Decurrent False Aster
(Boltonia decurrens)

5-Year Review:
Summary and Evaluation

U.S. Fish and Wildlife Service, Midwest Region
Rock Island Ecological Services Field Office
Rock Island, Illinois

5-YEAR REVIEW
Decurrent false aster/*Boltonia decurrens*

1.0 GENERAL INFORMATION

1.1 Reviewers

Lead Regional Office – Midwest Regional Office, Carlita Payne, Recovery Coordinator, 612-713-5339

Lead Field Office – Rock Island Ecological Services Field Office, Jody Millar, 309-757-5800, ext. 202

Cooperating Field Offices – Illinois Private Lands Office, Gwen Kolb, 217-557-4474: Columbia, Missouri Field Office, Rick Hansen, 573-234-2132

1.2 Methodology used to complete the review:

This review was conducted by Jody Millar, Rock Island Field Office and Gwen Kolb, Illinois Private Lands Office. The Service provided notice of this status review via the *Federal Register* (71 FR 16176) on March 30, 2006, requesting new information on decurrent false aster (*Boltonia decurrens*) that may have a bearing on its classification as threatened. The review is based on material provided by Dr. Marian Smith, University of Illinois at Edwardsville (retired); Dr. Paige Mettler-Cherry, Lindenwood University; and Tom Keevin, Recovery Team Leader; recovery team members, and other partners; literature review and site visits. This document was prepared in coordination with the field offices and scientists listed above. Formal peer review was not requested since the information contained in this document is not deemed influential in the context of the Office of Management and Budget Final Information Quality Bulletin for Peer Review.

1.3 Background

1.3.1 FR Notice citation announcing initiation of this review:

Federal Register vol. 71, No. 61, Thursday March 30, 2006, pp 16176-16177

1.3.2 Listing history:

Original Listing
FR notice: 53 FR 45858
Date listed: November 14, 1988
Entity listed: Species – Decurrent false aster (*Boltonia decurrens*)
Classification: Threatened

1.3.3 Associated rulemakings:

None

1.3.4 Review History:

Decurrent false aster was included in a cursory five-year review of all species listed before January 1, 1991 (56 FR 56882). The five-year review resulted in no change to decurrent false aster's listing classification of threatened.

1.3.5 Species' Recovery Priority Number at start of review:

The recovery priority number is 8 reflecting a species with a moderate degree of threat and high potential for recovery.

1.3.6 Recovery Plan:

Name of plan: Decurrent False Aster, *Boltonia decurrens*, Recovery Plan
Date issued: September 28, 1990
Dates of previous revisions: None

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

2.1.1 Is the species under review a vertebrate? *No.*

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria? *Yes.*

2.2.2 Adequacy of recovery criteria.

2.2.2.1 Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat? *No*

The major change from the recovery plan criteria is the clarification of the term, "population". In the recovery plan, population could be interpreted to mean a distinct geographic plot. The recovery team has decided that the term in this context should mean a more broad geographic area where genetically similar *Boltonia decurrens* disperses laterally, and within which band it may appear or disappear at any given location. The band typically may encompass a third of a navigation pool. The populations are identified by the closest managed or most reliable plot location (Mettler-Cherry, pers. comm. 2009).

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information:

When the following recovery criteria are met, decurrent false aster will be considered for delisting:

Criterion 1: *A basic research program to determine the requirements of a naturally reproducing population must be completed.* Much research has been conducted that

provides basic information on life history needs, management opportunities and threats (Smith et al. 1993, Smith et al. 1995, Smith et al. 1998, Smith and Moss 1998, Smith and Cawly 2002, Mettler-Cherry et al. 2006, Smith and Hunsley 2006). *B. decurrens* is a pioneer species indigenous to the floodplain of the Illinois River. It colonizes exposed shorelines following the recession of spring floods (Smith and Mettler 2002, Smith et al. 2005). The role of flooding in seed dispersal, germination, and seedling recruitment has been firmly established for *B. decurrens* in the past 15 years (Smith and Keevin 1998, Smith et al. 2005). Based on genetics research (DeWoody 2002, DeWoody et al. 2004) and habitat based demographics (DeWoody et al. 2004, Smith et al. 2005, Mettler-Cherry et al. 2006), *B. decurrens'* range along the Illinois River can be considered a metapopulation with patches or local populations undergoing extinction and recolonization based primarily on the flood pulse of the Illinois River.

Basic research identified under Criterion 1 has been met.

Criterion 2: *Twelve geographically distinct self-sustaining natural or established populations of the species must be protected through purchase in fee, easement, or by cooperative management agreements.* This criteria addresses habitat threats to the extent that a minimum number of populations are required to be sustained to provide source populations for flood events. Mettler-Cherry et al. (2006) identified 44 historical locations of *B. decurrens* from their Geographic Information Systems (GIS) database with numbers of individuals varying widely from year to year. In 2002, when 26 populations were identified, late floods and low precipitation resulted in a decline of total number of plants from more than one million in 2001 to fewer than 300,000 in 2002 (Smith 2001, Smith 2002). About half of these populations are periodically sustained by natural flood events (including major flood events in 1993 and 1995), and the remaining populations have been manipulated by land managers who use either artificial water control or agricultural discing.

However, based on DeWoody et al. 2004, populations of *B. decurrens* can more appropriately be described as a large metapopulation throughout its range, with individual sub-populations occurring in clusters within the Peoria, LaGrange and Mel Price navigation pools. The targeted number of natural sub-populations within each pool should be defined by habitat availability and population history within those pools (Mettler-Cherry pers. comm. 2009). The recovery target of 12 populations should be defined and identified in the context of a metapopulation over the next five years. Thus, this criterion has not been met. In addition, coordination is needed with landowners, principally Illinois Department of Natural Resources, U.S. Fish and Wildlife Service, and U.S. Army Corps of Engineers, for development of core population management plans, and cooperative agreements to insure perpetual management of those populations.

Criterion 3: *Populations must be monitored for a period of 5 years to determine if they are self-sustaining. Self-sustaining is defined for recovery purposes, as a population which is found to be stable or expanding during the 5-year monitoring period. B. decurrens* populations have been monitored for more than 20 years as

indicated on Tables 1a – 1f. As a fugitive species, the populations have not met the definition of stable in the narrow sense, but in the past 20 years, have generally maintained themselves within their geographic ranges, periodically expanding and contracting, depending on conditions of the floodplain.

Criterion 3 has generally been met. The recovery team will address an updated definition of self-sustaining which will take into consideration the natural fluctuations of this species. The degree to which hybridization with *Boltonia asteroides* occurs, or whether it is a serious threat to these populations (DeWoody 2002, DeWoody et al. 2009) is not clear at this time.

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat:

2.3.1.1 New information on the species' biology and life history:

Many of the recent research publications are referenced on the website of Dr. Marian Smith (http://www.siue.edu/~msmith/DrMarianSmith.htm#publications) and in this document. A major finding was the success in artificial propagation of the plant in the lab, and also being able to successfully grow the plant from seed in the field (Smith et al. 1995).

2.3.1.2 Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:

Smith et al. (2005) describe the complex life cycle of *B. decurrens* that has evolved in response to the dynamics of the historic flood regime, having significant effects on the demography of the species. This flood regime has changed dramatically since the last century due to the construction of navigation dams and agricultural levees. Late floods (recession after June 1) and/or low growing season (June-October) precipitation have been found to reduce population growth. Early floods (recession before June 1) and high precipitation during the growing season lead to explosive population growth. This environmental stochasticity affects not only the growth rate, but also the variability in population size. Development of a GIS database for the Illinois River valley resulted in the identification of 26 subpopulations at 44 locations (Mettler-Cherry et al. 2006, Mettler-Cherry and Smith 2006). In the short term, these subpopulations continue to appear, disappear and shift annually, typical of a metapopulation. The *B. decurrens* metapopulation is largely confined to the narrow littoral zone along a 400-km stretch of the Illinois River, and extinction of large subpopulations is common (Mettler-Cherry et al. 2006). The genesis of new populations is facilitated by the ability of the seeds to float for extended periods (Smith and Keevin 1998), provided that suitable habitat exists in areas connected to the ebb and flow of the river. Smith et al. (2005) demonstrated that the threatened status of *B. decurrens* can be explained by historical changes in flooding. Conservation strategies for this species must look beyond efforts to maintain static "protected" populations and make strategic use of the environmental variability to which *B. decurrens* is adapted. Management plans

which make use of flooding, discing, and other disturbance tools, and hand seeding techniques have been developed for National Wildlife Refuges (NWR) along the Illinois River where populations are known to occur (e.g., Chautauqua NWR, Two Rivers NWR).

2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):

DeWoody et al. (2004) found that seed dispersal along the river, and not pollen flow, is likely the primary determinant of population genetic structure since individual populations or subpopulations were widely interspaced and subject to frequent extinction and colonization. Significant genetic differentiation was detected among populations, but not among regions, suggesting that long-distance dispersal events occur and involve seed from a small number of populations. The observations of DeWoody et al. (2004) are consistent with a metapopulation model and confirm the importance of regular flooding events capable of producing suitable habitat and dispersing seeds long distance, as necessary, to the long-term persistence of *B. decurrens*.

B. decurrens historically grew in wet prairies, shallow marshes, and on mud flats of open rivers, creeks and lakeshores (Schwegman and Nyboer 1985). The plant is now found mostly in open, disturbed alluvial soil habitats (Schwegman and Nyboer 1985, Smith and Mettler 2002). *B. asteroides* may be found in a wide range of soil types and will tolerate moderately dry soils (Schwegman and Nyboer 1985). In the 1985 studies conducted by Schwegman and Nyboer, *B. decurrens* and *B. asteroides* were found growing at a site at Beardstown, IL, with no apparent hybridization. In recent surveys of mixed populations, individuals were found that had decurrent leaves but lacked rhizomes (Dr. Paige Mettler-Cherry, pers. comm. 2008). The sharing of generalized habitat with *B. asteroides* has apparently led to hybridizations (DeWoody 2002) and may be a new threat to the specialized *B. decurrens* based on field observations (Dr. Marian Smith, pers. comm. 2008).

2.3.1.4 Taxonomic classification or changes in nomenclature: None.

2.3.1.5 Spatial distribution, trends in spatial distribution (e.g., increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g., corrections to the historical range, change in distribution of the species' within its historic range, etc.):

Comprehensive surveys of historical, extant, and potential *B. decurrens* sites were conducted from late August to early October in 2000 (Smith), 2001 (Smith), and 2002 (Smith) to determine species status, number, and habitat type. Population locations of all historical surveys and records were geo-referenced with United States Geological Survey (USGS) 1:24000 Digital Raster Graphic topographic maps. A Geographic Information System (GIS) was developed to identify and locate specific habitat patches for *B. decurrens*. This information is reported in compact disc format by Mettler-Cherry and Smith (2006) and analyses are provided in Mettler-Cherry et al. (2006).

Based on herbarium specimens, *B. decurrens* was historically known to occur on the Illinois River floodplain in 11 Illinois counties along the Illinois River valley (from north to south: LaSalle, Marshall, Peoria, Woodford, Tazewell, Fulton, Mason, Schuyler, Cass, Morgan, and Calhoun Counties) and in St. Clair County on the Mississippi River floodplain (Schwegman and Nyboer 1985) . It also occurred on the Mississippi River floodplain in three Missouri counties near the confluence of the Illinois and Mississippi Rivers: Lincoln, St. Charles, and St. Louis Counties (Morgan 1980, Hickey 1988). Surveys in Illinois conducted over the past five years (Mettler-Cherry and Smith 2006, Dr. Paige Mettler-Cherry, pers. comm. 2008) have found *B. decurrens* to be extant in 14 counties (LaSalle, Bureau, Putnam, Marshall, Peoria, Woodford, Tazewell, Fulton, Mason, Schulyer, Cass, Morgan, Scott, and Jersey) along the Illinois River and two counties (Madison and St. Clair) on the Mississippi River. In Missouri, it was found in only one of the three counties where it was previously recorded, St. Charles County (Mettler-Cherry et al. 2006).

2.3.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):

Late floods and/or low precipitation reduce population growth, while early floods and high precipitation lead to explosive population growth (Smith et al. 2005). Elasticity analysis shows that changes in floods and growing season precipitation alter life history pathways responsible for population growth, from annual to biennial and eventually clonal pathways when conditions are unfavorable (Smith et al. 2005). Construction of levees has resulted in the separation of the floodplain from these natural processes and reduces the available habitat of *B. decurrens* to the narrow band outside the levees and above ordinary high water. In addition, alteration of the historic flood regime (i.e., high water levels in spring, low in fall) has reduced the amount of remaining habitat accessible to the species (Smith et al. 2005, Mettler-Cherry et al. 2006).

Private land management programs sponsored by USDA and the Service have supported several floodplain population sites. Several State and Federal wildlife refuges (see Table 1) have also engaged in intensive management to insure continued growth of *B. decurrens.* GIS overlays (Mettler-Cherry and Smith 2006) now document potential areas for the re-establishment of this plant. One site being studied is the Emiquon Preserve, a 7,000 acre Nature Conservancy property in the floodplain of the Illinois River where *B. decurrens* likely flourished but was eliminated due to levees and agricultural practices (Sparks et al. 1998, TNC 2009). Intense management is planned for the reintroduction using fire, bare soils and seeding. Strategic use of environmental variability is necessary to maintain this species throughout its range (Smith and Mettler, 2002).

2.3.1.7 Other:

None.

2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range:

Seasonal timing of flood recessions and growing season conditions have a dramatic effect on population size and fecundity (Smith et al. 2005, Mettler-Cherry et al. 2006). In 2002, the central and southwest climate divisions of Illinois experienced a wet spring, followed by a drier than average summer with above average normal temperatures in July and August. This resulted in plants smaller in height with significantly fewer inflorescences per plant, both characteristics symptomatic of unfavorable site conditions, i.e., late flood recession followed by below average precipitation during the growing season (Smith et al. 2005). Based on field observations, the 2007 summer flood severely curtailed fall blossoming (Gwen Kolb, USFWS, Illinois Private Lands Office, pers. comm. 2007). The early summer flood in 2008 also damaged *B. decurrens'* reproduction for that year (Gwen Kolb, pers. comm. 2008). Results from a fall 2009 census are not yet available. Managed areas continue to serve as core population centers. Because of their importance in maintaining genetic flow and diversity throughout the range of the species, populations at the upstream end of the Illinois River system in LaSalle and neighboring counties need to be secured and managed.

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes: None known.

2.3.2.3 Disease or predation: No change known.

2.3.2.4 Inadequacy of existing regulatory mechanisms: No change.

2.3.2.5 Other natural or manmade factors affecting its continued existence:

Dr. Marian Smith observed that at two sites with mixed *B. decurrens and B. asteroides* populations, (Frederick and Beardstown, IL), *B. decurrens* was ultimately eliminated (Dr. Marian Smith, pers. comm. 2007). Although hybridization apparently occurred at Frederick (DeWoody 2002, DeWoody et al. 2009), other factors, including the weak competitive ability of *B. decurrens* relative to *B. asteroides*, may be the cause (Dr. Marian Smith, pers. comm. 2007). In 2008, Drs. Romano and Romano initiated a study to determine the presence and extent of hybridization between *B. decurrens* and *B. asteroides* at two northern sites (Hennepin and Sparland). The study was funded by the U.S. Fish and Wildlife Service, Rock Island Field Office. Molecular markers have proven useful in determining the existence and extent of hybridization. Occasionally, taxa that have developed during geographic isolation will undergo hybridization when reintroduced (Rhymer and Simberloff

1996). The potential for two species to coalesce into one species is of particular concern in this case because the less common taxon may literally become "assimilated" into the larger taxon with extensive hybridization and backcrossing until pure forms of the rare taxon become nonexistent (Rhymer and Simberloff 1996). During the course of their analysis, Drs. Romano and Romano will attempt to evaluate whether there are alleles that appear to be fixed differences between *B. decurrens* and *B. asteroides*. While they cannot guarantee that the markers they use will produce alleles that are diagnostic for *B. decurrens* and *B. asteroides*, there is at least a good possibility that such alleles exist and will be uncovered in this study.

In addition to hybridization, another developing threat is the prospect of climate change affecting the success and distribution of *B. decurrens*. Since the changes in climate are unknown, results are not predictable with much certainty. Seasonal timing of flood recessions and growing season conditions have a dramatic effect on population size and fecundity (Smith et al. 2005; see section 2.3.2.1 above) such that "normal" spring floods increase population size while abnormal flooding (e.g., midsummer, etc.) can eliminate the flowering population for that year.

Another developing threat is the increase in row cropping due to high grain prices related to ethanol production. Marginal floodplain crop ground that was in the Conservation Reserve Enhancement Program or idle may now be actively cropped to maximize yield. It is unclear how long this condition of high grain prices and pressure on idle lands will last. The intensive cropping may reduce opportunities for *B. decurrens* to emerge due to use of herbicides (the discing and clearing of floodplains actually reduces competition and encourages emergence of *B. decurrens* in suitable areas).

2.4 Synthesis

The life history and population status has been extensively described by researchers in the literature. Studies of germination requirements (Baskin and Baskin 1988, Smith and Keevin 1998, Baskin and Baskin 2002), seedling growth (Smith et al. 1995, Smith and Cawly 2002), nutrient requirements (Mettler et al. 2001), photosynthesis (Smith et al. 1993), flood-tolerance (Stoecker et al. 1995, Smith and Moss 1998, Smith et al. 1998) and demography (Smith et al. 2005, Mettler-Cherry et al. 2006) have been completed and published. Thus, Recovery Criterion 1: A basic research program to determine the requirements of a naturally reproducing population, have been met.

Recovery Criterion 2 requires that twelve geographically distinct self-sustaining natural or established populations of the species must be protected through purchase in fee, easement or by cooperative management agreements. "Geographically distinct" has been interpreted in recovery team discussions as more than the plot that the plant occupies; it includes the contiguous reach of the floodplain where individuals of one population may migrate seeking favorable conditions for establishment. Though as many as 26 populations have been identified (Mettler-Cherry et al. 2006), only two populations on Federal lands are currently protected through management plans. The Service will seek management agreements in fiscal year 2010 with the Illinois DNR and other agencies and landowners to maintain *B. decurrens* populations on their lands for perpetuity. Populations in the upper

Illinois River watershed need to be included in these cooperative agreements. Thus, this criterion has not been met.

Recovery Criterion 3 requires monitoring the populations for a period of five years to determine whether the populations are self-sustaining, i.e., stable or expanding. One of the most stable populations, Rice Lake Wildlife Management Area, is managed for *B. decurrens* using water control regimes to flood out competing vegetation and discing to provide bare soil. This criterion for 12 or more populations, however, has not been met. We will be working with our partners to insure through a cooperative agreement or other means over the next five years that at a minimum, 12 populations are maintained and monitored.

Also proposed over the next five years are two efforts that will provide additional information to aid recovery of this species. One effort is the proposal to reintroduce *B. decurrens* to the Emiquon Preserve where a backwater lake that was once drained and cropped, is now being restored to native floodplain habitats by The Nature Conservancy. Dr. Paige Mettler-Cherry of Lindenwood University is heading this effort which will also look at fire as a means to reduce competing vegetation. The other effort (Drs. Romano and Romano, Western Illinois University) is a research study to evaluate the genetic characteristics among the various populations of *B. decurrens* and to specifically examine the genetic interactions with *B. asteroides*. Dr. Smith has observed that where *B. asteroides* occurs with *B. decurrens*, hybridization may contribute to the elimination of *B. decurrens* from that population. However, hybridization may not be the only factor, as these few sites where this has happened tend to have drier conditions which favor *B. asteroides.* Research findings may or may not indicate a new threat to the species from hybridization.

Previously recognized threats (levees, water level fluctuations) and new threats (hybridization, climate change) affect the existence of decurrent false aster to the extent that it may become endangered in the foreseeable future throughout all or a significant portion of its range without management intervention. Therefore, this species continues to meet the definition of threatened. The listing classification of the decurrent false aster should remain as threatened under the Endangered Species Act.

3.0 RESULTS

3.1 Recommended Classification:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist (*Indicate reasons for delisting per 50 CFR 424.11):*
____ *Extinction*
____ *Recovery*
____ *Original data for classification in error*
___X_ No change is needed

3.2 New Recovery Priority Number: No change, remains 8

3.3 Listing and Reclassification Priority Number: None

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

The following actions are recommended to be accomplished over the next five years:

1. Request the recovery team define, "twelve distinct populations" such that specific geographic areas can be targeted for recovery and management agreements can be developed with landowners.

   B. *decurrens* exists as a large metapopulation throughout its range, with individual sub-populations occurring in clusters within the Peoria, LaGrange and Mel Price navigation pools. The targeted number of natural sub-populations within each pool should be defined by habitat availability and population history within those pools. Artificially managed populations should be included as part of the recovery plan as insurance against extinction and to insure the likelihood of a viable seed source during periods when conditions are favorable for population establishment. These 12 populations should be defined and identified in this context over the next five years.

2. Work with the Illinois DNR to develop a Memorandum of Understanding for management of *B. decurrens* for perpetuity on state-owned lands and a similar document for use on other lands.

3. Identify whether hybridization of *B. decurrens* with *B. asteroides* is a new threat to the species using the results of a study being conducted by Drs. Romano and Romano as discussed above.

4. Continue coordination with the recently formed *B. decurrens* Working Group organized by The Nature Conservancy at Emiquon Preserve, an effort that is a follow-up to the initial *B. decurrens* Workshop held in 2006 and funded by the USFWS Landowner Incentive Program..

5.0 REFERENCES

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Baskin, C. C., and J. M. Baskin. 1988. Germination ecophysiology of herbaceous plant species in a temperate region. American Journal of Botany 75(2): 286-305.

Baskin, C. C., and J. M. Baskin. 2002. Achene germination ecology of the federally threatened floodplain endemic *Boltonia decurrens* (Asteraceae). American Midland Naturalist 147:16-24.

DeWoody, J. A. 2002. Multiple demographic processes influence the genetic structure of *Boltonia decurrens* (Asteraceae), a threatened floodplain species. M.S. Thesis. University of Iowa, Iowa City, IA.

DeWoody, J., J. D. Nason, and M. Smith. 2004. Inferring demographic processes from the genetic structure of a metapopulation of *Boltonia decurrens* (Asteraceae). Conservation Genetics 5: 603-617.

DeWoody, J., J.D. Nason, and M. Smith. 2009. Evidence of low-frequency hybridization between *Boltonia decurrens* (Asteraceae), a federally-listed threatened herb, and *B.asteroides*, a widespread congener. American Journal of Botany. In Review.

Hickey, E.E. 1988. A four county survey for *Boltonia decurrens* (Torr. & Gray) Wood (False starwort). Report prepared by the Missouri Department of Conservation under order No. 30181-01589 for U.S. Fish and Wildlife Service. 40 pp.

Mettler, P. A., M. Smith, and K. Victory. 2001. The effects of nutrient pulsing on the threatened, floodplain species, *Boltonia decurrens*. Plant Ecology 155: 91-98.4.

Mettler-Cherry, P.A. and M. Smith. 2006. *Boltonia decurrens* Resource CD: United States Fish and Wildlife Service, Illinois Department of Natural Resources.

Mettler-Cherry, P.A., M. Smith and T.M. Keevin. 2006. Habitat characterization and geospatial metapopulation dynamics of threatened floodplain species *Boltonia decurrens* using a GIS. Wetlands, 26(2): 336-348.

Morgan, S. W. 1980. Status report on *Boltonia asteroides* var. *decurrens* in Missouri. Unpublished report, Missouri Department of Conservation, Jefferson City. 13 pp.

Rhymer, J.M., and D. Simberloff. 1996. Extinction by Hybridization and Introgression. Annual Review of Ecology and Systematics, 27:83-109.

Schwegman, J.E., and R.W. Nyboer. 1985. The taxonomic and population status of *Boltonia decurrens* (Torr. and Gray) Wood. Castanea 50:112-115.

Smith, M., Y. Wu, and O. Green. 1993. Effect of light and water-stress on photosynthesis and biomass production in *Boltonia decurrens* (Asteraceae), a threatened species. American Journal of Botany 80:859-864.

Smith, M., T. Brandt, and J. Stone. 1995. Effect of soil texture and microtopography on germination and seedling growth in *Boltonia decurrens* (Asteraceae), a threatened species. Wetlands 15: 392-396.

Smith, M. and J.S. Moss. 1998. An experimental investigation, using stomatal conductance and fluorescence, of the flood sensitivity of *Boltonia decurrens* and its competitors. Journal of Applied Ecology 35: 553-561.

Smith, M., and T. Keevin. 1998. Achene morphology, production and germination, and potential for water dispersal in *Boltonia decurrens* (Decurrent false aster), a threatened floodplain species. Rhodora 100: 69-81.

Smith, M., T. Keevin, P. Mettler-McClure, and R. Barkau. 1998. Effect of the flood of 1993 on *Boltonia decurrens*, a rare floodplain plant. Regulated Rivers: Research and Management 14:191-202.

Smith, M. 2000. Mitigation plan for *Boltonia decurrens* (decurrent false aster), Route 94, St. Charles County, MO. 16 pp.

Smith, M. 2001. 2001 Census for historical populations of *Boltonia decurrens*. U.S. Army Corp of Engineers, St. Louis District, St. Louis, MO. 6 pp.

Smith, M. 2002. Year 2002 Inventory of Decurrent False Aster (*Boltonia decurrens*). U.S. Army Corps of Engineers, St. Louis District, St. Louis, MO. 7 pp.

Smith, M. and J. Cawly. 2002. Effect of achene morphology and mass on germination and seedling growth of *Boltonia decurrens* (Asteraceae), a threatened floodplain species. Rhodora 104: 1-12.

Smith, M., and P. Mettler. 2002. The role of the flood Pulse in maintaining *Boltonia decurrens*, a fugitive plant species of the Illinois River: A case history of a threatened species. Pages 109-144 *in* B. Middleton, editor. Flood Pulsing in Wetlands: Restoring the Natural Hydrological Balance. John Wiley and Sons, New York, NY.

Smith, M., H. Caswell, and P. Mettler-Cherry. 2005. Stochastic flood and precipitation regimes and the dynamics of a threatened floodplain plant. Ecological Applications 15(3): 1036-1052.

Smith, M. and E. Hunsley. 2006. Effect of density and pattern on germination in *Boltonia decurrens*. Journal of the Torrey Botanical Society. 133(4): 528-534.

Sparks, R. E., J. C. Nelson, and Y. Yin. 1998. Naturalization of the flood regime in regulated rivers. BioScience 48:706-720.

Stoecker, M. A., M. Smith, and E. D. Melton. 1995. Survival and aerenchyma development under flooded conditions of *Boltonia decurrens*, a threatened floodplain species and *Conyza canadensis*, a widely distributed competitor. American Midland Naturalist 134:117-126.

The Nature Conservancy(TNC). 2009. Emiquon: Restoring the Illinois River. http://www.nature.org/wherewework/northamerica/states/illinois/preserves/art1112.html. Accessed July 28, 2009.

Table 1a. *Boltonia decurrens* population censuses

Data were compiled from agency reports, personal observations and censuses conducted by Dr. Marian Smith and students.

County	Site	Township	Section #	1984	1988	1989
Brown	LaGrange Lock and Dam	Cooperstown E	21			
Bureau	Hennepin Bridge	Leepertown	28,29	1		
Cass	Beardstown	Beardstown	16	75		
Fulton	Anderson Lake	Kerton	29	5		30
	Banner Marsh	Banner	12			
	Duck Club Road	Banner	25		~600	
	Rice Lake SFWA levee road	Banner	24			
	Rice Lake SFWA	Banner	23	100,000		4,000
Jersey	Gilbert Lake	Quarry	14			59
	The Glades	Rosedale	17			
LaSalle	Jonesville	22	23			
Madison	Horseshoe Lake	Nameoki	21			
	Waste Management	Nameoki	33, 34			
Marshall	Billsbach Lake	Hopewell	7	200	1007	10
	Goose Lake	Hopewell	24	200		6
	Sawyer Slough	Lacon	2			
	Sparland SFWA	Stueben	34			
Mason	Bath boat launch	20	7		10	
	Bath Lake Springs	20	6			
	Chatauqua Park	5	30			
	Chatauqua NWR					
	Havana Harbor	11	36			
	Knapps Island	24	35			
	Matanzas Marsh	14	28			
Morgan	Meredosia NWR	2	3,10	100		2,000
Peoria	Detweiller Park	15	34			
	McClugage Bridge	15	35			
	Mossville	10	23			
Putnam	Senachwine Lake	9	15, 16			
	Swan Lake	12	10			
Schuyler	Frederic Road and dump	Frederick	17	10,000		2,000
	Browning, Rte. 100	Browning	23, 24	100		53
Scott	Ferry Lake	Bloomfield W	25			
	Smith Lake	Naples Bluff E	6			
St. Clair	Fairmont Golf Course	3	4			
Tazewell	Cooper Park	Fondulac	14			10
	Pekin Lake SCA	Pekin	14			
Woodford	Blalock Creek	Partridge	31, 32		200	
	Spring Bay Fen	Spring Bay	11			
	Woodford County CA	Partridge	16			

Table 1b. *Boltonia decurrens* population censuses

Data were compiled from agency reports, personal observations and censuses conducted by Dr. Marian Smith and students.

County	Site	Township	Section #	1991	1992	1993
Brown	LaGrange Lock and Dam	Cooperstown E	21			
Bureau	Hennepin Bridge	Leepertown	28,29			
Cass	Beardstown	Beardstown	16		50	
Fulton	Anderson Lake	Kerton	29			
	Banner Marsh	Banner	12			
	Duck Club Road	Banner	25		200	1
	Rice Lake SFWA levee road	Banner	24			
	Rice Lake SFWA	Banner	23		1,000s	
Jersey	Gilbert Lake	Quarry	14			
	The Glades	Rosedale	17			
LaSalle	Jonesville	22	23			
Madison	Horseshoe Lake	Nameoki	21			
	Waste Management	Nameoki	33, 34			
Marshall	Billsbach Lake	Hopewell	7	200	10	100
	Goose Lake	Hopewell	24		10	200
	Sawyer Slough	Lacon	2			
	Sparland SFWA	Stueben	34	1,500	300	100's
Mason	Bath boat launch	20	7		11	
	Bath Lake Springs	20	6			
	Chatauqua Park	5	30			
	Chatauqua NWR					
	Havana Harbor	11	36			
	Knapps Island	24	35			
	Matanzas Marsh	14	28	9		
Morgan	Meredosia NWR	2	3,10		1,000	
Peoria	Detweiller Park	15	34			
	McClugage Bridge	15	35			300
	Mossville	10	23			
Putnam	Senachwine Lake	9	15, 16			9
	Swan Lake	12	10	5,000		100's
Schuyler	Frederic Road and dump	Frederick	17		65	
	Browning, Rte. 100	Browning	23, 24		100	
Scott	Ferry Lake	Bloomfield W	25			
	Smith Lake	Naples Bluff E	6		44	
St. Clair	Fairmont Golf Course	3	4			
Tazewell	Cooper Park	Fondulac	14		25	25
	Pekin Lake SCA	Pekin	14			
Woodford	Blalock Creek	Partridge	31, 32	50	20	5
	Spring Bay Fen	Spring Bay	11			
	Woodford County CA	Partridge	16			

Table 1c. *Boltonia decurrens* population censuses

Data were compiled from agency reports, personal observations and censuses conducted by Dr. Marian Smith and students.

County	Site	Township	Section #	1994	1995	1996
Brown	LaGrange Lock and Dam	Cooperstown E	21			
Bureau	Hennepin Bridge	Leepertown	28,29	50		
Cass	Beardstown	Beardstown	16		0	50
Fulton	Anderson Lake	Kerton	29	100	250	44
	Banner Marsh	Banner	12	40		12
	Duck Club Road	Banner	25	4	137	349
	Rice Lake SFWA levee road	Banner	24			
	Rice Lake SFWA	Banner	23	59,000	20,000	30,000
Jersey	Gilbert Lake	Quarry	14	20,000	5,000	1,000
	The Glades	Rosedale	17			
LaSalle	Jonesville	22	23			
Madison	Horseshoe Lake	Nameoki	21	80,000	450,000	50,000
	Waste Management	Nameoki	33, 34			
Marshall	Billsbach Lake	Hopewell	7	100		1
	Goose Lake	Hopewell	24	100		1
	Sawyer Slough	Lacon	2		12	
	Sparland SFWA	Stueben	34			
Mason	Bath boat launch	20	7	30		
	Bath Lake Springs	20	6			
	Chatauqua Park	5	30			
	Chatauqua NWR					Plants present
	Havana Harbor	11	36		50	30
	Knapps Island	24	35			
	Matanzas Marsh	14	28			
Morgan	Meredosia NWR	2	3,10	15	6,000	400
Peoria	Detweiller Park	15	34	20		
	McClugage Bridge	15	35	8,000	6,000	340
	Mossville	10	23			68
Putnam	Senachwine Lake	9	15, 16			5
	Swan Lake	12	10			
Schuyler	Frederic Road and dump	Frederick	17		15,000	50
	Browning, Rte. 100	Browning	23, 24		20	200
Scott	Ferry Lake	Bloomfield W	25			
	Smith Lake	Naples Bluff E	6	10	100	25
St. Clair	Fairmont Golf Course	3	4			
Tazewell	Cooper Park	Fondulac	14	104	35	35
	Pekin Lake SCA	Pekin	14	100's	100's	10,000
Woodford	Blalock Creek	Partridge	31, 32	1000's		
	Spring Bay Fen	Spring Bay	11	Plants present		
	Woodford County CA	Partridge	16	60,000	50,000	100

Table 1d. *Boltonia decurrens* population censuses

Data were compiled from agency reports, personal observations and censuses conducted by Dr. Marian Smith and students.

County	Site	Township	Section #	1997	1998	1999
Brown	LaGrange Lock and Dam	Cooperstown E	21			
Bureau	Hennepin Bridge	Leepertown	28,29	8500	1200	4510
Cass	Beardstown	Beardstown	16	8	15	250
Fulton	Anderson Lake	Kerton	29	23	15	426
	Banner Marsh	Banner	12		5	18,900
	Duck Club Road	Banner	25	Plants present		96
	Rice Lake SFWA levee road	Banner	24			10
	Rice Lake SFWA	Banner	23	500,000	10,000	500,000
Jersey	Gilbert Lake	Quarry	14	2,500	1,300	1,500
	The Glades	Rosedale	17		1	
LaSalle	Jonesville	22	23		Plants observed	
Madison	Horseshoe Lake	Nameoki	21	100,000	1,000	900
	Waste Management	Nameoki	33, 34			
Marshall	Billsbach Lake	Hopewell	7	50,000		
	Goose Lake	Hopewell	24			
	Sawyer Slough	Lacon	2	38	29	
	Sparland SFWA	Stueben	34		1000's	50
Mason	Bath boat launch	20	7	Plants present		
	Bath Lake Springs	20	6	Plants present		
	Chatauqua Park	5	30	100's		
	Chatauqua NWR					
	Havana Harbor	11	36	50	0	150
	Knapps Island	24	35			100's
	Matanzas Marsh	14	28			
Morgan	Meredosia NWR	2	3,10	1,000	750	890
Peoria	Detweiller Park	15	34	12	26	11
	McClugage Bridge	15	35	5,000	750	700
	Mossville	10	23		200	
Putnam	Senachwine Lake	9	15, 16	4	59	
	Swan Lake	12	10			
Schuyler	Frederic Road and dump	Frederick	17	2,000	10	150
	Browning, Rte. 100	Browning	23, 24			50,000
Scott	Ferry Lake	Bloomfield W	25			
	Smith Lake	Naples Bluff E	6	5		
St. Clair	Fairmont Golf Course	3	4	3,000	25	175
Tazewell	Cooper Park	Fondulac	14	195	9	32
	Pekin Lake SCA	Pekin	14	>100,000	>100,000	
Woodford	Blalock Creek	Partridge	31, 32	100's		
	Spring Bay Fen	Spring Bay	11		2	29
	Woodford County CA	Partridge	16	165		3,120

Table 1e. *Boltonia decurrens* population censuses

Data were compiled from agency reports, personal observations and censuses conducted by Dr. Marian Smith and students.

County	Site	Township	Section #	2000	2001	2002
Brown	LaGrange Lock and Dam	Cooperstown E	21		12	
Bureau	Hennepin Bridge	Leepertown	28,29	320	1953	
Cass	Beardstown	Beardstown	16	15	4	8
Fulton	Anderson Lake	Kerton	29	744	559	Plants observed
	Banner Marsh	Banner	12			
	Duck Club Road	Banner	25	Plants present		
	Rice Lake SFWA levee road	Banner	24			
	Rice Lake SFWA	Banner	23	970,000	~1,000,000	
Jersey	Gilbert Lake	Quarry	14	3,500	400	
	The Glades	Rosedale	17	1		
LaSalle	Jonesville	22	23	7,300		
Madison	Horseshoe Lake	Nameoki	21	200,000	3,937	
	Waste Management	Nameoki	33, 34	500	350	200
Marshall	Billsbach Lake	Hopewell	7	200		
	Goose Lake	Hopewell	24	200		
	Sawyer Slough	Lacon	2			
	Sparland SFWA	Stueben	34	25		
Mason	Bath boat launch	20	7			
	Bath Lake Springs	20	6			
	Chatauqua Park	5	30			
	Chatauqua NWR				17	
	Havana Harbor	11	36		6	
	Knapps Island	24	35			
	Matanzas Marsh	14	28	Plants present		
Morgan	Meredosia NWR	2	3,10	1,300	989	
Peoria	Detweiller Park	15	34			
	McClugage Bridge	15	35	1,200	150	
	Mossville	10	23			
Putnam	Senachwine Lake	9	15, 16			
	Swan Lake	12	10			
Schuyler	Frederic Road and dump	Frederick	17	500	35	
	Browning, Rte. 100	Browning	23, 24	100,000		
Scott	Ferry Lake	Bloomfield W	25	300		
	Smith Lake	Naples Bluff E	6			
St. Clair	Fairmont Golf Course	3	4	200		
Tazewell	Cooper Park	Fondulac	14	305	439	
	Pekin Lake SCA	Pekin	14	>100,000	Plants present	
Woodford	Blalock Creek	Partridge	31, 32	380		
	Spring Bay Fen	Spring Bay	11	Plants present		
	Woodford County CA	Partridge	16	700	84	

Table 1f. *Boltonia decurrens* population censuses

Data were compiled from agency reports, personal observations and censuses conducted by Dr. Marian Smith and students.

County	Site	Township	Section #	2005	2006
Brown	LaGrange Lock and Dam	Cooperstown E	21		
Bureau	Hennepin Bridge	Leepertown	28,29		
Cass	Beardstown	Beardstown	16		
Fulton	Anderson Lake	Kerton	29	Plants observed	
	Banner Marsh	Banner	12		
	Duck Club Road	Banner	25		
	Rice Lake SFWA levee road	Banner	24		
	Rice Lake SFWA	Banner	23		
Jersey	Gilbert Lake	Quarry	14		300
	The Glades	Rosedale	17		
LaSalle	Jonesville	22	23		
Madison	Horseshoe Lake	Nameoki	21		
	Waste Management	Nameoki	33, 34	5,000	
Marshall	Billsbach Lake	Hopewell	7		
	Goose Lake	Hopewell	24		
	Sawyer Slough	Lacon	2		
	Sparland SFWA	Stueben	34		350
Mason	Bath boat launch	20	7		
	Bath Lake Springs	20	6		
	Chatauqua Park	5	30		
	Chatauqua NWR				150
	Havana Harbor	11	36		
	Knapps Island	24	35		
	Matanzas Marsh	14	28		
Morgan	Meredosia NWR	2	3,10		100
Peoria	Detweiller Park	15	34		
	McClugage Bridge	15	35		
	Mossville	10	23		
Putnam	Senachwine Lake	9	15, 16		
	Swan Lake	12	10		
Schuyler	Frederic Road and dump	Frederick	17		
	Browning, Rte. 100	Browning	23, 24		
Scott	Ferry Lake	Bloomfield W	25		
	Smith Lake	Naples Bluff E	6		
St. Clair	Fairmont Golf Course	3	4		
Tazewell	Cooper Park	Fondulac	14		
	Pekin Lake SCA	Pekin	14		
Woodford	Blalock Creek	Partridge	31, 32		
	Spring Bay Fen	Spring Bay	11		
	Woodford County CA	Partridge	16		

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Boltonia decurrens*

Current Classification: Threatened

Recommendation resulting from the 5-Year Review

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
__X__ No change is needed

Appropriate Listing/Reclassification Priority Number, if applicable ___8__

Review Conducted By: Jody Millar, Rock Island Field Office

FIELD OFFICE APPROVAL:
Lead Field Supervisor, Fish and Wildlife Service

Approve _____ Date 3-30-10

REGIONAL OFFICE APPROVAL:
Assistant Regional Director, Ecological Services, Fish and Wildlife Service, Midwest Region

Approve Lynn M Lewis Date 4/20/10