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Status of the Proposed Rare Species Bidens Discoidea in Pennsylvania

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Abstract:

The continual reassessment of the status of threatened and endangered species is necessary and important in maintaining accurate lists of state species of concern. The annual, *Bidens discoidea* (Asteraceae) was recommended for listing as a rare plant by the Pennsylvania Biological Survey, primarily on the basis of the meager number of historical collections known from the state. Little current information was available to justify this status. My goals in this study were to determine the current status of *Bidens discoidea* populations in Pennsylvania by 1) field checking sites where the plant was previously collected; 2) visiting additional areas of suitable habitat to search for the plant; 3) investigating seed viability and germination characteristics, and comparing them with those of another local species (*Bidens comosa*). *Bidens discoidea* was found at 17 of the 28 lakes surveyed; population sizes varied from 0-300 plants per site. The plant was not present at any of the 13 historical sites along the Delaware River. An average of 92% of *Bidens discoidea* seeds were viable. Germination requirements include light and excess water; *Bidens comosa* germination rates in the dark were higher that those of *Bidens discoidea.* I concluded that the proposed rare status of *Bidens discoidea* is valid; guidelines for protection are recommended.

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INTRODUCTION

The alarming decline in biodiversity occurring locally in Pennsylvania, as well as globally, undoubtedly poses a significant threat to the functioning of our ecosystems. Deforestation has reduced the world's forest cover from 50% of the earth's land surface to less than 20% (Bryant, 2002), eliminating habitat for plants and animals as well as substantially impacting the state of the environment. In Pennsylvania alone, over 800 species of plants and animals are rare, threatened or endangered, and approximately eight million acres of the state's forests have been lost (Thompson, 2002; Anonymous); many of the forested areas that exist today are badly fragmented, contain a significant number of non-native species, and are substantially different from the state in which they existed prior to the 1700's. Native species in Pennsylvania now comprise less than 63% of the vascular flora (Rhoads & Klein, 1993); this decrease in the amount of native flora is attributed to a number of factors, including habitat loss and the explosion of introduced non-native plants. The decline in native plants is likely to continue with the effects of development and the exhaustion of natural resources—one estimate states that development in Pennsylvania's metropolitan areas will increase by 47% from 1990 to 2020 (Thompson, 2002).

Recognizing these threats to our ecosystem, lawmakers have acknowledged the need for protection of rare native species. The national Endangered Species Act of 1973 (16 U.S.C.§§ 1531 et seq.) brought about the first form of protection for plants whose populations were in danger in the United States. Pennsylvania adopted regulations for state protection of rare plant species in 1982—under the Wild Resources Conservation Act (17 PA Code § 45), the state's Department of Environmental Resources (DER) was given the power to collect information on plants of concern in the state in order to formulate a list of plant species in need of protection, as well as to devise and enforce protection guidelines. DER has since been split into two organizations: the Department of Environmental Protection (DEP) and the Department of Conservation and Natural Resources (DCNR). Presently, plants in Pennsylvania are under the jurisdiction of DCNR, which is responsible for maintaining the state's Plants of Special Concern list.

Pennsylvania's Plants of Special Concern list currently is comprised of a total of 657 vascular plants that are classified as rare, threatened, or endangered. This number also includes plants that have no official status, but whose numbers are believed to be in danger. These plants are classified as having a proposed status, or a status that is tentatively undetermined. The Plants of Special Concern list is drawn up by the Vascular Plants Technical Committee of the Pennsylvania Biological Survey, a group of state botanists and ecologists knowledgeable about rare plants in the state. This committee is also responsible for making recommendations for updates and additions to the list. After voting on these changes, the Vascular Plants Technical Committee forwards recommendations to DCNR, the department responsible for taking the official steps to update the list. DCNR is required to prepare and submit an official Draft Regulation Packet Proposal, which outlines every proposed regulation change and reasons for the changes. This proposal also includes general background information and costs associated with the regulations changes. The packet proposal is submitted to the Independent Regulatory Review Commission (IRRC), a commission that reviews all regulation changes in the state, as well as the Environmental Resources Committee and the Energy Committee. Proposed regulation changes are also published in the PA Bulletin, a weekly publication that lists current regulatory changes in the state to alert the general public. After DCNR receives feedback from

each of these committees, as well as the general public, a final draft, which addresses these comments, is submitted, and changes are then official. The process can be quite complicated, and can take as long as two years.

The Plants of Special Concern list has not been officially updated in approximately 10 years. This has resulted in shortcomings of the list. Currently, over 35% of plants on the list have no official status due, in most cases, to lack of information. As a result of this absence of information about occurrence and population sizes for a number of these plants, official changes in the statuses are difficult to make, thus these plants currently receive no official protection by law in the state. A list that is comprised of plants whose proposed statuses are based on studies supplying information about location, population sizes, and number of populations in the state would greatly facilitate official status updates for plants on the list. These studies are fundamental for obtaining official protection for plants that are in need of it and removing from the list those that are not.

Bidens discoidea (Torr. & Gray) Britt. is one such species on the Plants of Special Concern list about which little information is known. This plant, commonly known as small beggarticks, is an annual in the Asteraceae (Aster family). *Bidens discoidea* is a facultative wetlands species, and occurs along lake margins (Fig. 1). Other common sites where the plant can be found are in mossy hummocks and peat bogs occurring around lakes. *Bidens discoidea* is a high light specialist (Menges & Waller, 1983), flowers in mid-August, and can reach heights as tall as five feet. The range of the plant covers the eastern United States and adjacent Canada, and extends westward to Texas and Oklahoma (NatureServe). Leaves are trifoliate; leaflets are lanceolate to lance-ovate and serrate. Flowering heads are narrow and discoid. The plant closely resembles *Bidens frondosa*, however the flowering heads of this plant have 5-10 outer involucral bracts that are ciliate; those of *B. discoidea* have 3-5 non-ciliate outer involucral bracts.

Figure 1: *Bidens discoidea* line drawing (by Anna Aniśko).

Bidens discoidea is currently listed as proposed rare on the Plants of Special Concern List. More information is required about its occurrence in Pennsylvania to justify the proposed status. To date, there have been no field studies in the state specifically implemented to determine the distribution of *Bidens discoidea* or the number of populations present, and most of

the few herbarium records that exist are not current. Very little is known about occurrences outside of Pennsylvania; Hickler (1999) notes that *Bidens discoidea* is "in need of attention from field botanists to clarify its status" in the state of Massachusetts. No other recent publications addressing the abundance of the plant throughout its range exist. In addition, little information is known about seed germination requirements or seed viability. Experiments examining seed germination requirements may provide information leading to a better understanding of the reasons for the proposed rare status of this plant.

The purpose of this study was to obtain enough information, by means of a field study, to assess whether the current proposed rare status of *Bidens discoidea* is valid and to use this information to advise the Vascular Plants Technical Committee about the status of the plant. Additional goals were to gain a better understanding of the seed viability and seed germination requirements of *Bidens discoidea*.

METHODS

Herbarium search

Herbarium searches for *Bidens discoidea* were performed at the Morris Arboretum (MOAR) and the Academy of Natural Sciences (PH) in order to revisit sites where the plant was once present. Database searches were also performed for the following herbaria: CM, WILK, SHIP, CLM and ATLAS.

Field assessment

In order to assess the status of *Bidens discoidea*, a total of 28 lakes in northeastern Pennsylvania were visited (Table 1). For most lakes, a boat was used to examine the lakeshore, hummocks, peat bogs, and other areas of appropriate habitat for *Bidens discoidea*; several lakes were examined on foot. The number of *Bidens discoidea* individuals was estimated, photographs were taken, and associates occurring with the plant were recorded at each site. For each lake where *Bidens discoidea* was present, at least one individual was GPS referenced and collected, and maps of occurrences were produced. Specimens were deposited at the Morris Arboretum (MOAR), duplicates at the Academy of Natural Sciences (PH). In addition to northeastern Pennsylvania lakes, 13 sites along the Delaware River were examined by foot to determine if *Bidens discoidea* still existed in the Easton area, where specimens were collected in the late 1800's (see Appendix B).

Seed germination and viability

To better understand *Bidens discoidea* seed germination requirements, seed germination and viability tests were performed on *Bidens discoidea* and *Bidens comosa*, a relative of *Bidens discoidea* occurring in the same habitat but in more abundance. Achenes from both species were collected from plants in the field in late fall, and left to dry in envelopes for approximately two months. To mimic field stratification, achenes from each of the two species were mixed into a wet sandy substrate and placed inside separate cloth mesh bags, two for each species for a total of four bags. The bags were placed inside four separate plastic pots, watered thoroughly, and covered with plant potting soil. The pots were buried outdoors approximately eight inches into the ground, and after three months the pots were removed. The achenes were separated from the substrate, fully imbibed, then placed in parafilm-sealed petri dishes containing the following treatments: 1) saturated filter paper (saturated with 4 mL of deionized water), 2) damp filter paper (saturated with 0.75 mL of deionized water), 3) wet sand, and 4) wet peat. Each petri dish contained 25 achenes. Petri dishes were placed in a growth chamber, on a 12/12 hour day/night

cycle at 35˚/20˚C. Two replicates of each of these treatments received either 24-hour fluorescent light or 24-hour darkness, for a total of 32 petri dishes. Percent germination was recorded 5 and 12 days after incubation.

Seed viability was tested on stratified and imbibed seeds of both species by using the TTC seed viability test (Cottrell, 1947). The compound 2,3,5-Triphenyltetrazolium chloride (TTC) induces a chemical reaction that turns living material pink. To determine seed viability, 75 embryos each of *Bidens discoidea* and *Bidens comosa* were dissected from the achenes, exposed to a 0.1% solution of TTC, and monitored for color changes. In addition, the achenes of both species were examined for morphological differences.

RESULTS

Field assessment

A total of 28 lakes were visited in northeastern Pennsylvania. *Bidens discoidea* was present at of 17 of these lakes and absent at 11, with population sizes ranging from 10 to 300 individuals (Table 1, Fig. 2). Mossy hummocks were the most common site in which the plant was found. Other common sites were fallen logs, stumps, and shorelines soils. The height of flowering individuals ranged from three inches to four feet, and the most common associates were *Bidens comosa, Bidens frondosa, Chamaedaphne calyculata var. angustifolia*, and species of moss (see Appendix A for a complete associates list). *Bidens discoidea* was not present at any of the 13 sites along the Delaware River.

Table 1: List of *Bidens discoidea* field sites examined, location, and populations sizes.

Location	*B. discoidea* present?	Number	Elev. (ft)	County	Latitude	Longitude
Along Delaware River*			various	Northampton, Bucks		
Behren Pond			1810	Luzerne	N41° 11.182'	W75° 47.776'
Duck Harbor Pond			1385	Wayne	N41° 45.207'	W75° 12.534'
Frances Slocum Lake			1080	Luzerne	N41° 19.860'	W75° 53.669'
Hickory Run Lake			1600	Carbon	N41° 2.587'	W75° 41.070'
Lake Greeley	no		1160	Pike	N41° 24.726'	W75° 1.590'
Lower Woods Pond			1415	Wayne	N41° 44.589'	W75° 16.373'
Sand Spring Lake			1500	Carbon	N41° 1.686'	W75° 41.156'
Unnamed Lake			1855	Luzerne	N41° 20.390'	W76° 13.800'
Tobyhanna Lake			1960	Monroe	N41° 12.331'	W75° 24.386'
Upper Woods Pond			1495	Wayne	N41° 45.619'	W75° 16.592'
Lake Warren			550	Bucks	N40° 541'	W75° 154'
Egypt Meadow Lake		10	1715	Pike	N41° 21.260'	W75° 11.749'
Fairview Lake		50	1530	Pike	N41° 23.892'	W75° 11.208'
Forest Lake		200	1254	Pike	N41° 24.376'	W75° 7.868'
Gouldsboro Lake		30	1900	Monroe	N41° 13.886'	W75° 27.356'
Lake Maskenozha		20	1200	Pike	N41° 11.317'	W74° 59.269'
Lake Minisink		150	1350	Pike	N41° 12.974'	W75° 3.169'
Lake Sylvan		30	1200	Luzerne	N41° 15.426'	W76° 9.316'
Lehman Lake		100	1190	Pike	N41° 10.817'	W74° 59.952'
Lily Lake		125	1024	Luzerne	N41° 8.525'	W76° 4.872'
Little Mud Pond	yes	100	1400	Pike	N41° 16.023'	W75° 0.624'
Lower Lake		5	1720	Pike	N41° 18.969'	W75° 13.227'
Miller Pond		300	1485	Wayne	N41° 43.348'	W75° 21.276'
Minks Pond		150	1250	Pike	N41° 12.223'	W74° 59.982'
Nuangola Lake		10	1165	Luzerne	N41° 9.555'	W75° 58.533'
Pecks Pond		50	1360	Pike	N41° 17.985'	W75° 5.273'
Promised Land Lake		50	1730	Pike	N41° 18.521'	W75° 11.787'
White Deer Lake		30	1485	Pike	N41° 24.304'	W75° 7.827'
Total estimate of plants:		1410				

*Sites along Delaware River examined: Sandts Edy Boat Access Area, Route 22 Bridge, Jay Snyder Memorial Park, Martins Creek Environmental Preserve Boat Access Area, Wy-hit-tuk Park, Theodore Roosevelt Recreation Area, Uhlerstown, Frye's Run, Riegelsville Acess Point (PA Fish and Boat Commission Access), Tinicum Park, and three other unnamed stop off points/scenic areas.

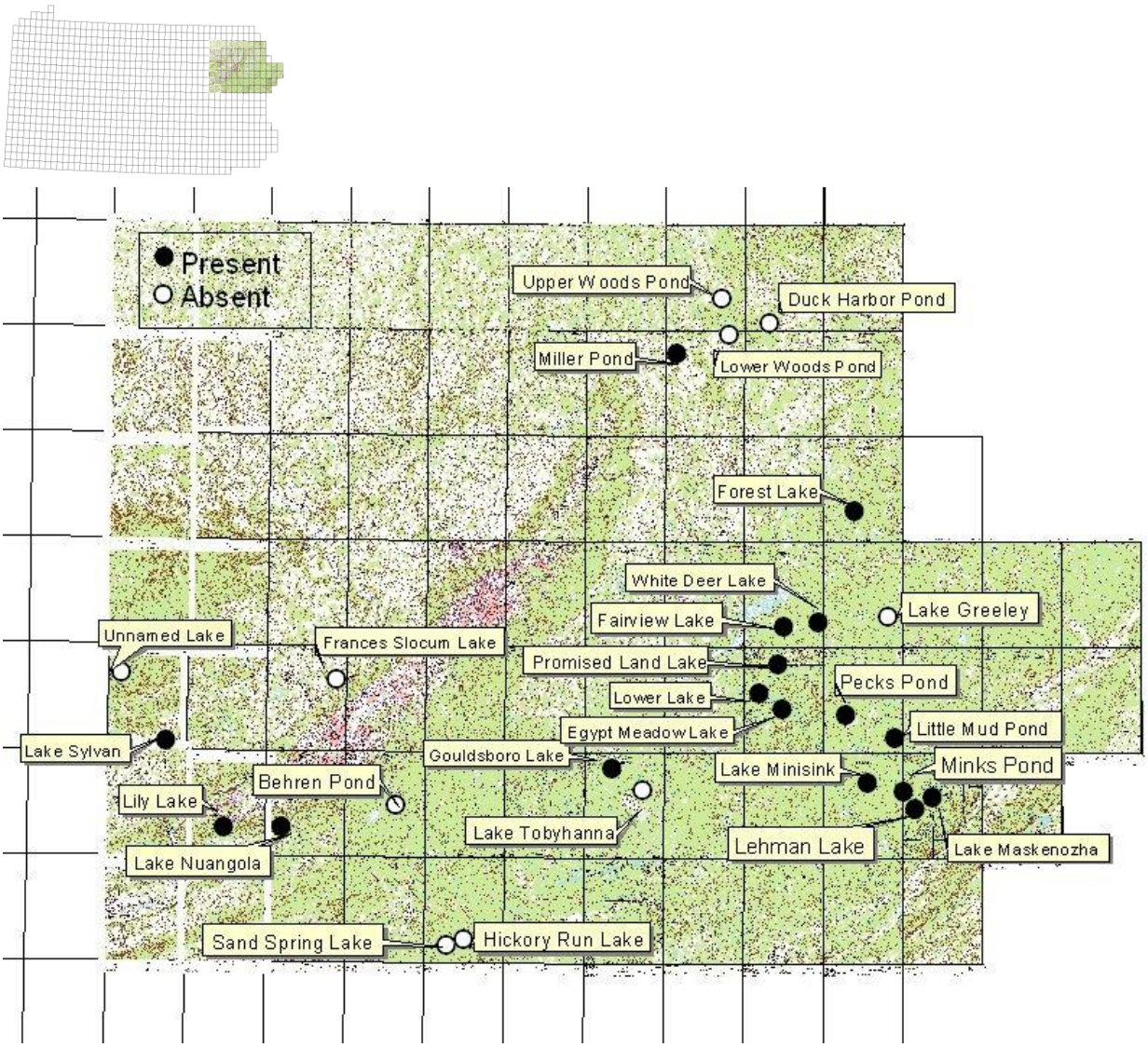

Figure 2: Sites surveyed for *Bidens discoidea*. Black circles indicate presence of *Bidens discoidea*, white circles indicate absence of the species.

Seed germination and viability

Bidens discoidea and *Bidens comosa* achenes were 92% and 91% viable, respectively. Both species germinated on all three substrates (saturated filter paper, sand, and peat) so long as the substrate was fully saturated (Fig. 3). Neither species germinated on the damp filter paper in the light condition, and both species had very low germination rates on the damp filter paper in the dark condition. Although *Bidens discoidea* and *Bidens comosa* achenes germinated under dark conditions, germination values for both species were higher in the light treatments (Fig. 3, 4). In every dark treatment, however, germination values for *Bidens comosa* were greater than those for *Bidens discoidea.*

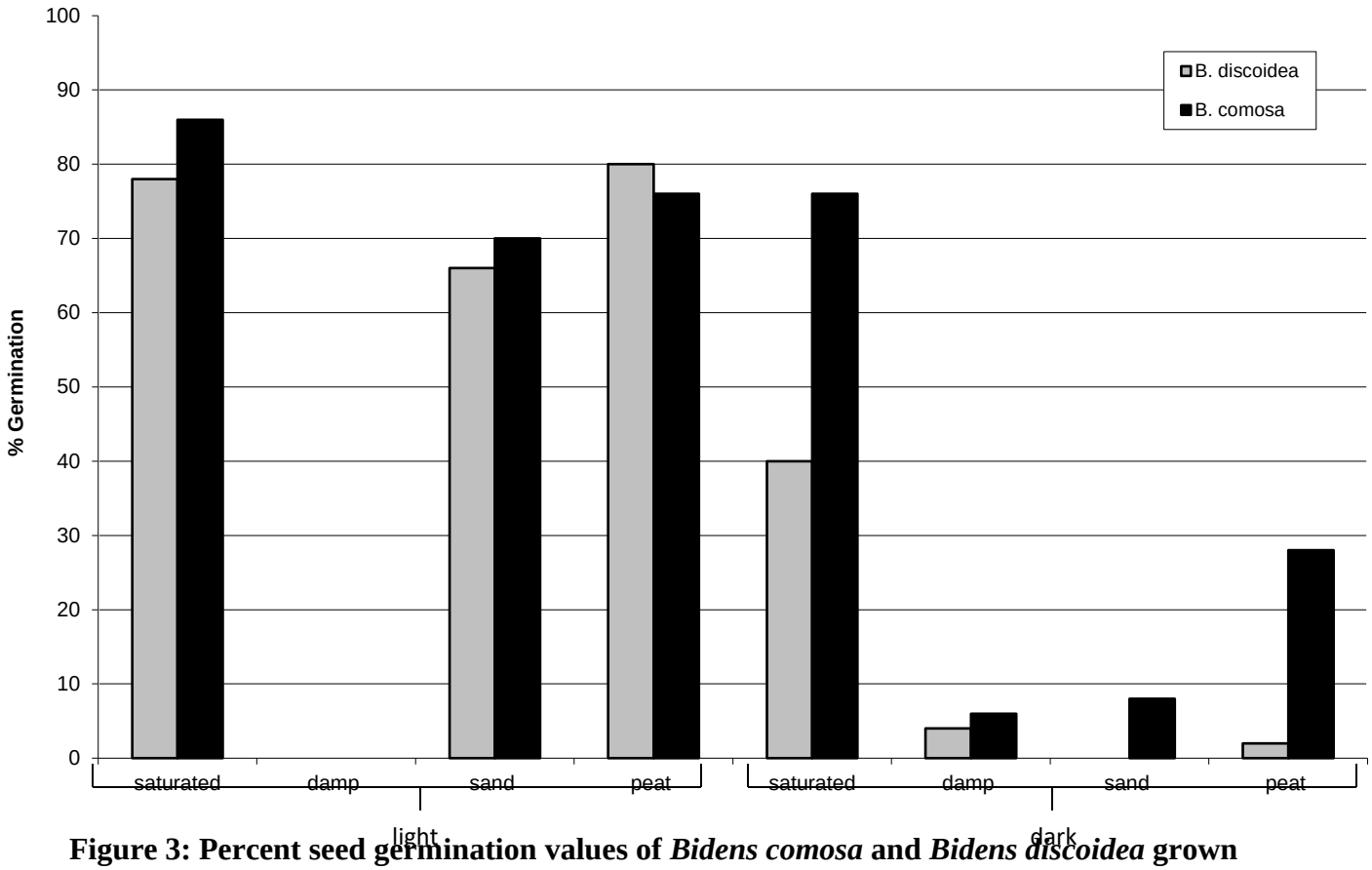

Figure 3: Percent seed germination values of *Bidens comosa* and *Bidens discoidea* grown in the dark or light on three different substrates. Saturated and damp refer to levels of water saturation on filter paper.

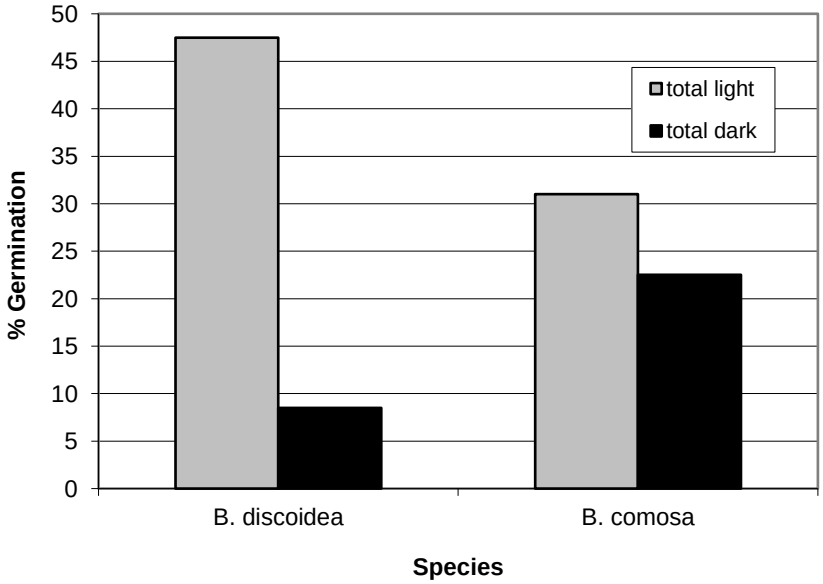

Figure 4: Average percent germination for four treatments for *Bidens discoidea* and *Bidens comosa* in total light and total darkness.

Achene morphology

The achenes of both species have awns, which bear barbs, an adaptation for dispersal (Ferren & Schuyler, 1980). *Bidens comosa* achenes are larger in size and have three awns with retrorse barbs, while *Bidens discoidea* achenes have two awns with antrorse barbs (Fig 5).

Figure 5: *Bidens discoidea* and *Bidens comosa* achenes. a) Comparison of the achenes of the two species. b) Silhouettes of each species. *B. comosa* barbs are retrorse; *B. comosa* barbs are antrorse.

DISCUSSION

Field assessment

In this project, the study area consisted of northeastern Pennsylvania lakes (Fig. 2), in addition to several sites along the Delaware River where previous specimens were collected. *Bidens discoidea* was known to occur in the glacial lakes of northern Pennsylvania (Rhoads & Block, 2000), and the lakes in the northeastern part of the state were favorable study sites due to their close proximity to Philadelphia.

The lack of occurrence of *Bidens discoidea* at a large percentage of the total sites visited was surprising. Of the 28 lakes surveyed, *Bidens discoidea* was found at 17 lakes and absent at 11 (Fig. 2, Table 1). At sites where the plant was present, population sizes ranged from as little as 5 plants per site to 300, although small populations in some cases reflect a very small area of the lake surveyed because of time constraints or limitations in visiting all areas of the lake (due to lack of sufficient boating equipment). The plant was most commonly found growing in lakes on fallen trees and mossy hummocks; it was also common growing along the lakeshore in cleared areas, such as adjacent to docks. The largest *Bidens discoidea* populations were found at Forest Lake (Pike County) and Miller Pond (Wayne County); these lakes both had a number of mossy hummocks present throughout the lake, and large marshy areas along the shoreline or lake interior.

At 10 of the 11 lakes where *Bidens discoidea* was not found, habitat appeared to be suitable, and many of the species that normally co-occur with the plant were present. The only exception was Sand Spring Lake, located in Carbon County, where no mossy hummocks or stumps existed in the lake interior and the shoreline was heavily shaded. At the other 10 sites, habitat did not differ in any apparent way from that of lakes where *Bidens discoidea* was found,

and at some lakes (e.g. Lake Greeley, Lower Woods Pond, Behren Pond) the habitat appeared to be very suitable for the plant due to the abundance of mossy hummocks and marshy areas. The sites where *Bidens discoidea* was found were not restricted geographically from the sites where the plant was absent, and no apparent differences in habitat existed to explain the lack of presence of *Bidens discoidea*. Elevation was not a factor in determining whether *Bidens discoidea* was present or not. It is possible that there are differences in soil and water chemistry between the sites where *Bidens discoidea* was present and absent, however these factors were not examined in this study, and would be favorable factors to investigate in future studies.

In addition to visiting lakes in northeastern Pennsylvania, 13 sites along the Delaware River were examined. Thomas Porter, a botanist in the late 19th century, collected several specimens of *Bidens discoidea* along the Delaware River between 1869 and 1899, but did not give specific collection locations other than counties (Bucks and Northampton) (Appendix B). These sites were revisited, and although habitat appeared to be appropriate and suitable for *Bidens discoidea* at several sites along the Delaware River Canal, and a number of associates were found, *Bidens discoidea* was not present at any of these 13 sites. Collections of the plant in the Bucks and Northampton County area have not occurred since 1932, with the exception of one collection in 1961. Thus, it is very likely that *Bidens discoidea* no longer exists along the Delaware River in the Easton area.

The lack of *Bidens discoidea* at each of these sites could be due to a number of factors, including habitat change, and significant changes in the abiotic and biotic components of the Delaware River over the past 100 years. Also, many of the sites visited in this study were shaded, and substrates consisted of large rocks. This is in contrast to the sites where *Bidens discoidea* was found in the northeastern lakes of Pennsylvania, where substrates were sand, peat, or shoreline soil, and plants were exposed to direct sunlight.

The absence of *Bidens discoidea* at the 10 lakes where the habitat appeared appropriate, and at all sites surveyed along the Delaware River and Canal, spurs questions about the degree of rarity of this plant. Plants listed on the Pennsylvania Plants of Special Concerns List, if not extirpated from the state, are designated in one of three categories described below (the numerical values assigned to each category serve only as general recommendations):

1) PE—Pennsylvania Endangered
   - in danger of extinction
   - 1-5 sites, < 5,000 individuals

2) PT—Pennsylvania Threatened
   - may become endangered
   - 6-20 sites, 5,000-10,000 individuals

3) PR—Pennsylvania Rare
   - uncommon, found in restricted geographic areas or low numbers
   - 21-50 sites, 10,000-100,000 individuals

Bidens discoidea presently has a proposed rare status, based primarily on herbarium records. When determining the status of a plant species, it is important to consider the total number of sites in the state, thus this number was formulated and determined to be 25. This number includes the 17 populations identified during this study, as well as eight additional populations determined from recent herbarium collections, as follows: Lake Paupack, 2003; Twin Lakes,

2002; Niagra Pond, 1999; Mean Hollow Ponds, 1998; Cranberry Pond Basin, 1998; Dollar Lake, 1998; SGL #213, 1998; and Rose Lake, 1995 (Appendix B).

Due to the small number of known sites existing in the state (25), the small populations sizes, in addition to the restricted geographical range of *Bidens discoidea* in the state, it is concluded that *Bidens discoidea*'s present proposed rare status is valid. Though visits to more lakes in northeastern Pennsylvania would strengthen this claim, the lack of explanation for the absence of this species in lakes with appropriate habitat as well as the elimination of populations along in the Delaware River area validate the claim that *Bidens discoidea* should be considered a rare plant in the state of Pennsylvania.

Seed germination and viability

Bidens discoidea achenes had high viability values (92%), and did not differ from those of *Bidens comosa* (91%), thus the rarity of *Bidens discoidea* does not appear to be due to low seed viability. Both species germinated on all three substrates (filter paper, peat, and sand), and did not show preferential germination on any one substrate (Fig. 3). However, germination values for both species on the damp filter paper were very low, compared to the saturated substrates, thus water appears to be a necessary requirement for both *Bidens discoidea* and *Bidens comosa*. These results support the hypothesis that water is necessary for germination for *Bidens discoidea,* a facultative wetland species (Rhoads & Block, 2000). When petri dishes were not kept saturated, i.e., when they were not watered daily, germinated seedlings of *Bidens discoidea* died rapidly, thus it is evident that a constant supply of water is required during the seedling stage.

Both species displayed higher germination values when exposed to light (Fig. 3, 4), however, *Bidens comosa* had higher percent germination values in the dark compared to *Bidens discoidea,* especially when grown on saturated filter paper. These physiological differences may have some relation to the difference in abundance of these two species in Pennsylvania. It is possible that the ability of *Bidens comosa* to germinate at lower light levels may allow a higher percentage of buried seedlings to germinate compared to *Bidens discoidea,* thereby conferring competitive advantage.

Achene morphology

The seeds of animal dispersed species are often highly specialized and have mechanisms for attachment onto the skin or fur of animals (Ferren & Schuyler, 1980). The achenes of *Bidens discoidea* and *Bidens comosa* both contain awns with pointy barbs that are thought to aid in dispersal, but they differ in several major ways. *Bidens discoidea* achenes have two awns with barbs that face upwards (antrorse barbs), while *Bidens comosa* achenes contain three awns that are reflexed inward at the tips, and have downward facing barbs (retrorse barbs) (Fig. 5).

These contrasts in morphology provide different advantages for each species. The downward facing barbs and reflexed achenes of *Bidens comosa* serve as tools for grasping onto a substrate and holding the achene in place, better adapting this species for attachment onto fur. In contrast, the antrorsely-barbed achenes of *Bidens discoidea* are not as well adapted for securing the achene to a substrate. Presumably, this achene morphology promotes dispersal by water and allows the achenes to follow receding water levels (Ferren & Schuyler, 1980), as the barbs face upward in relation to the bank. The presence of antrorsely-barbed awns, or the lack of barbs, is correlated with other local species occurring in habitats with fluctuation water levels, including the following intertidal zone species: *Zizania aquatica, Eleocharis obtuse* var. *peasei, Eleocharis olivacea* var. *reductiseta,* and *Schoenoplectus smithii* (Ferren & Schuyler, 1980). Two local

Bidens species that occur in habitats with fluctuation water levels are *Bidens frondosa* var. *anomala* and *Bidens bidentoides*; both have antrorsely-barbed awns.

The morphology of *Bidens discoidea* achenes, presumably better adapting the achene to reach moist substrates, renders the species less adapted for animal dispersal compared to the retrorsely-barbed achenes of *Bidens comosa*. This trade-off may be a factor in *Bidens discoidea*'s absence at lakes with suitable habitat located within several miles of other lakes colonized by the species.

Guidelines for protection and future studies

In order to maintain current *Bidens discoidea* populations and promote the occurrence of new sites, the following recommendations should be considered. First, a goal to maintain and preserve as much habitat in wetland areas and lakes in Pennsylvania should be established. Since the species is common along lakeside edges, paving for boat ramps down to the water's edge should be limited where *Bidens discoidea* is present, and the removal of stumps or hummocks for boating and recreation should be prohibited. In addition, the use of motor boats should be prohibited or limited where possible, since wave action can cause erosion, disrupting *Bidens discoidea* habitat and possibly killing young seedlings not fully established. Any act substantially reducing or increasing the water level of a lake should be prohibited, as this may reduce the number of plants germinating in the summer due to unfavorable seed bank locations.

Future studies examining a number of factors would shed more light on the biology of *Bidens discoidea* and reasons for its rarity, as well as yield a better understanding of ways to protect existing populations. A thorough study of water and soil biology at lakes where *Bidens discoidea* is found should be undertaken, as well as studies examining pollination ecology. Since *Bidens discoidea* is an annual, an important addition to this study would include yearly revisits to the sites where *Bidens discoidea* was present to monitor changes in populations. In addition, more thorough studies of seed germination requirements would be helpful in gaining a more complete understanding of the range of conditions necessary for germination and growth from seedlings to mature, flowering individuals.

CONCLUSION

In conclusion, this study revealed that there are only 25 known *Bidens discoidea* sites in the state of Pennsylvania, and an absence of sites where habitat appears to be appropriate. In addition, *Bidens discoidea* is found in restricted geographic areas in the state. For these reasons, *Bidens discoidea* should be officially listed on Pennsylvania's Plants of Special Concern list as a rare plant.

Seed germination and viability experiments revealed that *Bidens discoidea* seeds were 92% viable, and required light and constant moisture to germinate. The morphology of achenes seems to better adapt this species for dispersal by water rather than animals, a possible explanation for the lack of colonization at sites where habitat appears to be appropriate.

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LITERATURE CITED

Anonymous. Penn's Woods: *Sustaining our Forests.* Bureau of Forestry, Pennsylvania (undated).

Bryant, Peter. 2002. *Biodiversity and Conservation*. Hypertext book: http://darwin.bio.uci.edu/~sustain/bio65/. University of California, Irvine. Irvine, CA.

Cottrell, H. J. 1947. *Tetrazolium salt as a seed germination indicator*. Nature. 159: 748.

Endangered Species Act of 1973. 16 U.S.C.§§ 1531 et seq., available at <http://endangered.fws.gov/esa.html>

Ferren, Wayne R. and Schuyler, Alfred E. 1980. *Intertidal Vascular Plants of River Systems Near Philadelphia.* Proceedings of the Academy of Natural Sciences of Philadelphia. 132: 86-120.

Hickler, Matthew G. 1999. Notes on the Habitat and Life-History of Bidens discoidea: An Epiphyte in Massachusetts Floodplain Ponds. Rhodora. 101: 298-299.

Menges, Eric S. & Waller Donald M. 1983. *Plant Strategies in Relation to Elevation and Light in Floodplain Herbs.* The American Naturalist. 122: 451-460.

NatureServe Website. www.natureserve.com. Accessed 23 July 2003.

Rhoads, Ann F. and Block, Timothy A. 2000. *The Plants of Pennsylvania: An Illustrated Manual.* University of Pennsylvania Press, Philadelphia, PA.

Rhoads, Ann F and Klein, William M. 1993. *The Vascular Flora of Pennsylvania: Annotated Checklist and Atlas.* American Philosophical Society, Philadelphia, PA.

Thompson, Sue A. 2002. *Biodiversity in Pennsylvania: Snapshot 2002*. Pennsylvania Biodiversity Partnership, Pittsburgh, PA.

Wild Resources Conservation Act. 1982. 17 PA Code § 45.

APPENDIX A

Bidens discoidea associates list

Species	Common name	Family
Onoclea sensibilis	Sensitive fern	(Fern)
Osmunda cinnamomea	Cinnamon fern	(Fern)
Osmunda regalis	Royal fern	(Fern)
Thelypteris palustris	Marsh fern	(Fern)
Acer rubrum	Red maple	Aceraceae
Sagittaria latifolia	Duck-potato	Alismataceae
Toxicodendron vernix	Poison sumac	Anacardiaceae
Cicuta bulbifera	Water-hemlock	Apiaceae
Peltandra virginica	Arrow-arum	Araceae
Aster praealtus?	Aster	Asteraceae
Bidens bipinnata	Spanish needles	Asteraceae
Bidens cernua	Bur-marigold	Asteraceae
Bidens comosa	Beggar-ticks	Asteraceae
Bidens frondosa	Beggar-ticks	Asteraceae
Erechtites hieraciifolia	Fireweed	Asteraceae
Euthamia graminifolia	Grass-leaved goldenrod	Asteraceae
Impatiens carpensis	Jewelweed	Balsaminaceae
Betula populifolia	Gray birch	Betulaceae
Brasenia schreberi	Watershield	Cabombaceae
Sambucus canadensis	American elder	Caprifoliaceae
Viburnum recognitum	Northern arrow-wood	Caprifoliaceae
Hypericum mutilum	Dwarf St. John's-wort	Clusiaceae
Triadenum virginicum	Marsh St. John's-wort	Clusiaceae
Cornus amomum	Kinnikinik	Cornaceae
Carex canescens	Silvery sedge	Cyperaceae
Carex stricta	Tussock sedge	Cyperaceae
Eleocharis acicularis	Needle spike-rush	Cyperaceae
Eleocharis olivacia	Capitate spike-rush	Cyperaceae
Rhynchospora alba	White beak-rush	Cyperaceae
Drosera rotundifolia	Round-leaved sundew	Droseraceae
Chamaedaphne calyculata var. angustifolia	Leatherleaf	Ericaceae
Kalmia angustifolia	Sheep laurel	Ericaceae
Lyonia ligustrina	Maleberry	Ericaceae
Rhododendron viscosum	Swamp azalea	Ericaceae
Vaccinium corymbosum	Highbush blueberry	Ericaceae
Vaccinium macrocarpon	Cranberry	Ericaceae
Eriocaulon decangulare	Ten-angle pipewort	Eriocaulaceae
Apios americana	Groundnut	Fabaceae
Iris versicolor	Northern Blue flag	Iridaceae
Juncus pelocarpus	Brown-fruited rush	Juncaceae
Lycopus virginicus	Bugleweed	Lamiaceae
Scutellaria lateriflora	Mad-dog skullcap	Lamiaceae

Scutellaria galericulata	Common scullcap	Lamiaceae
Utricularia macrorhiza	Common bladderwort	Lentibulariaceae
Utricularia minor	Lesser bladderwort	Lentibulariaceae
Decodon verticillatus	Water-willow	Lythraceae
Comptonia peregrina	Sweetfern	Myricaceae
Nuphar lutea	Spadderdock	Nymphaeaceae
Nymphaea odorata	Fragrant water-lily	Nymphaeaceae
Ludwigia palustris	Marsh-purslane	Onagraceae
Oxalis stricta	Common yellow wood-sorrel	Oxalidaceae
Agrostis spp.	Bentgrass	Poaceae
Calamagrostis canadensis	Canada bluejoint	Poaceae
Leersia oryzoides	Rice cutgrass	Poaceae
Microstegium vimineum	Stiltgrass	Poaceae
Polygonum amphibium	Water smartweed	Polygonaceae
Polygonum hydropiperoides	Water smartweed	Polygonaceae
Polygonum sagittatum	Tearthumb	Polygonaceae
Pontederia cordata	Pickerel-weed	Pontederiaceae
Lysimachia terrestris	Swamp-candles	Primulaceae
Rosa palustrus	Swamp rose	Roaaceae
Potentilla palustris	Marsh cinquefoil	Rosaceae
Spiraea latifolia	Meadow-sweet	Rosaceae
Spiraea tomentosa	Hardhack	Rosaceae
Cephalanthus occidentalis	Buttonbush	Rubiaceae
Galium tinctorium	Bedstraw	Rubiaceae
Linaria vulgaris	Butter-and-eggs	Scrophulariaceae
Sparganium spp.	Bur-reed	Sparganiaceae
Typha latifolia	Common cat-tail	Typhaceae
Boehmeria cylindrica	False nettle	Urticaceae
Viola sororia	Common blue violet	Violaceae
Parthenocissus quinquefolia	Virginia-creeper	Vitaceae
Xyris montana	Yellow-eyed-grass	Xyridaceae

Appendix B—historical records of *Bidens discoidea*

Month	Day	Year	Collector Name	Coll. #	County	Location	Ancillary Location	Herb.	Acces.#	Lat.	Long.
7		1869	Garber, A.P.		Northampton	Near Easton		PH			
9		1869	Garber, A.P.		Northampton	Vicinity of Easton					
9	11	1869	Porter, T.C.	s.n.	Northampton	Above Easton	Banks of the Delaware	CM	100017	40.68833333	-75.22111111
9	16	1869	Porter, T.C.		Northampton	Above Easton	On the Delaware	PH			
9	16	1869	Porter, T.C.		Northampton	Near Easton	Pot Rock				
9	27	1869	Porter, T.C.		Northampton	Above Easton	On the Delaware	PH			
9	27	1875	Porter, T.C.		Northampton	Above Easton	On the Delaware	PH			
8	26	1878	Guttenberg, G.	s.n.	Erie	Presque Isle		CM	100015	42.16305556	-80.10138889
8	27	1879	Miller, J	s.n.	Erie	Presque Isle		CM	169554	42.16305556	-80.10138889
9	14	1886	Fretz, C.D.		Bucks	Bristol		PH			
10	1	1886	Porter, T.C.		Northampton	Above Easton	Shore of the Delaware				
9	1	1894	Porter, T.C.		Northampton	Easton		PH			
9	12	1894	Crawford, J.		Bucks	Tullytown/Penn Valley		PH	504614		
9	7	1899	Porter, T.C	s.n.	Northampton	Easton	Pot Rock, on the Delaware, above	CM	100016	40.68833333	-75.22111111
9	5	1899	Porter, T.C.		Northampton	Above Easton		PH			
9	23	1917	Bartram, E.B.		Pike	Lake Maskenozha		PH	648413		
8	14	1923	Long, B.	28722	Bucks	Lumberville		PH			
10	4	1931	Wilkens, H.	1300	Berks	3/4 mile SE of Fleetwood		PH			
10	3	1931	Long, B.	35645	Bucks	1.5 miles E of Oxford Valley		PH			
9	24	1932	Long, B.	38562	Bucks	Eddington		PH			
9	13	1939	Wahl, H.A.	486	Susquehanna	2 miles N of West Auburn		PH			
9	19	1943	Berkheimer, D.	4330	Berks	Seyfert	0.37 mi SE; {alt 220 ft}	CM	100014	40.28833333	-75.88388889
9	19	1943	Berkheimer, D.	4330	Berks	3/8 mile SE of Seyfert		PH			
9	4	1943	Long, B.		Montgomery	West Manayunk	Moist sandy cobbly shore of Schuylkill River	PH			
9	5	1943	Long, B.	60175	Montgomery	West Manayunk	Moist sandy cobbly shore of Schuylkill River	PH	955927		
9	3	1946	Glowenke, S.L.	8965	Luzerne	Nuangola Lake		PH			
10	9	1948	Berkheimer, D.		Bedford	Swale	1 3/8 miles NNE of Manns Choice	PH			
9	16	1948	Berkheimer, D.		Bedford	Swale	3/8 mile SW of Younts Station. Alt.: 1075 ft.	PH			
9	15	1951	Henry, L.K.; Buker, W.E.	s.n.	Bedford	Bedford	Younts, NNE	CM	100013	40.01861111	-78.50416667
8	31	1960	Wherry, E.T.		Pike	Twin Lakes		PH			
8	24	1961	Long, B.	87718	Bucks	1 mile N of Uhlerstown	Sandy cobbly shore of Delaware River	PH	955875		
9	18	1962	Berkheimer, D.		Bedford		Border of dam, 3 3/8 miles S of Centerville	PH			
9	0	1984	Klemow, K.		Luzerne	Nuangola Lake	Bog	WILK		41.15888889	-75.97388889
8	24	1985	Klotz, L.H.	1274	Franklin	Mountain Run Ponds		SHIP		39.95833333	-77.54166667
9	21	1985	Grisez, T.J.	956	Erie	Presque Isle State Park	Trail off S side of Peninsula Dr	CM	319212	42.16305556	-80.10111111
8	25	1986	Klotz, L.H.	1530	Franklin	Mount Cydonia Ponds		SHIP		39.89166667	-77.53333333
9	27	1987	Klotz, L.H.	1578	Franklin	Mount Cydonia Ponds	W of Irishtown Rd N of junction Kettle Spr Rd	SHIP		39.89166667	-77.53333333
9	23	1989	Bissell, J.K.; et al.	89:356	Erie	Presque Isle State Park	N shore of Ridge Pond	CLM	026939	42.16305556	-80.10111111
9	3	1995	Isaac, B.L.; Issac, J.A.		Potter	Rose Lake		CM			
9	4	1998	Bissell, J.K.		Crawford	SGL #213		CLM			
9	4	1998	Bissell, J.K.		Crawford	Near Dollar Lake		CLM			

Month	Day	Year	Collector Name	Coll. #	County	Location	Ancillary Location	Herb.	Acces.#	Lat.	Long.
11	1	1998	Klotz, L.H.		Cumberland	Mean Hollow Ponds					
8	20	1999	Bissell, J.K.; et al.		Erie	Cranberry Pond Basin	Presque Isle State Park	CLM			
9	24	1999	Bissell, J.K.; et al.		Erie	Niagra Pond	Presque Isle State Park	CLM			
8	16	2000	Rhoads, A.F. & Block, T.A.	s.n.	Pike	Egypt Meadows Lake	Palmyra Township	MOAR		41.35278417	-75.19657611
8	17	2000	Rhoads, A.F. & Block, T.A.	s.n.	Pike	White Deer Lake	Blooming GroveTownship	MOAR		41.40544333	-75.13084444
8	16	2000	Rhoads, A.F.; et al.		Pike	Egypt Meadows Lake		MOAR			
8	27	2002	Rhoads, A. F.; Block, T.A.	s.n.	Pike	Forest Lake		MOAR		41.53	-75.07333
8	27	2002	Rhoads, A. F.; Block, T.A.	s.n.	Pike	Twin Lakes	Small lake	MOAR		41.38639	-74.90444
8	12	2003	Rhoads, A. F.; Block, T.A.	s.n.	Pike	Lake Paupack		MOAR		41.31972	-75.26556
9	9	2003	Rhoads, A. F.; Block, T.A.	s.n.	Pike	Lake Maskenozha		MOAR		41.18333	-74.99694
9	10	2003	Rhoads, A. F.; Block, T.A.	s.n.	Pike	Pecks Pond		MOAR		41.28083	-75.08722
9	10	2003	Rhoads, A. F.; Block, T.A.	s.n.	Pike	Forest Lake		MOAR		41.535	-75.07694
9	10	2003	Rhoads, A. F.; Block, T.A.	s.n.	Pike	Forest Lake		MOAR		41.53	-75.07333
9	9	2003	Rhoads, A. F.; Block, T.A.	s.n.	Pike	Lehman Lake		MOAR		41.17722	-75.0025
9	9	2003	Rhoads, A. F.; Block, T.A.	s.n.	Pike	Minks Pond		MOAR		41.19917	-74.99611
9	9	2003	Rhoads, A. F.; Block, T.A.	s.n.	Pike	Minks Pond		MOAR		41.19917	-74.99611
9	15	2003	Petzold, JL	0304	Pike	Pecks Pond	~15 miles WSW of Milford	MOAR		41.28083	-75.08722
9	15	2003	Petzold, JL	0303	Pike	Egypt Meadow Lake	~4 miles east of S tip of Lake Wallenpaupack	MOAR		41.35611	-75.19528
9	15	2003	Petzold, JL	0305	Pike	Little Mud Pond	~3.7 miles southeast of Pecks Pond	MOAR		41.26667	-75.01083
9	10	2003	Petzold, JL	0307	Pike	Forest Lake	~7.5 miles NE of N tip of Lake Wallenpaupack	MOAR		41.535	-75.07694
9	10	2003	Petzold, JL	0308	Pike	Forest Lake	~7.5 miles NE of N tip of Lake Wallenpaupack	MOAR		41.535	-75.07694
9	10	2003	Petzold, JL	0309	Pike	White Deer Lake	~5.5 miles east of Lake Wallenpaupack	MOAR		41.40333	-75.13111
9	10	2003	Petzold, JL	0310	Pike	White Deer Lake	~5.5 miles east of Lake Wallenpaupack	MOAR		41.40333	-75.13111
9	9	2003	Petzold, JL	0311	Pike	Lehman Lake	~17 miles northeast of East Stroudsburg	MOAR		41.17722	-75.0025
9	9	2003	Petzold, JL	0313	Pike	Lehman Lake	~17 miles northeast of East Stroudsburg	MOAR		41.17722	-75.0025
9	9	2003	Petzold, JL	0314	Pike	Minks Pond	~17.3 miles northeast of East Stroudsburg	MOAR		41.19917	-74.99611
9	9	2003	Petzold, JL	0315	Pike	Minks Pond	~17.3 miles northeast of East Stroudsburg	MOAR		41.19917	-74.99611
9	20	2003	Petzold, JL	0316	Monroe	Gouldsboro Lake	~4 miles northeast of Tobyhanna	MOAR		41.23027778	-75.45638889
9	16	2003	Petzold, JL	0318	Luzerne	Nuangola Lake	Nuangola	MOAR		41.15889	-75.97389
9	16	2003	Petzold, JL	0319	Luzerne	Lily Lake	~2.2 miles south Glen Lyon Township	MOAR		41.14222	-76.08167
9	16	2003	Petzold, JL	0320	Luzerne	Lily Lake	~2.2 miles south Glen Lyon Township	MOAR		41.14222	-76.08167
10	1	2003	Petzold, JL	0323	Wayne	Miller Pond	~20 miles NNE of Lake Wallenpaupack	MOAR		41.7225	-75.35556
10	1	2003	Petzold, JL	0351	Wayne	Miller Pond	~20 miles NNE of Lake Wallenpaupack	MOAR		41.7225	-75.35556
10	1	2003	Petzold, JL	0325	Wayne	Miller Pond	~20 miles NNE of Lake Wallenpaupack	MOAR		41.7225	-75.35556
9	30	2003	Petzold, JL	0339	Pike	Promised Land Lake	Promised Land State Park	MOAR		41.31806	-75.20944
9	30	2003	Petzold, JL	0340	Pike	Promised Land Lake	Promised Land State Park	MOAR		41.31806	-75.20944
9	30	2003	Petzold, JL	0341	Chester	Lower Lake	Promised Land State Park	MOAR		39.98	-75.61
9	30	2003	Petzold, JL	0342	Pike	Fairview Lake	~3 miles East of Lake Wallenpaupack	MOAR		41.39944	-75.18639
10	7	2003	Petzold, JL	0343	Luzerne	Sylvan Lake	~3 miles SSW of Sweet Valley township	MOAR		41.25917	-76.15556
10	7	2003	Petzold, JL	0348	Luzerne	Sylvan Lake	~3 miles SSW of Sweet Valley township	MOAR		41.25917	-76.15556
9	15	2003	Petzold, JL	0353	Pike	Lake Minisink	1.6 miles SE of Old Bushkill Rd/Rt 402 intersct.	MOAR		41.21583333	-75.05333333
					Bedford	Centerville		ATLAS		39.82944444	-78.65

Month	Day	Year	Collector Name	Coll. #	County	Location	Ancillary Location	Herb.	Acces.#	Lat.	Long.
					Bedford	Manns Choice		ATLAS		40.0025	-78.59138889
					Bedford	Yount Station		ATLAS		40.225	-78.475
					Berks	Fleetwood		ATLAS		40.45388889	-75.81833333
					Berks	Gibraltar		ATLAS		40.28416667	-75.87222222
					Berks	Reading		ATLAS		40.33555556	-75.92722222
					Berks	Seyfert		ATLAS		40.28833333	-75.88388889
					Bucks	Bristol		ATLAS		40.10055556	-74.85222222
					Bucks	Eddington		ATLAS		40.08444444	-74.94527778
					Bucks	Lumberville	To NJ body	ATLAS		40.40666667	-75.03833333
					Bucks	Oxford Valley		ATLAS		40.18111111	-74.86666667
					Bucks	Penn Valley		ATLAS		40.17972222	-74.79638889
					Erie	Presque Isle		ATLAS		42.16305556	-80.10138889
					Luzerne	Lily Lake	(Long Pond)	ATLAS		41.14222222	-76.08166667
					Luzerne	Nuangola		ATLAS		41.155	-75.97861111
					Luzerne	Orange		ATLAS		41.38861111	-75.89388889
					Northampton	Easton		ATLAS		40.68833333	-75.22111111
					Pike	Lake Maskenozha		ATLAS		41.19166667	-74.99166667
					Pike	Twin Lakes		ATLAS		41.39166667	-74.9
					Susquehanna	West Auburn	To Bradford body	ATLAS		41.72027778	-76.10666667