>
<td>19 counties, mostly western half of state.</td>
<td>Chester et al. (1993).</td>
</tr>
<tr>
<td>Texas</td>
<td>Brewster</td>
<td>Herbarium specimens</td>
</tr>
<tr>
<td>Virginia</td>
<td>13 counties</td>
<td>(W-1)</td>
</tr>
<tr>
<td>West Virginia</td>
<td>Fayette, Jackson, Mason, Morgan</td>
<td>(W-1); Herbarium specimens</td>
</tr>
</tbody>
</table>
APPENDIX 3.

Natural Diversity Database Element Ranking System

Modified from: NatureServe Conservation Status [W-5].

Global Ranking (G)

G1
Critically imperiled world-wide. Less than 6 viable elements occurrences (populations for species) OR less than 1,000 individuals OR less than 809.4 hectares (ha) (2,000 acres [ac]) known on the planet.

G2
Imperiled world-wide. 6 to 20 element occurrences OR 809.4 to 4,047 ha (2,000 to 10,000 ac) known on the planet.

G3
Vulnerable world-wide. 21 to 100 element occurrences OR 3,000 to 10,000 individuals OR 4,047 to 20,235 ha (10,000 to 50,000 ac) known on the planet.

G4
Apparently secure world-wide. This rank is clearly more secure than G3 but factors exist to cause some concern (i.e. there is some threat, or somewhat narrow habitat).

G5
Secure globally. Numerous populations exist and there is no danger overall to the security of the element.

GH
All sites are historic. The element has not been seen for at least 20 years, but suitable habitat still exists.

GX
All sites are extirpated. This element is extinct in the wild.

GXC
Extinct in the wild. Exists only in cultivation.

GIQ
Classification uncertain. The element is very rare, but there is a taxonomic question associated with it.
National Heritage Ranking (N)

The rank of an element (species) can be assigned at the national level. The **N-rank** uses the same suffixes (clarifiers) as the global ranking system above.

Subspecies Level Ranking (T)

Subspecies receive a **T-rank** attached to the G-rank. With the subspecies, the G-rank reflects the condition of the entire species, whereas the T-rank reflects the global situation of just the subspecies or variety.

For example: *Chorizanthe robusta* var. *hartwegii*. This plant is ranked **G2T1**. The G-rank refers to the whole species range (*i.e.*, *Chorizanthe robusta*), whereas the T-rank refers only to the global condition of var. *hartwegii*. Otherwise, the variations in the clarifiers that can be used match those of the G-rank.

State Ranking (S)

**S1**
**Critically Imperiled.** Less than 6 element occurrences OR less than 1,000 individuals OR less than 809.4 ha (2,000 ac). **S1.1** = very threatened; **S1.2** = threatened; **S1.3** = no current threats known.

**S2**
**Imperiled.** 6 to 20 element occurrences OR 3,000 individuals OR 809.4 to 4,047 ha (2,000 to 10,000 ac). **S2.1** = very threatened; **S2.2** = threatened; **S2.3** = no current threats known.

**S3**
**Vulnerable.** 21 to 100 element occurrences OR 3,000 to 10,000 individuals OR 4,047 to 20,235 ha (10,000 to 50,000 ac). **S3.1** = very threatened; **S3.2** = threatened; **S3.3** = no current threats known.

**S4**
**Apparentely Secure.** This rank is clearly lower than S3 but factors exist to cause some concern (*i.e.*, there is some threat, or somewhat narrow habitat).

**S5**
**Secure.** Demonstrably secure to ineradicable in the state.

**SH**
All state sites are historic; the element has not been seen for at least 20 years, but suitable habitat still exists. Possibly extirpated.

*Conservation Assessment for the Kidneyleaf Mud-plantain (Heteranthera reniformis Ruiz & Pavón)*
**SNR, SU**
Reported to occur in the state. Otherwise not ranked.

**SX**
All state sites are extirpated; this element is extinct in the wild. Presumed extirpated.

**Notes:**

1. Other considerations used when ranking a species or natural community include the pattern of distribution of the element on the landscape, fragmentation of the population/stands, and historical extent as compared to its modern range. It is important to take a bird’s eye or aerial view when ranking sensitive elements rather than simply counting element occurrences.

2. Uncertainty about the rank of an element is expressed in two major ways: by expressing the rank as a range of values (e.g., S2S3 means the rank is somewhere between S2 and S3), and by adding a ‘?’ to the rank (e.g. S2?). This represents more certainty than S2S3, but less than S2.