Appendix A
Techniques to Locate Seasonal Pools

Locating and mapping seasonal pools should be a conservation priority because an inventory of seasonal pool distribution and status is currently unavailable in the mid-Atlantic region. Appendix A gives an overview of techniques that can be used to locate seasonal pools, and points the reader to sources of additional information.

Step 1: Pre-Identification Techniques

The following methods are considered "pre-identification" techniques because they locate potential seasonal pools. These potential pools need to be verified to ascertain that they are indeed seasonal pools (see Step 2).

Aerial Photography

Description: Aerial photography is an unobtrusive method for locating landscape features, such as potential vernal pools, across a large geographic area (Stone, 1992; Jensen, 2000). Seasonal pool identification will be easiest if the photograph is taken during a relatively wet year in late fall, winter, or early spring when deciduous leaves are not on the trees and there is no snow. Larger-scale photographs are better suited for identifying seasonal pools. For example, photos at a scale of 1:4,800 (or 1 inch = 400 feet) are better than photos at a scale of 1:12,000 (or 1 inch = 1000 ft) for correctly identifying seasonal pools (Calhoun et al., 2003). Scales of at least 1:12,000 to 1:4,800 are necessary to identify potential seasonal pools.

Notes: Color infrared (CIR) or black and white film can be used for the aerial photographs (Plate 4-1). CIR is more useful because it highlights the presence of water. On CIR photos, pools appear black because water absorbs color infrared light, contrasting with lighter-colored vegetated areas (pink, orange, yellow). Compared to black and white, CIR film provides better differentiation between tree shadows and small pools, discrimination of depth and permanence of water, detection of pools under dense canopies, and differentiation of land-cover types (Stone, 1992).

The use of black and white aerial photography, though not as consistent and accurate as CIR, is also a valuable tool (and significantly less expensive than CIR). On black and white aerials, pools appear black, though they may also appear in various shades of gray if dominated by vegetation.

Utilizing stereoscopic sets of photographs (viewed with a stereoscope) allows analysis of the landscape in three-dimensions (Jensen, 2000). This technique greatly improves finding seasonal pools and depressions (Calhoun, 2003). Stereoscopes used in previous seasonal pool studies include a 2X pocket stereoscope and a mirror stereoscope (Stone, 1992; Pawlak, 1998). In a study in Massachusetts, 52% of potential vernal pools identified from 1:4,800 black and white photographs, using a 2X pocket stereoscope, were determined to fit the physical description of vernal pools (isolated depressions that hold water for two continuous months) after a field survey (Stone, 1992). In a study in deciduous forests of Maine, 93% of potential vernal pools identified from 1:4,800 scale black and white photographs, using panchromatic stereophotos, were determined to be actual vernal pools after a field survey (Calhoun et al., 2003).

A digital orthophoto quadrangle (DOQ) or quarter-quadrangle (DOQQ) is a computer-generated image of an aerial photograph which has been orthorectified (i.e., altered so that it has the geometric properties of a map) to allow accurate measurements of ground distance on the photos.

This ensures that the photos can be used with automated mapping and Geographic Information System (GIS) software along with other digital cartographic data.

Regardless of film types used, having assistance from someone with photo-interpretation training and experience with local ecology will greatly enhance the success of pre-identification aerial photography (Stone, 1992).

Challenges: Because seasonal pools are typically small, they may be difficult to identify on aerial photos (Tiner, 1990; DiMauro and Hunter, 2002). There are challenges to using aerial photographs: 1) available aerial photographs may be out of date or incomplete and scheduling a fly-over for new aerial photographs is very costly; 2) pools located under dense coniferous, deciduous or mixed canopy cover may be very difficult to pick out; 3) shadows of trees can obscure pools or be mistaken for pools; 4) clusters of conifers on black and white photos often show up as dark spots that look like pools; and 5) small pools are less likely to be identified compared to large pools (Stone, 1992; Calhoun et al., 2003).

Additional Resources: Burne (2001) provides detailed guidance on using aerial photographs to identify potential seasonal pools. Aerial photographs are typically available from federal, state, or county sources, or off the web (e.g., **USGS:** *http://geography.usgs.gov*, **USDA:** *http://www.nrcs.usda.gov/technical/maps.html*).

U.S. Geological Survey Topographic Maps

Description: The U.S. Geological Survey (USGS) produces topographic (topo) maps at a 1:24,000 scale (or 1 inch = 2000 feet), commonly known as 7.5-minute quadrangle maps. These maps utilize contour lines to convey the three-dimensional landscape on a two-dimensional map. Both natural and man-made features are shown on these maps.

Notes: On topo maps, seasonal pools may be associated with or identified by contours designating depressions, wet spot symbols, and small ponds. Concentrations of these features indicate particularly good areas to search for seasonal pools.

Challenges: Because seasonal pools tend to be small in size, only contain water for part of the year, and may be difficult to assess outside of a wet season, they often do not feature on USGS topo maps (Williams, 1987).

Additional Resources: Topographic maps can be purchased from outdoor equipment stores and bookstores or can be ordered from the USGS (*http://geography.usgs.gov*).

U.S. Fish & Wildlife Service National Wetland Inventory Maps

Description: The U.S. Fish and Wildlife Service began developing a series of topical maps of the United States' water resources in 1974 as part of a National Wetland Inventory (NWI) based on a wetland classification system developed by Cowardin et al. (1979) (NWI 2002).

Notes: On NWI maps, areas where seasonal pools are likely to be found can be identified by looking for: 1) wetlands not connected to streams or lakes, 2) wetland classes that are hydrologically isolated, including ponds (PUB (palustrine unconsolidated bottom), POW (palustrine open water)), marshes (PEM (palustrine emergent), PAB (palustrine aquatic bed)), wet meadows (PEM (palustrine emergent)), shrub swamps (PSS (palustrine scrub shrub)) or forested wetlands (PFO (palustrine forested)). In some cases, as on the USGS topo maps, large seasonal pools may be identified on NWI maps as ponds.

Challenges: Only forested wetlands greater than approximately 0.5 – 1.2 ha in size and unforested wetland areas greater than 0.4 ha in size are shown on NWI maps; most seasonal pools are smaller than these sizes and thus will be difficult to detect (Tiner, 1990; DiMauro and Hunter, 2002; Tiner, 2003a, b). NWI maps should not be the only source used to locate potential seasonal pools because they will disproportionately locate the largest pools.

Additional Resources: Full descriptions and definitions of NWI wetland codes (e.g., PFO1A) can be obtained on the NWI website (*http://www.nwi.fws.gov/mapcodes.htm*). Many NWI maps are now available in digital format for public use. A mapping tool called the Wetlands Mapper is offered by the U.S. Fish and Wildlife Service, which allows the user to produce customized maps (*http://wetlandsfws.er.usgs.gov*). Hard copies of NWI maps can be purchased from Cooperator-Run Distribution Centers (*http://wetlands.fws.gov/distribution_ctrs.htm*).

Step 2: Verification

Ground-truthing

Description: Ground-truthing (field surveying), the practice of surveying the land on foot, is essential for validating the presence of a seasonal pool. Ground-truthing is always required to verify whether what you have identified as a potential seasonal pool using an aerial photograph or map is indeed a seasonal pool. Additional pools not previously identified using aerial photographs or maps may be discovered during ground-truthing of potential pools. Ground-truthing can reveal as many as 25% more pools than identified from aerial photographs alone (Calhoun et al., 2003). In a study in Massachusetts, 79% of pools discovered in field surveys that were missed from aerial photographs were within 25 meters of other photo-selected pools (Stone, 1992).

Notes: Once having identified a potential seasonal pool on an aerial photograph, their location should be transferred onto maps to aid in field location (Stone, 1992). Photo-identified seasonal pools should be verified in the field early in the process, which can allow the photo-interpreter to correct or adjust the "search image" or "pool signature" to the conditions of the date and type of aerial photo used (Stone, 1992).

Alternative Techniques:

Systematic Ground-truthing

Description: Ground-truthing has been used to cover areas systematically.

Notes: Stone (1992) searched 201 m long by 20 m wide strip plots selected from a grid array using a stratified random design. DiMauro and Hunter (2002) and Calhoun et al. (2003) used 1200 m stratified random transects (500 m one direction, 200 m at 90 degree turn, 500 m at another 90 degree turn) within 1 km^2 grid squares to ascertain density and characteristics of pools not identified on aerial photographs or NWI maps. Because seasonal pools may be clustered in the landscape, ARMI-NE used an adaptive cluster sampling approach to survey for vernal pools at National Parks (Delaware Water Gap National Recreation Area, Gettysburg National Historic Park, Rock Creek Park, Shenandoah National Park) and National Wildlife Refuges (Canaan Valley, Erie, Great Swamp, Patuxent, Wallkill River) in the mid-Atlantic region. A systematic grid of points set 500 m apart was established on each Park or Refuge and sets of 20 points were randomly selected for survey. After navigating to a point, a 50 m^2 plot around that point was searched for seasonal pools. If no pools were found, the surveyor went to the next point. If pools were found, an adaptive cluster sampling approach was adopted, in which additional 50 m^2 plots adjacent to plots with vernal pools were surveyed, ad infinitum.

GIS-Modeling

Description: Several states and studies have used GIS technology to model the locations of vernal pools across the landscape.

Notes: In New Jersey, the Rutgers University Center for Remote Sensing & Spatial Analysis is using on-screen digitizing, image processing, and GIS coverages including freshwater wetlands, soil type, land use-land cover, digital elevation models, and color infrared digital orthophotography to identify likely areas of vernal pool occurrence. Once areas are identified using GIS, image interpretation and fieldwork were used to verify actual vernal pool occurrence in the Highlands, Pinelands, and Delaware Bayshore landscape regions (*http://www.dbcrssa.rutgers.edu/ims/vernal*). In Massachusetts, Grant (2005) used modeling approaches and found that certain landscape features such as land use, surficial geology, and topography could predict the occurrence of a seasonal pool. Stone (1992) found that the presence and amount of forest cover surrounding a pool, elevation, and surficial geology (glaciolacustrine lake bottom deposits) were characteristics useful in identifying areas with a high potential for supporting seasonal pools with indicator species.

Appendix B
Techniques to Monitor Seasonal Pools

This appendix outlines techniques that may be used to document a pool's location and to record what animals are using the pool. As highlighted in this manual, seasonal pools are a valuable resource, but their distribution is poorly recorded for the mid-Atlantic region. Information on their distribution and the species they support may be incorporated into a monitoring program or database. New Jersey currently has the only formal statewide program for seasonal pool documentation and certification in the mid-Atlantic region; their requirements for documentation are referred to among the techniques. For precise requirements of the New Jersey Department of Environmental Protection Land Use Regulation Program "vernal habitat," refer to the Freshwater Wetlands Vernal Habitat Protocol (*http://www.state.nj.us/dep/landuse/forms/vernalpr.doc or http://www.state.nj.us/dep/landuse/fww/vernal/index.html*).

Documenting the Location of a Seasonal Pool

Note: New Jersey requires 1) a metes and bounds description, aerial photograph, professional survey, or GPS coordinates; 2) a symbol on a standard map (USGS topo) to show the pool's location; and 3) a sketch map/written description.

Metes and Bounds Description
Provide written directions for locating the pool; include compass bearings and accurate measured distances (of 1000 feet or less) from at least two permanent landmarks. Also include distinctive permanent landmarks along the path of travel.

Aerial Photograph
If an aerial photograph is available on which the seasonal pool is clearly visible, highlight its location.

GPS Coordinates
Use a global positioning system (GPS) receiver and record UTM (Universal Transverse Mercator) or latitude and longitude coordinates along with an estimated position error.

Symbol on Standard Map
Mark the pool's location and two permanent landmarks on a photocopy of an 8.5" by 11" section of a USGS topographical map, a tax assessor's map, or a NWI map. Make sure that the map has all the information on it (e.g., quadrangle name, map scale) necessary to relocate the pool.

Sketch Map
Draw the pool relative to at least two permanent landmarks; include distances and compass bearings.

Photograph of the Pool
Take photographs of the pool in its landscape setting to aid relocation of the site and to document the pool's surroundings and hydroperiod at the time. Note the pool location, day and time of the photo, and the direction of the photo.

Finding and Documenting Indicator Species

It is difficult to estimate the population sizes of seasonal pool animals. Except during their brief and weather-dependent breeding seasons, adult pool-breeding amphibians are rarely observed above ground. During winter, adult amphibians hibernate beneath the leaf litter or in small mammal burrows, and thus appear absent from the surrounding landscape (Madison, 1997; Faccio, 2003). If breeding does occur, developing amphibians and invertebrates may be observed in the pool from late winter until they metamorphose or the pool dries out.

Note: To meet the "required field observations for certifying a vernal habitat" in New Jersey, obligate (indicator) or facultative species must be either 1) photographed, 2) videotaped, 3) audio recorded (in the case of frog and toad calling), or 4) described in writing.

Prractices to Prevent Negative Impacts to Pool Inhabitants

Handling of fauna should be avoided unless absolutely necessary for identification and photodocumentation (Box B-1). Handling amphibians presents challenges. Improper handing of amphibians may cause skin damage that could lead to secondary infections or may create bone and muscle injuries (Green, 2001). For detailed information on handling amphibians, refer to the USGS National Wildlife Health Center's Standard Operating Procedure (*http://www.nwhc.usgs.gov/research/amph_dc/sop_restraint.html*). Another major concern is the spread of disease-causing agents such as fungi, bacteria, and viruses between pools or animals. For more information on practices to prevent the spread of amphibian diseases, refer to The Declining Amphibian Population Task Force (DAPTF) Fieldwork Code of Practice (*http://ventura.fws.gov/es/protocols/dafta.pdf*).

Box B-1
Practices for safely handling and reducing disturbance to amphibians*

Do not disturb nesting or mating animals.

Rather than holding amphibians in your hands after capture, immediately place them in a zip lock bag or a plastic tub for a short period of time:

- Zip lock bags or plastic tubs must contain enough seasonal pool water to cover the gills and entire body of larvae.
- Lung-breathing adults should not be submerged and should have access to air as well as moist or wet areas within bags or tubs.

Avoid injury to animals:

- Do not handle amphibians with hands that have been applied with insect repellent or moisturizing lotions.
- Wet hands before handling amphibians to minimize damage to their outer protective layer of skin.
- Never hold or pull a salamander by its tail – it may break off.
- Return animals to their exact place of capture.
- When an animal is removed from beneath an object such as a log or stone, replace the object first, then release the animal next to it so it can crawl back under.

(Continued)

Avoid spreading disease:

- Wash hands thoroughly before and after handling an animal – especially before handling an animal from another pool.
- Thoroughly clean and disinfect boots, waders, nets and any other objects introduced into a pool between sites (remove all mud and debris; use bleach for disinfection).

Do not remove egg masses from the pool or detach them from vegetation:

- They are sensitive to water depth and location.
- The matrix that protects many egg masses may be disturbed with handling, increasing their susceptibility to predators or disease.
- If eggs do become detached, try to reattach them or situate them at the same depth and in the same area. Egg masses on the bottom of pools are subject to siltation and low dissolved oxygen concentrations and are less likely to hatch.

Avoid seining; it causes too much disturbance.

** Beebee, 1996; Green, 2001; White and White, 2002; Calhoun, 2003*

Evidence of Breeding Indicator Species

A minimum of two visits during daylight hours in the spring is recommended to document breeding indicator species at a seasonal pool. Visits during mid- and late summer are also recommended to document larvae and emerging juveniles and to determine whether the pool retained water long enough for successful population recruitment. Visiting pools at night may be treacherous and there is a greater chance for inadvertent disturbance to the pools. In general, avoid unnecessarily walking in or directly around the pool edge. If entering the pool, move slowly and carefully to avoid disturbing the habitat and animals or dislodging egg masses attached to branches in the water.

Evidence of seasonal pool use by indicator species includes the egg masses, larvae, and adults of ambystomatid salamanders, wood frogs, and eastern spadefoots and adult fairy shrimp. Suggestions for finding these species along with tips for photography are below. Unless required by a seasonal pool program that will lead to possible protection of the pool, we recommend taking a 'hands-off' approach to documenting the animals (e.g., photographing and identifying egg masses from the shore of the pool) to minimize impacts to these small ecosystems.

Amphibian Egg Masses: Identifying egg masses is a simple and low-impact way of recognizing use of the pool by indicator species. Refer to Fig. 3-2 to determine what time of year egg masses of indicator species are most likely present. Wearing polarized sunglasses increases clarity and depth of vision beneath the surface of the water. If vegetation is scarce, egg masses, particularly those of ambystomatid salamanders, may be on the bottom of the pool. Search for egg masses primarily in water depths less than three feet within three to ten feet of shore around fallen logs, vegetation or sticks/debris. Distinguish between egg masses of all indicator species in your area (Field Guide 4). Egg masses are best photographed using a polarizing filter on your camera. Wood frog egg masses tend to be in large communal rafts in the parts of the pool that receive the most sunlight and warm up and ice out the earliest.

Amphibian Larvae and Transforming Individuals: Salamander larvae can be easily distinguished from frog and toad larvae (tadpoles) – salamander larvae have bushy external gills while tadpoles do not (refer to Field Guide 5). Refer to Fig. 3-2 for what time of year larvae and transforming individuals of indicator species are most likely to be present. During the day,

salamander larvae tend to hide on the bottom of the pool beneath vegetation and detritus. Wood frog and eastern spadefoot tadpoles often congregate in schools in shallow parts of the pool. Dipnets (aquarium dip nets or D-shaped dip nets) or scoops may be used to capture larvae; once captured, they should be transferred quickly into a water-filled container. Transformed individuals respire with lungs rather than gills so they should not be submerged in water. To photograph larvae, keep them in water in a container, place a white background behind the container, and use a camera with a polarized lens. Ideally, try to get photographs of larvae from above, the side, and below.

Adult Amphibians: Adult frogs and salamanders are best found by carefully searching the water's edge and the terrestrial area adjacent to the pool beneath logs, rocks, and other debris. Wood frogs may be found in the pool itself day or night during the breeding season when males are calling. In general, it is not necessary to handle these amphibians in order to identify them. If it is necessary to photograph adults for documentation, follow these suggestions for handling. Most salamanders in cool spring weather move slowly and can be caught by hand by gently grasping in the middle of the body between forelimbs and hindlimbs (Green, 2001). Hold them in your cupped wet hand or place them in a container with a moist surface (e.g., with wet leaves or shallow water). Frogs, however, will require an active pursuit, by quickly bringing a cupped hand over them on land or using a dipnet on land or in water. Hold frogs and toads gently but firmly around the waist with hindlimbs extended to prevent kicking (Green, 2001). Alternatively, place the frog or toad in a deep container or a container with a lid (so it can't leap or hop out) with a moist surface on the bottom. Photograph adults from slightly above and off to one side of the individual and try to fill the frame of the photo with the animal.

Fairy Shrimp: Adult fairy shrimp tend to be unpredictable in occurrence and their distribution is not at all well known for the mid-Atlantic region (see Field Guide for the life history of fairy shimp). Because fairy shrimp are delicate, it is best to catch and examine them using plastic tubs or bins dipped into the water, letting the water and fairy shrimp flow into the container. After describing and photographing them, gently release them back to the pool by submerging the container in the water and letting them swim out. For most purposes, identifying fairy shrimp as in the Order Anostraca is sufficient. Species identification is difficult and requires examining a male specimen under a dissecting microscope (see Belk, 1975 and Belk et al., 1998 for identification).

Appendix C
Programs to Locate, Map, Monitor, and/or Protect Seasonal Pools in the Mid-Atlantic Region

Appendix C gives an overview of seasonal pool-related projects, initiatives, and programs occurring in the mid-Atlantic region, including work carried out by nongovernmental organizations, state and local agencies, and federal agencies. Many universities are also carrying out related research on pool-breeding amphibians and invertebrates, but are not included in this summary.

Regional Programs

There are no comprehensive region-wide initiatives to locate, map, or monitor seasonal pools in the mid-Atlantic. However, efforts sponsored by the USGS span National Parks and National Wildlife Refuges across the region. The USGS Amphibian Research and Monitoring Initiative-Northeast region (ARMI-NE) is mapping seasonal pools and monitoring amphibians at the pools at selected National Parks (Delaware Water Gap National Recreation Area, Gettysburg National Historic Park, Rock Creek Park, Shenandoah National Park) and National Wildlife Refuges (Canaan Valley, Erie, Great Swamp, Patuxent, Wallkill River) in the mid-Atlantic region (see *http://www.pwrc.usgs.gov/nearmi* for more information). Also, scientists at the USGS Leetown Science Center (LSC) have mapped all and monitored many seasonal pools in Delaware Water Gap National Recreation Area.

Mid-Atlantic State and Local Programs

District of Columbia

We are aware of two efforts to locate and map seasonal pools taking place in D.C. ARMI-NE (see "Regional Programs") has mapped seasonal pools and monitors seasonal pool-breeding amphibians in Rock Creek Park, a 1755-acre National Park. The Nature Conservancy has mapped seasonal pools in the Potomac Gorge area of the Chesapeake and Ohio Canal National Historic Park that traverses both D.C. and Maryland.

Delaware

There has not been a program undertaken at the state level to locate, map, monitor, or protect seasonal pools in Delaware. However, state wetland maps and GIS data layers show locations of approximately 1,500 Coastal Plain Ponds (CPP) in Delaware (isolated wetlands that may be seasonal). Only CPP greater than 0.25 acre are comprehensively included, but some as small as 0.10 acre may also be included. The coding for CPP wetlands, which follows a modified National Wetlands Inventory and Cowardin et al. (1979) alpha-numeric scheme for a given polygon, includes palustrine forested (PFO), palustrine shrub-scrub (PSS), and palustrine emergent (PEM) categories followed by a "2". Contact staff at the Delaware Department of Natural Resources and Environmental Control, Division of Water Resources for more information (see *http://www.dnrec.state.de.us/water2000/DWRStaff1.asp* for current staff listing).

The Delaware Natural Heritage Program has natural community information about some CPP, particularly those in Kent and New Castle counties. A report produced by the Delaware Natural Heritage Program helped to determine criteria used to map CPP on the state wetland maps (McAvoy and Clancy, 1994).

The Delaware Chapter of The Nature Conservancy (DE TNC) produced a report which mapped and assessed the conservation status of Delmarva Bays in Delaware (Zankel and Olivero, 1999; copies of the report are available through the DE TNC). DE TNC used a more restrictive definition for these wetlands than was used at the state level for CPP.

Maryland

There has not been a program undertaken at the state level to locate, map, monitor, or protect seasonal pools in Maryland. Wetland geospatial data are available from the Maryland Department of Natural Resources at the 1:12,000 scale (MD DNR Geospatial Data from 1988-1995, GIS download from *http://dnrweb.dnr.state.md.us/gis/data/data.asp*). Wetland geospatial data include all photo-interpretable wetlands greater or equal to 0.5 acres (2,023 m^2), although some wetlands less than or equal to 3 acres (12,141 m^2) obscured by conifers may have been missed.

Some Nontidal Wetlands of Special State Concern identified by the Maryland Department of the Environment and the MD DNR are seasonal pools, especially on the lower coastal plain, but they are not indicated as such on the map (Paula Becker and Scott Smith, pers. comm.). The state typically only identifies vernal pools that have state-rare, threatened or endangered species in them and these seasonal pools are in the MD DNR Heritage Database.

The Montgomery County Department of Environmental Protection (DEP) and the Maryland-National Capital Park & Planning Commission (M-NCPPC) initiated a vernal pool mapping program in 2002 to map seasonal pools throughout Montgomery County, Maryland as part of the Countywide Stream Protection Strategy. DEP is developing a Biological Monitoring Database.

New Jersey

The New Jersey Department of Environmental Protection's Endangered and Nongame Species Program established the Vernal Pool Survey Project in 2000. The project's main objectives are to locate, map, and inventory seasonal pools statewide. Additionally, this initiative will monitor the pools' amphibian populations utilizing a trained group of volunteers. Data collected by volunteers is entered into the Department of Environmental Protection's land use regulatory databases, which are used to guide land use decisions (Tesauro, 2004).

The Center for Remote Sensing and Spatial Analysis (CRSSA) lab at Rutgers University is a collaborator in New Jersey's Vernal Pool Survey Project. CRSSA is utilizing GIS data layers (e.g., soils, wetlands, geology) and various maps (e.g., digital elevation models, color orthophotography) to find areas where vernal pools are likely to occur. The Center scans high-resolution orthophotography of these hotspot areas to pinpoint potential vernal pool locations (see *www.dbcrssa.edu/ims/vernal* for more information).

Seasonal pools that are already certified in New Jersey are mapped (see *http://www.state.nj.us/dep/landuse/fww/vernal/index.html*). Volunteers continue to collect biological data about seasonal pools in New Jersey using Freshwater Wetlands Vernal Habitat Protocols (see Appendix B). Volunteer training sessions are held each year; the schedule is posted on their website.

Pennsylvania

In Pennsylvania, there are multiple ongoing collaborative efforts to learn more about seasonal pools and the biota they support. The Pennsylvania Department of Conservation and Natural Resources (DCNR) considers "vernal ponds" as "special habitat." Recently, a major program was initiated that will lead to a state-wide seasonal pool locating and monitoring program. The Pennsylvania Game Commission awarded a State Wildlife Grant to the Western Pennsylvania Conservancy (WPC) (*http://www.paconserve.org*) to develop a web-based seasonal pool registry and research program, beginning in the summer of 2005. This registry program will bring together academic institutions, non-profit organizations, state and federal agencies, and citizen volunteers to identify, locate, and study seasonal pools in Pennsylvania. This grant was awarded in response to DCNR's recognition that vernal pools are integral to the survival of many at-risk species of wildlife, and that the distribution and abundance of seasonal pools are currently unknown in Pennsylvania.

The Pennsylvania DCNR supports other efforts related to seasonal pool conservation and management through its Wildlife Resource Conservation Program (WRCP). In 2002, the WRCP collaborated with DCNR's Bureau of Forestry, The Nature Conservancy, and the WPC to fund a study constructing a set of biological criteria that would facilitate the classification and management of different types of seasonal pools in Pennsylvania. Other research projects include elucidating the population structure of seasonal pool-breeding amphibians using molecular genetics techniques and investigating the impacts of timber harvesting on woodland amphibians.

The Upper Susquehanna Coalition (USC), a network of natural resource professionals from three counties of Pennsylvania and twelve counties of New York that make up the headwaters of the Susquehanna River, has been extremely active in seasonal pool conservation. Through funds provided by the U.S. EPA in support of their ephemeral wetlands/seasonal pool program, USC is mapping pools throughout the upper Susquehanna watershed with the ultimate goal of mapping 940 pools. Additionally, the USC developed a seasonal pool assessment form in 2003, which facilitates a major data collection effort that began in spring of 2004. The seasonal pool assessment form is a GIS user interface that collects and organizes comprehensive information on the surveyed vernal pools. Some of this information will be automatically filled in according to location of data point. Other details recorded by the observer include: pool characteristics, site location, directions to the pool, area of the pool, surrounding habitat/land-use, water chemistry, vegetation and fauna data. For more information contact USC (*http://www.u-s-c.org/html/vernalpoolpage.htm*).

Virginia

There has not been a program undertaken at the state level to locate, map, monitor, or protect seasonal pools in Virginia. There have been exhaustive biological inventories of several seasonal pool systems, including a detailed description of the Shenandoah sinkhole pond system in Virginia (Buhlmann et al., 1999). The Grafton Ponds Sinkhole Complex has also been inventoried and mapped (Rawinski, 1997; Roble, 1998; Roble and Stevenson, 1998), and a comprehensive management plan is in development (Van Alstine et al., 2001).

West Virginia

There has not been a program undertaken at the state level to locate, map, monitor, or protect seasonal pools in West Virginia.

Appendix D
Sources of Additional Information on Seasonal Pools

Amphibian and Seasonal Pool Field Guides:

Altig, R., R.W. McDiarmid, K.A. Nichols, and P.C. Ustach. 1998. Tadpoles of the United States and Canada: A Tutorial and Key. Contemporary Herpetology Information Series 1998. Available from http://www.pwrc.usgs.gov/tadpole.

Conant, R. and J.T. Collins. 1998. A Field Guide to Reptiles and Amphibians of Eastern and Central North America. 3rd Edition, expanded. Houghton Mifflin, Boston.

Green, N.B. and T.K. Pauley. 1987. Amphibians and Reptiles in West Virginia. University of Pittsburgh Press, Pittsburgh, Pennsylvania.

Hulse, A.C., C.J. McCoy, and E.J. Censky. 2001. Amphibians and Reptiles of Pennsylvania and the Northeast. Cornell University Press, Ithaca, New York.

Kenney, L.P. and M.R. Burne. 2001. A Field Guide to the Animals of Vernal Pools. Massachusetts Division of Fisheries & Wildlife and the Vernal Pool Association, Westborough, Massachusetts.

Petranka, J.W. 1998. Salamanders of the United States and Canada. Smithsonian Institution Press, Washington, D.C.

Tyning, T.F. 1990. A Guide to Amphibians and Reptiles. Stokes Nature Guides. Little, Brown and Company, Boston.

White, J.F. and A.W. White. 2002. Amphibians and Reptiles of Delmarva. Tidewater Publishers, Centreville, Maryland.

Seasonal Pool Publications:

Biebighauser, T.R. 2002. A Guide to Creating Vernal Ponds. USDA Forest Service. Available from http://www.fs.fed.us/r8/boone/vernal.pdf.

Calhoun, A.J.K. and M.W. Klemens. 2002. Best development practices: Conserving pool-breeding amphibians in residential and commercial developments in the northeastern United States. MCA Technical Paper No. 5, Metropolitan Conservation Alliance. Wildlife Conservation Society, Bronx, New York.

Calhoun, A.J.K. and P. deMaynadier. 2004. Forestry habitat guidelines for vernal pool wildlife. MCA Technical Paper No. 6, Metropolitan Conservation Alliance. Wildlife Conservation Society, Bronx, New York.

Colburn, E.A. 2004. Vernal pools: Natural history and conservation. McDonald & Woodward Publishing Company, Blacksburg, Va.

Williams, D.D. 1987. The Ecology of Temporary Waters. Timber Press, Portland, Oregon.

Seasonal Pool Educational Programs:

Roger Tory Peterson Institute. Vernal Pool Project: Teacher professional development and classroom pool surveys (http://vernalpools.rtpi.org).

The Vernal Pool Association. Online resources for teachers and students (http://www.vernalpool.org).

Vernal Pool Society of Virginia. The Spring Pools Institute: Field courses for adults and mature youth; Virginia's Disappearing Ponds: Traveling educational outreach (http://www.lynchburgbiz.com/virginiasvernalpools).

Amphibian Monitoring Programs:

Frogwatch USA, National Wildlife Federation (in partnership with USGS). Long-term, volunteer-based frog and toad monitoring program (http://www.nwf.org/frogwatchUSA).

North American Amphibian Monitoring Program, Patuxent Wildlife Research Center, USGS. Collaborative, volunteer-based vocal amphibians monitoring program (http://www.pwrc.usgs.gov/NAAMP).