

THE UNDERGRADUATE RESEARCH ACADEMY
OFFICE OF UNDERGRADUATE ASSESSMENT & PROGRAM REVIEW
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PROJECT TITLE The Effects of Seed Dormancy and Mass on Germination and Viability in
 Federally Threatened Floodplain Species, *Boltonia decurrens*

ABSTRACT: The abstract is a brief but comprehensive summary of the contents of the proposal *in plain language*, approximately 150 words. Readers receive their first impression of the flavor of the topic from this abstract. The information in the abstract needs to be concise, well organized, self contained, and understandable to persons outside the discipline.

Boltonia decurrens is a plant on the federal list of threatened species; it exists only in the lower Illinois River and Mississippi River floodplains and is considered at risk of extinction in both states. Germination and early development are critical stages in a plant's life cycle; therefore, germination studies are necessary to the development of management strategies designed to establish new populations and to maintain current populations of *B. decurrens*. At this time, no study has been conducted to determine how long stored seeds retain their viability. The purpose of this study is to determine if the age of stored seeds plays a role in seed viability and germination. The study will also determine how a seed's mass affects these parameters. The results of this experiment will provide information that can be used to improve the way in which seeds of *B. decurrens* are stored and used in conservation efforts to maintain and restore populations.

Upon submitting this proposal, I verify that this writing is my own and pledge to fulfill all of the expectations of the Undergraduate Research Academy to the best of my abilities. I understand that failure to do so may result in return of fellowship money to the University and forfeiture of academic credit and honors recognition.

Signature of the Student

I am able, willing, and committed to providing the necessary facilities and to take the time to mentor this student during this project. I verify that this student is capable of undertaking this proposed project.

Signature of the Faculty Mentor

This project is within the mission and scope of this department, and the department fully supports the faculty mentor and student during this venture.

Signature of the Department Chairperson

I testify that all necessary research protocols (human, animal, toxic waste) have been fulfilled, and I

support this proposed faculty-student scholarly activity as within the mission of the College/School.

Signature of the Dean of the College/School

I. Introduction

Boltonia decurrens (decurrent false aster) is a perennial species in the sunflower family (Asteraceae) that is restricted to the lower Illinois River floodplain (Torrey and Gray, 1840) and nearby areas of the Mississippi River. In spite of its high seed production and ability to reproduce vegetatively, population size and number in *B. decurrens* have declined as a result of the construction of levees and navigation dams along the Illinois River (Schwegman and Nyboer 1985; Smith et al. 1998; U.S. Fish and Wildlife Service 1990). These levees and dams have destroyed the habitat of *B. decurrens* by altering patterns of regular flooding in the spring and recession of the floodwaters in early summer; several habitats with such patterns are now either permanently under water, or no longer experience flooding (Smith et al. 1993). The U.S. Fish and Wildlife Service placed *B. decurrens* on the Federal List of threatened species in 1988, and the species is listed as threatened in Illinois (Herkert & Ebinqer 2001) and as a “species of concern” in the state of Missouri (MDC 2002).



Species loss is becoming a very serious threat in the world. As of 2004, the World Conservation Union, which includes thousands of scientists from many different countries, estimates that the global rate of species extinction is between 100 and 1,000 times higher than what would be expected naturally; some estimates are higher still (IUCN 2004). The extinction of such species are damaging in more than just an aesthetic sense, goods and services provided by ecosystems, which include gas regulation and waste treatment, estimate a monetary value of around 33 trillion dollars (IUCN 2004). Furthermore, many species are used for food and fuel by humans, and between 10,000 and 20,000 species of plants alone are used in medicine worldwide (IUCN 2004).

There is a great importance in studying species such as *B. decurrens* because the species is one of many that are threatened by habitat degradation. Habitat loss, in such a case, does not merely refer to a change in the use of land, but also, as in the case of *B. decurrens*, as an interruption of natural fluctuations in the environment of a species (Smith et al. 2005). The altered flood patterns along the Illinois River are a potential threat to any species that has adapted to the natural patterns in this area. Furthermore, we can see similar river-floodplain ecosystems deteriorating in the developing world, the effects of which are often impossible to restore (Smith et al. 2005). By studying species such as *B. decurrens*, we can observe how habitat degradation effects flora and fauna restricted to such areas and better prepare for the preservation of these species.

II. Literature Review

As germination and the early development of seedlings are both critical stages in the life cycle of a plant (Harper et al. 1970; Smith and Cawly 2002), these stages are important areas of study; research on these subjects important to the development of effective conservation plans. Early studies (Smith and Keeven 1998) have shown *B. decurrens* to be a prolific seed producer with a fecundity reaching levels as high as 50,000 seeds per mature plant. Field studies, however, estimate mortality seeds to be as high as 99.99% (Moss 1997). As a result, studies of seed

germination are especially important in planning for the establishment of new populations and for the maintenance of extant populations of *B. decurrens*.

Research conducted by Smith and Cawly (2002) has suggested that seedling establishment is influenced by seed morphology during early stages of development, and earlier experiments have suggested that large seeds have higher rates of germination (production of a seedling) and viability (evidence of a living, but dormant, embryo) than their smaller counterparts (Smith and Keevin 1998). As is characteristic of the Asteraceae, *B. decurrens* produces two different types of flowers with two morphologically distinct seeds. Disk seeds are more numerous than ray seeds (ca. seven times more disk seeds in each inflorescence) and larger in size, averaging 1.8 mm in length, 1.3 mm in width, and 0.1 mg in mass; the seeds are flattened, and are characterized by the presence of two prominent bristles at the apex (Smith and Cawly 2002). The high surface area-to-mass ratio of the flattened seeds enable them to float for long periods of time (Smith and Keevin 1998), allowing the species to disperse on floodwaters to new areas along the floodplain. In contrast, ray seeds are smaller, averaging 1.3 mm in length, 0.9 mm in width, and 0.05 mg in mass; unlike disk seeds, ray seeds do not float and are thought to provide seedlings in close proximity to an existing population (Smith and Keevin 1998; Smith et. al. 1998).

One important aspect of seed physiology of *B. decurrens* has not been studied: the effect of age on seed germination and viability. Because population size and number vary drastically from year to year (Smith et al. 2005), conservation agencies collect seeds during years when populations are large, and plan to use these seeds to reintroduce the species into suitable habitat during years when environmental factors result in few or no existing populations. **No one knows, however, how long seeds remain viable, so it has been impossible to plan an effective program of seed collection and storage that will provide reliable and adequate seed reserve.** If the seeds of *B. decurrens* remain viable only for a short time, long term storage of seeds may not be an option. As an example, cottonwood seeds remain viable only for a few days (Baskin and Baskin 1998).

III. Objectives

Because of the potential effect of seed age on germination and viability and the importance of maintaining seed reserves for conservation planning, the present study will be conducted to determine the following:

1. How the age of seeds in *B. decurrens* relates to seed viability and germination. Seeds collected from populations of *B. decurrens* from 1990 to 2004 will be used to determine the effect of seed age on viability and germination.
2. In order to separate the effects of seed mass from seed age, a range of size classes from a selected year will also be tested for viability and germination.

Information from this study is critical to any conservation plan that includes re-seeding areas where historical populations have disappeared. In testing both of these objectives, a null hypothesis will be used to avoid potential bias in the data, i.e. that there will be no effect of either age or mass on viability or germination. If the results of this experiment do conform to the null hypothesis, they will be significant in that long term storage of *Boltonia* seeds will be permitted

in a recovery plan for the species.

IV. Methods

A. Effect of Seed Age

To determine the effect of seed age on germination and viability, seeds that were collected from 11 populations throughout the range of the species from 1990-1995, 1997-1999, and 2003-2004 and stored at 4°C at SIUE will be tested under conditions known to be optimal for the species (Smith and Keevin 1998). Seeds for each year will be placed in an 841 μ sieve; the sieve will be shaken to separate the larger disk seeds from smaller ray seeds (Smith and Cawly 2002). Only the disk seeds, which are more numerous will be used in this study. One-hundred disk seeds that are collected in this procedure will be randomly selected and placed in a labeled Petri dish. The process will be repeated for seeds from each of the 11 years, resulting in 11 Petri dishes with 100 seeds each. Each Petri dish will be filled with 30 ml of deionized water and placed in a Conviron plant growth chamber under the following regime: 300 μ mol m⁻²s⁻¹ light; and 30°C, 12 hr light/12 hr dark (Smith and Keevin 1998). Twice weekly, for ca. 4 weeks, the seeds will be monitored, and germinated seeds from each Petri dish will be removed and recorded.

At the end of the 4-week period, all seeds that have not germinated will be immersed in a 1% solution of 2,3,5-triphenyl-tetrazolium chloride solution to test for seed viability. Seeds will be incubated in the dark for 7 days and examined under a Nikon 104 dissecting microscope for evidence of respiration produced by a living embryo, which is indicated by a pink coloration of the embryo (Colby 1961).

B. Effect of Seed Mass

To separate the effect of seed mass on germination and viability, an 841 μ sieve will be used, as before, to separate seeds from the 2003 collection of seeds. Two categories of seeds will be created: 1. seeds that are too large to pass through the sieve; and 2. seeds that are small enough to pass through. Seeds from these categories will be randomly selected and combined in specific ratios to produce 11 groups of seeds with different overall masses. As in part A of this study, each Petri dish will contain 100 seeds. A Fisher Scientific accu-124D Dual Range balance will be used to determine the total mass of each group of seeds. Seeds will be tested for germination and viability following the procedures used in part A of this study.

C. Data Analysis

All data will be graphed using Sigma Plot 8.0 (SPSS, Inc. 2003) and tested using regression analysis for relationships between germination and viability in response to age and mass.

V. Timeline

July 1-29: *Boltonia decurrens* seeds from SIUE storage will be counted and placed in Petri dishes with water. Germinated seeds will be removed and recorded twice a week for these three weeks.

July 30- The Botany 2006 Conference in Chico California will be attended. This **Aug. 3:**

conference will be of aid in preparing the data obtained from the experiment for publication, and help with the writing process. Lectures and workshops focused on species conservation and restoration will be given priority, as well as other events that may be relevant to the research being done.

Aug. 4-12: Seeds that did not germinate will be tested for viability.

Aug. 13-19: More seeds from 2003 will be counted and combined in the predetermined ratios. The resulting groups will be weighed to determine the mass of each group.

Aug. 21 - The 2003 seeds will be placed in Petri dishes with water. Germinated
Sept. 18: seeds will be removed and recorded twice a week for four weeks and those that did not germinate will be tested for viability.

Oct. 1- Data from both experiments will be analyzed and prepared for publication, **Dec. 31** and for presentation at the Illinois State Academy of Sciences and the URA Symposium.

References

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Budget Justification:

Item	Cost	Vendor
Commodities		
Commodities will be purchased with grant money of Dr. Smith's		
Botanical Conference 2006 Expenses		
Botanical Conference Registration.....	\$160	
Transportation and Housing.....	\$215	Campus Res.
Travel Expenses		
Flight tickets for St. Lois to Sacramento.....	\$417.50	Southwest
Total.....	\$792.50	
ISAS Meeting Expenses		
2007 ISAS Meeting Registration.....	\$30	
Gasoline/Mileage for Meeting.....	\$50	
Total.....	\$80	