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Survey of *Salvinia* (Salviniaceae) in Eastern Arkansas

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Abstract

Salvinia, water spangles, is a genus of 10 species of free-floating heterosporous aquatic ferns with two species introduced to North America. *S. minima* Baker was introduced into the eastern United States by at least 1814 and occurs mainly across the southeastern United States. *S. molesta* Mitchell was recognized as a distinct species in the 1970s, was introduced into the United States as a water-garden plant in the 1980s, and has escaped and spread across the southeastern United States in the 1990s. It is recognized by federal agency as noxious aquatic weed. *S. minima* Baker was discovered in Arkansas in 1998. A status survey of eastern Arkansas was undertaken from 1998 - 2000 to determine the distribution and abundance of *S. minima* and *S. molesta*. A search of 33 Arkansas counties led to the discovery of *S. minima* at 21 localities in 11 counties: Arkansas, Ashley, Chicot, Desha, Jefferson, Lee, Lincoln, Monroe, Phillips, Prairie, and Pulaski. No populations of *S. molesta* were located in 33 counties. Search efforts must extend to southwestern Arkansas in the Red River watershed to complete the survey.

Introduction

Salviniaceae (water spangles) is a monogeneric fern family of 10 species of free-floating heterosporous aquatic ferns classified in genus *Salvinia* (Reed, 1954, 1965; Nauman, 1993; Schneller, 1990). They are most distinctive ferns with a peculiar adaptive vegetative morphology (Forno, 1983; Moran, 1992). Lacking true roots, they compensate for this with one submerged dimorphic frond which is highly dissected and functions as an absorption organ that also provides counter-balance to two companion floating-leaves on the surface of the water (Croxdale, 1978, 1979, 1981). All species have a propensity for vegetative expansion (Mitchell and Tur, 1975), making them potentially invasive and weedy species (Gaudet, 1973; Oliver, 1993; Dickinson and Miller, 1998). Two species occur in North America, *S. minima* and *S. molesta* (Nauman, 1993).

Salvinia minima Baker (water spangles) was discovered in Guiana (South America) in the middle of the eighteenth century and named in 1775. Small (1938) noted *S. minima* was first reported from North America in New York in 1814, with later discoveries of it in southern states. It was discovered in Florida as late as 1928, with most of these stations considered to be introductions where the species has naturalized (Small, 1938). Small (1938) reported that "how it was introduced...is not known". Nauman (1993) recognized *S. minima* Baker as native to North America, reporting its known range as Georgia, Florida, Alabama, Louisiana, Mexico, West Indies, and Central America. In the 1980s and 1990s this species expanded its known range westward in the Gulf States as well as into the southwestern United States. It was first reported west of the Mississippi River in

Louisiana (Landry, 1981) and then in Texas (Hatch, 1995). Its known range expanded northward from Georgia to South Carolina (Johnson, 1995). *S. minima* was discovered in Lonoke Co., Arkansas, in 1998 and in three additional locations in two more counties in 1999 (Peck, 1999). The populations persisted through the mild winter of 1998-1999 at these localities, suggesting that they were naturalized or well established introductions.

Nauman (1993) reported that *Salvinia molesta* Mitchell, giant water spangles was commercially cultivated in Florida and sent across the southern one-half of the United States for the water-garden trade. Nauman (1993) recognized that this represented a potential risk of escape and establishment. Nauman's prediction proved correct. Within a decade, escaped and well established infestations of *S. molesta* were discovered in Florida northward to South Carolina (Johnson, 1995), westward to Alabama (Haynes and Jacono, 2000), and across the Mississippi River to Louisiana and Texas (Jacono, 1999a,b). Ominously, more propagation sites that might foster more escapes are known to occur as far north as Virginia in the East and from California north to Washington in the West, indicative of future problems on a national scale. Infestations in Louisiana may spread northward to Arkansas in two watersheds, resulting in the establishment of this noxious aquatic weed in southeastern or southwestern Arkansas.

Salvinia molesta is the notorious "African Kariba water weed" that formed a dense carpet covering 1,000 square kilometers in three years (Schelpe, 1961; Mitchell and Tur, 1975) and was originally identified as *S. auriculata* Aublet. Noting that *S. auriculata* Aublet was a fertile species that did not cause such infestations in its native Brazil, Mitchell

(1972) recognized this aggressive, sterile weedy clone as a distinct species in Africa, a pentaploid of hybrid origin, possibly from Brazil (Moran and Smith, 1999). The current reported range of this pantropical weed includes Zimbabwe, Botswana, Kenya, South Africa, Zambia, Madagascar, Ceylon, Indonesia, Papua New Guinea, Western Australia, Queensland, Brazil, and now the United States. It forms such dense concentrations that it physically blocks commercial navigation, harms fisheries stock by depleting nighttime dissolved oxygen levels, and promotes disease-carrying mosquito populations (Forno and Harley, 1979; Thomas and Room, 1986; Room, 1990; Oliver, 1993). Research is being conducted to seeking safe and effective biological management (Gallardo, et al., 1998, 1999)

A preliminary field survey of *Salvinia* across eastern Arkansas was conducted to determine the extent of its distribution, the magnitude of local abundance, and whether there are limits to its persistence or vigor. The ultimate objective of this survey was to provide data to determine whether either species of *Salvinia* warrants a legal status in Arkansas as a state listed non-indigenous, invasive, or noxious weed.

Methods

A field survey was conducted from 1998 through 2000 in 33 counties in eastern Arkansas, including Arkansas, Ashley, Bradley, Chicot, Clay, Cleveland, Craighead, Crittenden, Cross, Desha, Drew, Faulkner, Grant, Greene, Independence, Jackson, Jefferson, Lawrence, Lee, Lincoln, Lonoke, Mississippi, Monroe, Phillips, Poinsett, Prairie, Pulaski, Randolph, Saline, St. Francis, Sharp, White, and Woodruff. The survey was ground-based, restricted to driving public roads and inspecting accessible waterways, impoundments, and ditches; observation during the survey was enhanced with binoculars. Rather than attempt to locate all populations or as many as possible, surveying ceased in a county once one population was discovered. No more than three days were spent searching in any single county. Thus, the survey was managed to emphasize the greatest geographic spread of work effort. Vouchers were collected and deposited at the UALR Herbarium (LRU). Estimates of aerial extent and abundance as well as names of associated vegetation were recorded. Selected samples were maintained in log phase growth at the UALR greenhouse to provide an index of maximum density that might be expected in the field.

The genus is readily identified by their floating leaves that are rounded with the top surface bearing white, coarse, stiff hairs and by the submerged leaves that are green, branched, and filiform. They are separated from each other easily with a hand-lens. *S. minima* has smaller leaves (dia. less than 0.5 cm) with hairs tipped with four prongs that flair apart. *S. molesta* has larger leaves (dia. greater than 1 cm)

with hairs tipped with four prongs that fuse together at the tip, resembling an old hand-cranked egg beater.

Results and Discussion

Plants of *Salvinia minima* Baker were found at 21 localities in 11 counties, adding 17 localities and 8 counties to the original reported state range (Peck, 1999). Currently Arkansas County has four localities, Prairie County has three, and Jefferson, Lee, Lonoke, Monroe, and Phillips counties have two localities each; four remaining counties have one locality. All populations were similar to those initially found (Peck, 1999); they were small (less than 0.1 meter square), sparse to thinly stocked, not forming multiple layers of crowded plants, and were present with other floating-leaved aquatic plants, including *Azolla mexicana* Presl, *Lemna minor* L., *Spirodela polyrhiza* (L.) Schleid., *Wolffia columbiana* Karst., and *Wolffella gladiata* (Hegelm.) Hegelm.

All field populations occurred at stocking densities less than 1% of wet weight and dry weight of the index maximum established under greenhouse conditions. In no instance was an infestation evident, based on aerial extent or stocking density of the population. No population of *Salvinia molesta* Mitchell was located. The failure to find any population of *S. minima* in 22 counties or *S. molesta* in any of the 33 counties surveyed does not mean that these counties are free of these species. Search time, manner, and mode were severely constrained; this preliminary survey should not be considered a complete examination of any entire watercourse nor any watershed.

Voucher Specimens: *Salvinia minima* Baker.—U.S.A.: ARKANSAS: Arkansas Co.: Mill Bayou drainage, 5 mi w DeWitt, T4S R4W S34, Peck 99003 LRU; Grand Cypress Lake, Bayou Meto WMA, T5S R6W S14, Peck 99004 LRU; La Grue Bayou, 3 mi n Casscoe on Co 146, T2S R3W S17, Peck 20184 LRU; Cypress Bayou, 1 mi w of Tichnor on Ark 44, T6N R2W S30, Peck 20185 LRU; Chicot Co.: Lake Boggy Bayou, 1 mi se of Dewey, T14S R1W S30, Peck 20214 LRU; Desha Co.: Silverlake Watershead, 10 mi ne Dumas, T8S R3W S31, Peck 99574 LRU; Jefferson Co.: Langford Lake watershead, 3 mi w Reydell, T6S R6W S13, Peck 99562 LRU; Wabbaseka Bayou, 1 mi s of Wabbaseka along US 78, T4S R 7W S18/19, Peck 20109 LRU; Lee Co.: Big Creek Drainage, 5 mi w Moro, T2N R1W S12, Peck 99583 LRU; L'Angeuille River Slough, 0.5 mi N of Wrightland on AR 2, T3N R3E S28, Peck 20138 LRU; Lincoln Co.: Mud Lake watershead, 8 mi e Gould, T8S R4W S13, Peck 99570 LRU; Lonoke Co.: Buffalo Ditch drainage, 1 mi e Geridge, T2N R6W S7, Peck 98002 LRU, Peck 99001 LRU; Bayou Two Prairie, wetland e of Co. 21, 1 mi n of Lonoke, T2N R8W S11, Peck 20152 LRU; Monroe Co.: Big Cypress Creek drainage, 1 mi e Cross Roads, T3S R1E S18, Peck 99588 LRU; Maddox Bay Oxbow, 1 mi w Lawrenceville on Ark 146, T2S R2W S23, Peck 20101 LRU; Phillips Co.: Big Creek drainage, 3 mi e Maple Corner on US 49, T2S R3E S1, Peck 20237 LRU; Little Cypress Creek drainage, 3 mi w Hickville, T1S R1E S18, Peck 99579 LRU; Prairie Co.: Honey Creek drainage, 6 mi s DuValls Bluff, T1N R4W S17, Peck 99592 LRU; Bayou Meto drainage, along Beck Rd, 6 mi w Stuttgart, T2S R6W S26, Peck 20250 LRU; Minnow Pond ditches, 2 mi s DuValls Bluff on Ark 33, T2N R4W S19/30, Peck 20249 LRU; Pulaski Co.: Old River Oxbow slough, on Ar 161 and Co5, T1S R11W S12, Peck 99650 LRU.

U. S. Public Law 101-646 of 1990 (Nonindigenous Aquatic Nuisance Prevention and Control Act) was passed

to enable programs to be developed that prevent the unintentional introduction of aquatic nuisance species and to allow the development of state aquatic nuisance species management plans. Federal agencies are actively involved in this program, including the U.S. Army Corps of Engineers Aquatic Plant Control Research Program, the U.S. Geological Survey Nonindigenous Aquatic Species Program, the U.S. Department of Agriculture National Biological Control Institute, and the U.S. Environmental Protection Agency. Currently, *Salvinia molesta* is listed as a federal noxious weed, meaning that importation into the United States or transportation across state lines is prohibited by Federal law, based on the application of the commerce clause in the U. S. Constitution. Distribution within a state of such a federally listed plant is permitted, unless specifically prohibited by an individual state and listed as a state noxious weed, thus linking state enforcement to that of federal authorities. Texas and Florida (Harvey, 1998) have enacted state legal authority. Additionally, NAS-USGS also lists water spangles, *S. minima*, as a "nonindigenous aquatic fern" based on the fact that this non-native species has been introduced beyond its natural range, whether or not it formed permanent populations or failed to persist.

The evidence so far does not suggest a need to list *Salvinia minima* as a noxious weed in Arkansas. It may be prudent for the state of Arkansas to join with other states (Florida and Texas) and federal authorities in banning the sale, transport, and cultivation of *S. molesta*. This action may reduce or prevent future infestations that may negatively impact commercial aquaculture of plants and animals in Arkansas and cause other unwanted environmental impacts.

While *Salvinia minima* is known to occur and persist to some extent within Arkansas, at present its state distribution or potential range of occurrence is imperfectly known. At present our observations on its local vigor are quite limited. The extreme drought in 2000 followed by an extreme winter event in 2000-2001 may have disfavored its occurrence as much as the mild winter of 1998-1999 and 1999-2000 may have favored its persistence. Whether *S. minima* arrived in Arkansas by natural means (waterfowl) or by human intervention is not known. How it has spread across multiple watersheds within the state also remains unknown, but both waterfowl or human activities may have contributed. As for spread within watersheds, passive movement by currents, waterfowl, and human activity might all have played a role. Thus our prospects for predicting or evaluating *Salvinia* persistence or expansion into weedy growth in Arkansas are imperfectly and insufficiently known.

Salvinia molesta Mitchell has not yet been found in Arkansas, but seemingly suitable habitat and conditions exist in the southeastern and southwestern regions in the state. With *S. minima* now known from 21 localities in 11

counties in southeastern Arkansas, the potential likelihood that *S. molesta* might also occur in Arkansas and might then become an infestation is viewed as a very real risk in the near future, particularly from populations in Louisiana or Texas. Both species have similar mechanisms for dispersal and survival. Further search in southeastern and southwestern Arkansas counties is warranted. Additionally, it is advised that all field biologists (agronomic, forestry, wildlife, or botanists) in Arkansas be trained to identify and be vigilant for the presence of this non-indigenous, invasive, and noxious plant in Arkansas.

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