16 Conserving Vernal Pool Habitat through Community Based Conservation

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> The more clearly we can focus our attention on the wonders and realities of the universe about us, the less taste we shall have for destruction.

These words from Rachel Carson are as relevant today as they were during the mid-20th century when she alerted people to the seemingly invisible perils of pesticides in the environment. In *Silent Spring* (1962) we were asked to consider a spring without the dawn chorus of birds. Forty years later, reports of amphibian declines and increasing incidences of disease suggest that frog choruses may also be in peril (see Collins and Storfer 2003, Muths et al. 2003). Environmental red flags are no

longer limited to remote tropical mountains or jungles that the average citizen cannot locate on maps (Stuart 2004). We can see the effects of environmental degradation at home.

The good news is that although Rachel Carson raised an alarm call, she was optimistic that people could make positive changes. She believed in nurturing the human "sense of wonder" as a first step in developing a conservation ethic in citizens. We believe vernal pools are small (and wondrous) enough that they will capture the interest of local citizens. Spring choruses of wood frogs, salamander courtship dances, and fairy shrimp (a magical name to begin with) can instill a sense of wonder in children and adults alike. The inherent attractiveness and accessibility of vernal pools, coupled with the difficulty in regulating them, suggest community based conservation may be the most effective strategy for conserving these habitats.

Community based conservation was a term widely used by environmental groups in the 1980s to describe international attempts to maintain biodiversity in developing countries while taking into account the needs of the local people (Gezon 1997; Brockington 2005). In North America we still tend to think of community based conservation as a paradigm for conserving biodiversity in developing countries where people directly sustain themselves on local resources (Alcorn 1993), yet loss of biodiversity due to land conversion is of increasing concern in our own backyards (Wilcove et al. 2000; Theobald 2003). In the U.S. and Canada, community based conservation is now used in terms of community forestry, grassroots ecosystem management, and collaborative conservation (Moseley 1999; Conley and Moote 2003). Snow (2001) states "collaborative conservation reaches across the great divide connecting preservation advocates and developers, commodity producers and conservation biologists, local residents, and national interest groups to find working solutions to intractable problems that will surely languish unresolved for decades in the existing policy system." This statement focuses on the conservation process as well as outcomes and recognizes that outcomes will ultimately be identified and realized by the stakeholders. We embrace this community based approach to vernal pool conservation because conserving pools and adjacent terrestrial habitat used by pool-breeding amphibians involves multiple property owners and interests. Given the complexity of vernal pool habitat, and the difficulty of remotely identifying pool functions, involvement of local citizens is essential for effective conservation of pools (Berkes and Folke 2003).

The purpose of this chapter is to illustrate how community based conservation using citizen scientists can effectively bring about conservation of vernal pool habitat. We discuss the role citizen science has played historically and how citizen science can advance vernal pool conservation, and we provide the framework for initiating a vernal pool conservation plan (the "how"). An example of a successful community based vernal pool conservation initiative in four New England towns is provided as a case study.

COMMUNITY BASED CONSERVATION AND CITIZEN SCIENTISTS

Citizen participation is the cornerstone of a democratic society (Arnstein 1969; Sclove 1998), so it is not surprising that citizen engagement in social–ecological issues (after Berkes 2004, humans as part of ecosystems) is burgeoning. Over the past 30 years, since the establishment of statutory environmental standards, public awareness of environmental issues has increased. If we are to maintain ecological services (e.g., clean air and water resources) critical to our long-term health, we can little afford to separate humans from nature in today's human-dominated world (Sinclair et al. 2000; Kates et al. 2001; Gunderson and Holling 2002) Educating citizens on specific issues is now readily accomplished using the Internet, making even remote participation plausible (Stevenson et al. 2003). Citizens are often motivated to become involved at the local level because today many local governments play a lead role in land-use planning. Community based conservation can be a grassroots catalyst for change as responsible comprehensive plans and municipal ordinances that are attentive to important environmental issues are developed (Chapter 10, Mahaney and Klemens).

Scientific personnel working on widespread environmental problems have recognized that an authoritative top–down management framework is ineffective (Ludwig 2001; Berkes 2002). The idea of complementing top–down resource management with a bottom–up participatory approach is an increasingly respected strategy and encourages building partnerships to bridge the gaps between local needs and the agendas of other stakeholders (Johnson 2000; Mackinson 2001; James 2002; Brosius and Russell 2003; Moore and Kuntz 2003). Inclusive, people-oriented, and community based approaches to conservation are in part a reaction to the failures of exclusionary, inflexible regulations (Ludwig 2001; Berkes 2004; Sclove 1998) and are growing in both the U.S. and Canada (Savan and Sider 2003).

CAN CITIZEN SCIENCE MAKE A DIFFERENCE?

The term "citizen scientist" (citizens who collect scientific data according to standardized protocols) was coined in the 1990s by Dr. Rick Bonney at Cornell's Laboratory of Ornithology to acknowledge citizen contributions to science and to engage the public in large bird population monitoring programs (Stevenson et al. 2003). For over 100 years citizens across North America have successfully collected data on natural phenomenon (e.g., flowering phenology, leaf-fall, migration events), documented presence/absence of wildlife (call surveys, tracking) and measured environmental soil, air or water variables (e.g., nitrogen in the water, pollen in the air) (Table 16.1).

As environmental issues become increasingly complex (i.e., global warming, tracking population trends in amphibians or neotropical migrant birds), data collection on large spatial and temporal scales is often beyond the reach of individual researchers (see Pattengill-Semmens and Semmens 2003). Decision-makers have traditionally depended on these researchers to provide data to support their policy decisions. Unfortunately, such research may be detached from local specifics,

TABLE 16.1
Selected Examples of Citizen Science Programs from around the Region

Program	Region/Partners	Purpose	Web Site
Adopt-a-Pond	Banrock Station Wetlands Foundation Canada	To provide teachers, students and community groups with information resources and educational opportunities to conserve, restore and create wetland habitats	http://www.torontozoo.com/adoptapond/
Appalachian Mountain Club Citizen Science program (2005)	Northeastern U.S.	Citizen monitoring of phenological events, air quality	http://www.outdoors.org/conservation/index.cfm
Christmas Bird Count (1900)	Audubon Society with partners in Cornell Lab of Ornithology, Bird Studies Canada, Humboldt Institute, and others	All-day census of early-winter bird populations. Results compiled into the longest running database on trends of early winter bird populations across the Americas	http://www.audubon.org/bird/cbc/
Citizen Science Canada	Canada Wildlife Habitat Canada EMAN TD Friends of the Environment Foundation	Citizen data collection on water quality, frogs, butterflies, air quality for improving communities. Help decision-makers gather as much information as possible to make effective and sustainable choices in planning for our environment	http://www.citizenscience.ca/
Cornell Laboratory of Ornithology Programs for Citizen Scientists (e.g., Backyard Bird Count, Birds in Forested Landscapes)	Canada, Mexico, and U.S.	The lab is a nonprofit membership institution whose mission is to interpret and conserve the Earth's biological diversity through research, education, and citizen science focused on birds	http://www.birds.cornell.edu/
Keeping Track Monitoring Program (1994)	Vermont	Citizen tracking of large ranging mammals	www.keepingtrack.org

Program	Region/Partners	Purpose	Web Site
Maine Damselfly and Dragonfly Survey (1999-2004)	Maine	Multiyear citizen odonate atlasing program	http://mdds.umf.maine.edu/
National Ecological Observatory Network (NEON;) Citizen Gateway Science (in development)	U.S. nonprofit organization	First national ecological measurement and observation system designed to answer regional to continental scale issues developing Citizen Science programs	http://www.neoninc.org
NatureWatch (e.g., IceWatch, PlantWatch, WormWatch, FrogWatch) (1994)	Canadian Nature Federation/University of Guelph/Ecological Monitoring and Assessment Network (EMAN)	A suite of community-based or "citizen science" monitoring programs	http://www.naturewatch.ca/english/
North American Amphibian Monitoring Program (1995)	Canada, Mexico, and U.S.	Long-term monitoring program designed to track the status and trends of frog and toad populations	http://www.pwrc.usgs.gov/naamp/
North American Breeding Bird Atlas Explorer	Canada and US; citizen-based	Provides up-to-date information on breeding bird surveys by state and province	http://www.pwrc.usgs.gov/bba/
Reef Environmental Education Foundation (REEF)(1990)	U.S. Partners The Nature Conservancy and guidance by the National Marine Fisheries Service	To educate and enlist divers in the conservation of marine habitats. The REEF Fish Survey Project allows volunteer SCUBA divers and snorkelers to collect and report information on marine fish populations	http://www.reef.org/index.shtml
Vermont Institute of Natural Science (VINS): Citizen Science Programs (1970)	Vermont	To protect our natural heritage through education and research designed to engage individuals and communities in the active care of their environment	http://www.vinsweb.org/cbd/citizensci.html
Wetland Health Evaluation Program (1997)	Minnesota	Citizen monitoring of wetlands. Data are used by the Minnesota Pollution Control Agency to track wetland health throughout the Twin Cities metropolitan area	www.mnwhep.org

time-consuming, data-poor and expensive. Citizen scientists provide local knowledge, local perspective on the issues, and the watchdog capacity needed to assess decision performance and evaluate change that directly affects conditions around them. Although there continues to be debate on the scientific merit of such data, in most cases the data collected by citizen science programs have been very credible and used effectively to draw attention to environmental concerns at the community level.

COMMUNITY BASED CONSERVATION OF VERNAL POOL HABITAT

There are many challenges to vernal pool conservation at the local level. The current demand for instantaneous data and decision-making is problematic for conservation issues, such as vernal pool protection, that rely on baseline conditions and indicators of long-term change. Additionally, most vernal pools occur on private property (Dahl 2000) where externally imposed conservation may be perceived as a threat to landowner rights. Therefore, conservation at this level requires stakeholder education and involvement from the start. Planning for development and conservation of resources must go hand-in-hand.

To date, community based monitoring of vernal pools has been limited in the U.S. and Canada. For example, a U.S. National Directory of volunteer environmental monitoring programs for aquatic resources identified 772 programs in 1998: only nine addressed vegetated wetlands, and even then the focus was on birds. Today citizen-based vernal pool conservation measures range from local road closings during peak amphibian migrations to wetland ordinances (Table 16.2), yet the majority of initiatives focus on public education or monitoring rather than long-term protection of vernal pool habitat.

In this section, we provide guidance for communities interested in vernal pool conservation through communitywide planning using data collected by citizen scientists. Even though we cannot provide a cookbook approach to pool conservation, we can identify key steps in the process gleaned from our experience working with local communities. Details of the process and the ultimate implementation of a plan, however, will be shaped by the community itself. It is assumed that the community will have already embraced a goal of improving conservation of pool resources. We have identified five key steps for meeting this goal: (1) organizing a local vernal pool habitat conservation initiative which includes clear targets and a means for assessing success, (2) recruiting and retaining citizen scientists, (3) developing quality control measures to ensure project credibility, (4) conducting a vernal pool inventory and ecological assessment, and (5) putting the data to work. A brief discussion of each is presented below.

(1) Organizing a Local Conservation Initiative

First, one must define "local." For vernal pool issues, the scale (e.g., village, town, municipality, watershed, province) will be dictated by logistical constraints and political realities: how much area can be part of a project and still be effectively

TABLE 16.2
Examples of Vernal Pool Citizen-Science Initiatives in the Region

Program (Inception)	Region/Partnership	Purpose	Web Site
"Big Night" Salamander Crossings Brigades Project (2002)	Vermont Department of Fish and Wildlife/Bonnyvale Environmental Education Center	Citizen crossing guards for amphibians migrating to breeding pools	http://www.beec.org/projects.html#reptile
Jefferson Salamander Monitoring (2003)	Canadian Biosphere Reserves Association with partners Ontario Niagra Escarpment and University of Guelph	Project to revisit the 1991 Jefferson sites and investigate other potential habitat to identify where Jefferson Salamanders occur along the Escarpment	http://www.escarpment.org/Monitoring/salamanders.htm
New Jersey Fish and Wildlife Vernal Pool Mapping Project (2002)	New Jersey Rutgers University and Conserve Wildlife Foundation	Citizen mapping of New Jersey vernal pools	http://www.state.nj.us/dep/fgw/vpoolart.htm
Ohio Vernal Pool Partnership (2005)	Ohio Environmental Council and The Nature Conservancy	Community-based conservation of vernal pools through education, partnerships, science	www.ovpp.org
Ontario Vernal Pool Association (2004)	Ontario, Canada	Promote education, study, and protection of vernal pool habitats	http://www.ontariovernalpools.org/
Upper Susquehanna Coalition Vernal Pool Page (1992)	New York and Pennsylvania Federal, state, and local partners	To create a database of vernal pools in an effort to better understand their functions	http://www.u-s-c.org/html/vernalpoolpage.htm
Very Important Pool Program (1999–2004)	Maine Maine Audubon Soiciety, University of Maine	Citizen monitoring of vernal pools around the state for five years	www.maineaudubon.org

surveyed and managed through local conservation strategies? After that question is answered, partners and stakeholders should be identified. Local conservation of vernal pool habitat requires leaders (town or project initiators) who cultivate partnerships and involve stakeholders. Partnerships can open doors to financial support, logistical support, and lend a project broader credibility with the public and potential funders. Stakeholders are all those who might be affected by the conservation planning. These might include state, provincial, or federal agencies, environmental organizations, land trusts, land-use/policy organizations, consultants, developers, scientists, educators, citizens, and resource land owners (after Preisser et al. 2000, and see Rubec 2003). Stakeholders should be involved from the inception of the project. In this way, stakeholders become champions for the initiative and are more likely to "trust" data collected by citizens.

Organizers must identify how pool conservation efforts fit into local land-use planning and produce clear objectives/outcomes that can be shared with stakeholders and the media. Once the goal is clear (i.e., identify, survey and map all vernal pools or develop a vernal pool ordinance), organizers must decide what inventory and assessment tools and protocols to use (see Appendix A for examples of Best Management Practice literature and other guides). Also, organizers may decide to include vernal pool resources in existing regional habitat mapping projects (e.g., Beginning with Habitat [Maine], Wildlife Habitat Canada).

Having selected a method for vernal pool inventory and assessment, an organizer must then become familiar with the administrative structure of the local government, who should be involved in the project (e.g., town planner or manager, town council) and identify who should be notified about the project (e.g., town council, land trusts, conservation commission; see Vasseur et al. 1997). At this stage, key partners and stakeholders (and eventually landowners with pools) must be educated about the vernal pool resource and may be enlisted to help define the project path. Having the support and trust of local landowners is key to the success of a project. These are developed through informational workshops, presentations to local governing units and project planning meetings. Landowners should be invited to organizational meetings and field visits.

Administrative and technical support may be provided by the partners, the municipality, or a combination of both. Administrative duties include providing a clearinghouse for disseminating information to citizen scientists, the public, and stakeholders, and managing the database (including processing citizen data) and mapping of the resource, preferably using a Geographic Information System [GIS]. The town, municipality or administrative unit should then work closely with the partners and citizens to guide the rest of the project.

Clear targets should be identified by the project organizers. In this way, partners and stakeholders know what outcomes to expect and citizens have a clear goal to meet. A target may range from mapping all the pools in a town to conserving 20% of all pools in a town to a comprehensive wetland ordinance. Organizers should also put in place a means of assessing success and redressing failures.

(2) Engaging and Retaining Citizen Scientists

A prime objective of local vernal pool initiatives has been to develop an educated citizenry capable of making informed decisions about conserving local vernal pools. To engage citizens, project leaders must clearly communicate the project goal and the means by which to accomplish the goal. Clear organization, standardized protocols and operating procedures and predetermined reporting strategies will ensure that citizen volunteers see progress and feel part of a defined project that has a realistic outcome.

Still, people volunteer for a variety of reasons, and it can be challenging to engage and retain citizen scientists. Important issues for citizens are those that directly affect them, their families, or the quality of their community. To engage citizens in giving their time and efforts to vernal pool conservation the message must be enticing and the incentives compelling. We suggest the following approach to encourage engagement:

- *Create an interest by elevating and fostering public awareness to raise "vernal pool literacy."* Within the community, popularize the ecological and educational benefits of vernal pools. For example, an appreciation of vernal pool ecology can be increased through media coverage of amphibian migrations, distribution of visually appealing citizen guides, newspaper articles about vernal pool projects, newsletters, mailings, listserves, phone calls, and presentations (see Appendix A for citizen resources on vernal pools).
- *Instill a sense of ownership and responsibility.* Citizens can be inspired by what project leaders say and how they say it. Citizen scientists must feel that their work makes a difference and that they are valued contributors. Convey the concept of a sense of place, how vernal pool wildlife enhances local biodiversity and landscape health (Chapter 15, Gruner and Haley), the vulnerability of vernal pools and their inhabitants, and the ability for citizens to make a difference for future generations through proactive participation. It is important to help the public understand specific human impacts to the vernal pool system (e.g., in watershed terms, "We all live downstream!"). A personal stake will motivate volunteers to actively participate in vernal pool conservation.
- *Provide training for goal-oriented projects***.** Teach skills needed to achieve the objective through workshops, illustrated manuals, Web-based field guides and protocols. Help the public understand its ability to act and affect change regarding vernal pool conservation through their participation. Provide inspiring examples of citizen projects.

- *Put on a public face*. Publish accounts of the project in local newspapers, brochures, Web sites, and magazines (e.g*., NEON Citizen Science Magazine*, the Web-based *Journal of Citizen Science*). Promote a sense of accomplishment and pride to project participants with high profile articles and accounts. Encourage citizen scientists to write letters to the editor, to speak with local reporters about their work, and to host tours of local pools.

Offer a variety of avenues for involvement and encourage citizen scientists to participate wherever they feel comfortable. Citizens will likely stay with the project if they feel they are having a fulfilling hands-on experience with a biological system and if the research is relevant. Does their work increase knowledge of the resource and direct stewardship of the surrounding environment? Will the collection of data document baseline conditions that may be used to monitor changes over time? And will the results be used in community planning and decision making? The ability to influence policy at the local level and to have a role in making sure the decisions address citizen and stakeholder concerns is a compelling reason to stay involved. More specifically:

- *Encourage further involvement*. Provide opportunities to be actively involved in the field (collecting data) and in the public arena (influencing local or state/provincial policies, laws, and decisions). Encourage citizens to serve on municipal committees or boards responsible for identifying high priority conservation lands or reviewing development activities; help conduct scientific research; write or solicit newspaper or magazine articles about the ecology and conservation of vernal pools; work with youth groups and/or school groups to inventory local pools; and testify before a local, provincial, or state board about the importance of pools. Many citizens in our vernal pool monitoring programs have become active on these fronts.
- *Communicate results and provide feedback*. Continually provide citizen scientists, landowners, and stakeholders with documentation of their contributions and appreciation for their efforts. It is critical that volunteers can view data they have collected and visualize the broader impacts of the information they have generated. Landowners should receive a formal letter of acknowledgment and a copy of the data collected from their land. A presentation that includes the results of the project and production of a GIS data layer representing citizen data are effective visual feedback mechanisms. GIS capability is becoming more common in rural towns and will be a powerful tool to most in the future (Chapter 14, Baldwin et al.). Some towns have created Web pages that highlight their vernal pool accomplishments (see Case Study).

(3) Quality Control of Data

Quality control methods for data collected by volunteers are well-developed. Many community based projects adopt protocols used by state or provincial agencies. For example, NatureWatch (activities monitored through partnership with University of Guelph, Nature Canada, and the Ecological Monitoring and Assessment Network [EMAN]) uses EMAN protocols rewritten for lay people. The U.S.-based National Ecological Observatory Network (NEON) Citizen Science Gateway endorses projects that meet set criteria for data collection (IBRCS 2003).

Vernal pool monitoring protocols have been developed for monitoring pond-breeding amphibians in the north-central U.S. (see Knutson et al. 2002) and for monitoring wood frog and spotted salamander populations in the northeastern U.S. (see USGS Amphibian Research and Monitoring Initiative [ARMI] egg mass counting protocol and Managers Monitoring Manual for Egg Mass Surveys [http://www.pwrc.usgs.gov/monmanual/techniques/eggmass.htm]). Frogwatch is a community based program in Canada managed by Nature Canada and EMAN. Data sheets and collection protocols are also provided in a number of vernal pool citizen guides (Kenney 1995; Tappan 1997; Calhoun and Klemens 2002; Calhoun 2003). To ensure reliable data, volunteers should be provided with written protocols for each stage of the data collection. Biological assessments should be documented with photographs of indicator species and egg masses. Digital photographs of pools and the immediate surrounding habitat are also useful for creating baseline information that can be used to document changes in pool habitat over time. (All equipment for the monitoring programs should be available to the participants at no cost as an incentive to participate.)

To ensure quality data, organizers must invest time in training volunteers in the field. Project leaders must work with volunteers to practice filling out data forms and to locate and count egg masses. Well-trained citizen scientists can collect reliable information on vernal pool breeding fauna (Oscarson and Calhoun 2007). Oscarson and Calhoun (2002) found no statistically significant differences between volunteer and biologist egg mass counts and indicator species identification in his study in southern Maine.

(4) Conducting the Vernal Pool Inventory and Assessment

Communities may develop their own inventory and assessment criteria or adapt existing ones. Calhoun and Klemens (2002), for example, recommend a tier-rating system for pools based on both pool biological criteria and condition of the adjacent terrestrial habitat (Table 16.3). Pools supporting larger breeding populations of target amphibian species (determined through egg mass counts) and that have a relatively intact adjacent terrestrial habitat are rated as Tier 1, or having the highest priority for conservation. The priority rating system assumes that communities will not be able to conserve every pool and provides planners with a tool to predict which pools may provide the greatest long-term support of pool-breeding amphibians. This model could easily be adapted to community needs. For example, the biological criteria suggest egg mass thresholds for determining biological significance, but egg mass

TABLE 16.3
Vernal Pool Assessment Sheet

VERNAL POOL ASSESSMENT SHEET

A. Biological Value of the Vernal Pool

(1) Are there *any* state-listed species (Endangered, Threatened, or Special Concern) present or breeding in the pool?
Yes_____ No_____

(2) Are there two or more vernal pool indicator species breeding (i.e., evidence of egg masses, spermatophores [sperm packets], mating, larvae) in the pool?
Yes_____ No_____

(3) Are there 25 or more egg masses (regardless of species) present in the pool by the conclusion of the breeding season?
Yes_____ No_____

B. Condition of the Critical Terrestrial Habitat

(1) Is at least 75% of the land 100 feet from the pool undeveloped?
Yes_____ No_____

(2) Is at least 50% of the habitat from 100–750 feet of the pool undeveloped?
Yes_____ No_____

NOTE: For these purposes, "undeveloped" means open land largely free of roads, structures, and other infrastructure. It can be forested, partially forested, or open agricultural land.

C. Cumulative Assessment

Number of Questions Answered YES in Category A	Number of Questions Answered YES in Category B	Tier Rating (I = Highest Priority)
1–3	2	Tier I
1–3	1	Tier II
0	1–2	Tier III
1–3	0	Tier III

Source: Calhoun et al. 2002. With permission.

numbers may vary regionally (Calhoun et al. 2003). A community may adjust these numbers to reflect existing or proposed state, county, or provincial regulations. Similarly, invertebrate or plant pool indicators could be incorporated into the biological criteria (Chapter 6, Colburn et al.; Chapter 5, Cutko and Rawinski). Disturbance to critical terrestrial habitat should be included in the rating calculations, but again, the nature and thresholds for disturbance can change with the science and may need to be rated relative to other available habitats (Calhoun et al. 2005). For example, in some development situations, it might be appropriate to designate management zones around the pool (see Figure 12.3) that incorporate known terrestrial habitat rather than using concentric circle zoning approach (Chapter 12,

Windmiller and Calhoun; Baldwin et al. 2006). The key is to base the assessment on the best available science and to tailor it to the goals of the community.

Case Study

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New England Citizen Scientists Work to Develop Local Vernal Pool Conservation Plans

The town of Falmouth, ME, and the towns of Farmington, Simsbury, and Suffield, CT, formed partnerships with the University of Maine and nongovernmental environmental groups to inventory and assess their vernal pool resources. The Connecticut towns established a partnership with the Farmington River Watershed Association (FRWA) and the Metropolitan Conservation Alliance, a program of the Wildlife Conservation Society. The town of Falmouth was assisted by Maine Audubon Society. We selected town planners or members of conservation commissions to coordinate activities and manage volunteers as they were familiar with the town planning processes, active in local conservation, and were willing to recruit and manage volunteers within their town.

Potential vernal pools were remotely identified using aerial photography. Landowners were contacted to request permission to gain access to privately owned pools. Local coordinators in each town recruited volunteers by contacting local naturalists and ecologists, educators, and other active members of the community. Volunteer training sessions, which included field visits, were conducted prior to the field season. Identified pools were assigned to each volunteer along with maps, field data sheets and various field guides to assist in pool surveys. A ListServ was created to facilitate communication among volunteers, coordinators, biologists, and principal investigators.

Volunteers surveyed vernal pools in early April 2003 in Connecticut and mid-April 2003 in Maine and were required to collect data on pools twice during the season (Figure 16.1). Data on biological value, number of egg masses per breeding amphibian species, state-listed species, and other pool indicators) and the condition of the terrestrial habitat surrounding the pool were gathered in the field. Tier ratings (assigning relative conservation priority) were assigned to each pool surveyed, based on biological value and the condition of the terrestrial habitat reported in the volunteer data sheets.

Results

Fifty-two volunteers surveyed 382 vernal pools. Of the 382 potential surveyed pools, 262 (69%) were confirmed as vernal pools. Volunteers in this study were able to accurately collect biological and physical data on vernal pools in the field. Data from each pool were entered into a GIS database and delivered to each town (Figure 16.2). All four towns have begun to propose and develop conservation plans and apply conservation mechanisms to protect high priority vernal pools. The Connecticut towns are working to incorporate the vernal pool data along with other biological data sets into a regional ongoing Farmington Valley Biodiversity Project. Results from the Biodiversity Project are being used to identify priority areas within each town to focus conservation efforts, and to guide town planners in how to incorporate the results within the municipal

FIGURE 16.1 Volunteer field-training session. Damon Oscarson instructs citizen scientists in Connecticut on how to fill out data collection forms.

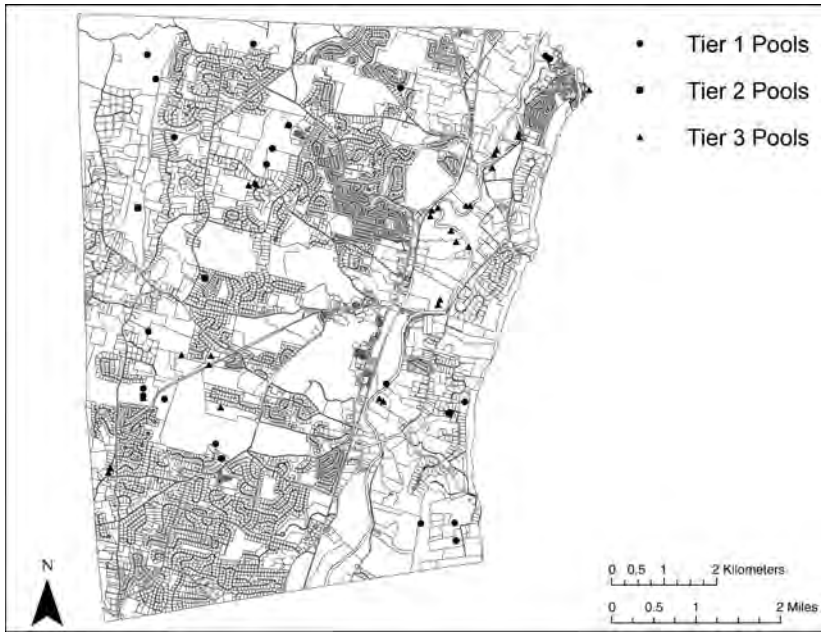

FIGURE 16.2 Final map of the 2004 vernal pool assessment conducted in one of our study towns in Connecticut. Tier 1 pools are the highest conservation priority based on egg mass abundance and quality of the adjacent terrestrial habitat. Tier 2 and 3 pools are lower priority but may provide restoration opportunities or, in the absence of Tier 1 pools, be critical for conserving pool-breeding species.

planning and regulatory process. In Maine, the town of Falmouth has recently passed amendments to their Zoning and Site Plan Review Ordinance which includes a Resource Conservation Zoning Overlay District (RCZOD). The new RCZOD covers the remaining undeveloped areas in the town and sets standards for subdivisions to preserve areas on each site which have high natural resource value. These Conservation Subdivisions allow for cluster development and require 50% of the residential area plus the unsuitable area to be set aside for open space preservation. The open space area must contain important conservation areas which include vernal pools and their associated upland habitat mapped by the town. The Falmouth Conservation Commission has also formed a Vernal Pool Subcommittee to discuss and pursue other conservation strategies. The commission has published a vernal pool brochure and created a Web site to educate the public about efforts to protect vernal pools in their town.

Inventory

We suggest the following steps for completing a successful vernal pool inventory. Our focus is on conserving vernal pool landscapes and because of this, for the development of guidelines, we have used the life history needs of breeding amphibians that require habitat beyond the pool. Many protections are based on abundance of egg masses and presence of breeding amphibians. Communities wishing to do detailed invertebrate or water chemistry studies will have to develop different protocols in addition to these (see protocols at http://www.anr.state.vt.us/dec/waterq/bassvernal.htm; Burnham and Sorenson 2003).

Locate Existing Data

Natural resources maps from ENGOs (environmental nongovernmental groups), state or provincial agencies should be reviewed. Data on vernal pools may be available from consulting firms, land trusts, or municipal projects that have identified natural resources for planning purposes.

Obtain Recent Aerial Photography and Photointerpret Potential Pools

Potential pools should be identified using recent, spring, leaf-off color infrared photography at a scale of 1:4800 or 1:12000 (see Chapter 4, Burne and Lathrop for details). Other types of aerial photographs may be used but are less desirable. Photointerpretation may have to be outsourced if the expertise does not exist at the local level. Protection of vernal pools and most small isolated wetlands is, in part, limited by a resource manager's ability to map them on a large scale (Grant 2005). As a result, many New England states and New Jersey have started mapping vernal pools and soliciting citizen involvement (Burne 2001; Tappan and Marchand 2004; Lathrop et al. 2005). Citizens can improve the accuracy of aerial photointerpretation through local knowledge and with field-verifications. For example, the Rutgers University Center for Remote Sensing and Spatial Analysis (in New Jersey) has developed an interactive Internet mapping site to aid the state and its citizens in conducting surveys (see Lathrop et al. 2005).

Produce a Master Map of Potential Pools

It is critical to have a map of all potential pools within the project area for citizens to view. Each pool should be assigned an identification number. Local knowledge will be invaluable in refining these maps.

Determine Ownership of Each Potential Pool

Contact the landowner for permission to assess the pool or pools on her or his property. A letter requesting permission for access should include a summary of the project highlighting its benefits to the landowner and the community, an invitation to the owner to attend an informational workshop on the project, and assurance that the property will be undisturbed by the assessment. Even if the pool is on public land, it is best to contact the owner or managers of the lands.

Assessment

Completing an assessment of the pool resources will require indoor and outdoor citizen-training sessions and a strong volunteer support network. Here is a framework that can be modified according to project goals:

1. Conduct the indoor volunteer training workshop in late winter/early spring. Training should include a presentation on vernal pool ecology, egg mass, amphibian, and invertebrate identification, and should supply protocols for preventing the spread of amphibian diseases (see the Declining Amphibian Populations Task Force code of practice on preventing spread of disease). At this session, volunteers should learn how to fill out data sheets and receive guidance on when and how often to collect data. Details on successful training sessions are discussed in Oscarson and Calhoun (2007), and they include establishing a volunteer electronic list-serve, volunteer access to expert advice throughout the project, and field support.
2. Recruit a volunteer coordinator (either from the municipality or the citizen scientists) who will be responsible for encouraging volunteers, following up on progress made at each sampling period, and for collecting data at the end of the field season. Volunteer coordinators may also solve problems (trouble finding pools, confusion over data).
3. Hold a field-based workshop after the wood frogs have laid eggs (ambystomatid salamanders lay eggs less explosively and should be counted at least two weeks after wood frog counts). During this session, volunteers will gather to determine pool assignments. Only those pools for which access is granted should be inventoried. Usually volunteers are familiar with the town and landowners and will choose pools close to home or associated with people they know. After pool assignments are made, volunteers should inventory a pool with an expert and practice filling out data sheets. Sampling protocols for counting egg masses are published on-line (see USGS, Amphibian Research and Montoring Initiative http://armi.usgs.gov/). This field experience is critical. In addition, it may

be necessary to have a biologist on call who is willing to assist volunteers in the field as needed.
4. Provide a mechanism for volunteers to include pools that may have been missed through photointerpretation.
5. Enter data into a spreadsheet, calculate assessment ratings, and develop spatial maps using GIS technology. Ideally, data and photos from each pool can be linked to the pool locations using GIS. If GIS is not available, overlay maps can be created.

CONSERVATION RECOMMENDATIONS

(5) Putting the Data to Work

Following inventory and assessment, a community will have a vernal pool data layer to incorporate into its GIS database or other spatial planning tools. We recommend using the data to effect on-the-ground local conservation of vernal pools. Translation of these data into conservation will be as varied as the political units and communities involved, and will range from voluntary adherence to Best Management Practices to local regulation through ordinances (see Colburn 2004). When possible, existing templates should be used to help the group craft a plan. Section III of this book provides detailed information for communities on how to conserve pools once a vernal pool database is in place. Chapter 10 summarizes federal and provincial regulations and local strategies for pool conservation; Chapter 11, Chapter 12, and Chapter 13 discuss specific land-use activities that should and should not occur in vernal pool habitats and suggest management guidelines; and Chapter 14 presents some innovative ideas for applications of spatial modeling tools to conservation planning. Because of local knowledge and interest, conservation planning at the local level can be much more effective with input from citizen scientists than when regulated from afar by a regional, state, or provincial governmental body. How far a community taps into the skills of this work force is dependent upon the community. Completion of the inventory and assessment of vernal pools is a major first step to conservation planning.

We emphasize that the vernal pool inventory should be used to identify the characteristics of exemplary pools in your region. Biological and terrestrial conditions may vary from region to region. If communities use a tier-rating system as in Calhoun and Klemens (2002), they should be flexible in their approaches to conservation. For example, if a community has very few Tier 1, or high priority pools, they should look for restoration opportunities and may want to concentrate efforts on some pools with lower priority ratings (restoration examples can be found at the Ohio Vernal Pool Partnership or the Ontario Vernal Pool Association). We cannot provide the formula for effecting conservation in your community, but we do provide an example of a successful project in New England that might provide some inspiration (see Case Study).

SUMMARY

Citizen scientists can be successfully trained to conduct vernal pool inventories and assessments as a baseline for developing local vernal pool habitat conservation plans. The key to successful local initiatives is to engage conservation partners and to include stakeholders in the planning and implementation process. We recognize five key steps to developing local vernal pool resource protection: (1) organizing a local vernal pool habitat conservation initiative (with clear objectives or targets), (2) recruiting and retaining citizen scientists, (3) developing quality control measures to ensure project credibility, (4) conducting the vernal pool inventory and ecological assessment, and (5) putting the data to work. Currently many vernal pool identification resources and informational documents exist (most are also Web-based) making citizen engagement and education a mere matter of exposure. Local protection strategies are more effective and comprehensive than higher level governmental regulations and ultimately will make the conservation of resources part of the economic development and fabric of community life.

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REFERENCES

Alcorn, J.B. (1993). Indigenous peoples and conservation. *Conservation Biology* 7: 424–426.

Arnstein, S.R. (July 1969). Ladder of citizen participation. *AIP Journal* 216–224.

Baldwin, R., Calhoun, A.J.K., and deMaynadier, P.G. (2006). Conservation planning for amphibian species with complex habitat requirements: a case study using movements and habitat selection of the wood frog (*Rana sylvatica)*. *Journal of Herpetology* 40: 443–454.

Berkes, F. (2002). Cross-scale institutional linkages: perspectives from the bottom up. In Ostrom, E., Dietz, T., Dolsak, N., Stern, P.C., Stonich, S., and Weber, E.U. (Eds.). *The Drama of Commons*, National Academy Press, Washington, D.C., pp. 291–321.

Berkes, F. (2004). Rethinking community based conservation. *Conservation Biology* 18: 621–630.

Berkes, F. and Folke, C. (Eds.) (2003). *Navigating Social-Ecological Systems: Building Resilience for Complexity and Change*. Cambridge University Press, Cambridge.

Brockington, D. (2005). Politics and ethnography of environmentalisms in Tanzania. *African Affairs* 105/481: 97–116.

Brosius, J.P. and Russell, D. (2003). Conservation from above: an anthropological perspective on transboundary protected areas and ecoregional planning. *Journal of Sustainable Forestry* 17: 39–66.

Burne, M.R. (2001). Massachusetts Aerial Photo Survey of Potential Vernal Pools. Natural Heritage and Endangered Species Program, Department of Fisheries and Wildlife. Westborough, MA.

Burnham, D. and Sorenson, E. (2003). Vermont Wetlands Bioassessment Program: An Evaluation of the Chemical, Physical, and Biological Characteristics of Seasonal Pools and Northern White Cedar Swamps. Final Report. Vermont Department of Environmental Conservation and Vermont Department of Fish and Wildlife, Nongame and Natural Heritage Program, Waterbury, VT.

Calhoun, A.J.K. and Klemens, M.W. (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., Walls, T., McCollough, M., and Stockwell, S. (2003). Developing conservation strategies for vernal pools: a Maine case study. *Wetlands* 23: 70–81.

Calhoun, A.J.K., Miller, N.A., and Klemens, M.W. (2005). Conserving pool-breeding amphibians in human-dominated landscapes through local implementation of Best Development Practices. *Wetlands Ecology and Management* 13: 291–304.

Carson, R. (1962). Silent spring. Houghton Mifflin, Boston, MA.

Colburn, E.A. (2004). *Vernal Pools: Natural History and Conservation*. McDonald and Woodward Publishing, VA.

Collins, J.P. and Storfer, A. (2003). Global amphibian declines: sorting the hypotheses. *Diversity and Distribution* 9: 89–98.

Conley, A. and Moote, M.A. (2003). Evaluating collaborative natural resource management. *Society and Natural Resources* 16: 371–386.

Dahl, T.E. (2000). Status and trends of wetlands of the conterminous United States 1986–1997. U.S. Fish and Wildlife Service, Office of Biological Service, Washington, D.C.

Gezon, L. (1997). Institutional structure and the effectiveness of integrated conservation and development projects: case study from Madagascar. *Human Organization* 56: 462–470.

Grant, E.H.C. (2005). Correlates of vernal pool occurrence in the Massachusetts, USA landscape. *Wetlands* 25: 480–487.

Gunderson, L.H. and Holling, C.S. (2002). *Panarchy: Understanding Transformations in Human and Natural Systems*. Island Press, Washington, D.C.

IBRCS [Infrastructure for Biology at Regional to Continental Scales Working Group.] (2003). Rationale, blueprint, and expectations for the National Ecological Observatory Network. IBRCS White Paper, American Institute of Biological Sciences.

James, S.M. (2002). Bridging the gap between private landowners and conservationists. *Conservation Biology* 16: 269–271.

Johnson, M.D. (2000). A sociocultural perspective on the development of U.S. natural resource partnerships in the 20th century. USDA Forest Service Proceedings, RMRS-P-13.

Kates, R.W., Clark, W.C., Corell, R., Hall, J.M., Jaeger, C.C., Lowe, I., McCarthy, J.J., Schellnhuber, H.J., Bolin, B., Dickson, N.M., Faucheux, S., Gallopin, G.C., Grübler, A., Huntley, B., Jäger, J., Jodha, N.S., Kasperson, R.E., Mabogunje, A., Matson, P., Mooney, H., Moore, B., III, O'Riordan, T., and Svedin, U. (2001). Sustainablility science. *Science* 292: 641–642.

Kenney, L.P. (1995). Wicked Big Puddles: A Guide to the Study and Certification of Vernal Pools. Reading Memorial High School-Vernal Pool Association, Reading, MA.

Knutson, M.G., Lyon, J.E., and Parmelee, J.R. (2002). Resources for monitoring pond-breeding amphibians in the northcentral USA in Farm ponds as critical habitats for native amphibians: final report. Submitted to the Legislative Commission on Minnesota Resources by U.S. Geological Survey Upper Midwest Environmental Sciences Center, La Crosse, WI.

Lathrop, R.G., Montesano, P., Tesauro, J., and Zarate, B. (2005). Statewide mapping and assessment of vernal pool: a New Jersey case study. *Journal of Environmental Management* 76: 230–238.

Ludwig, D. (2001). The age of management is over. *Ecosystems* 4: 758–764.

Mackinson, S. (2001). Integrating local and scientific knowledge: an example in fisheries science. *Environmental Management* 27: 533–545.

Moore, E.A. and Koontz, T.M. (2003). A typology of collaborative watershed groups: citizen-based, agency-based, and mixed partnerships. *Society and Natural Resources* 16: 451–460.

Moseley, C. (1999). New Ideas, Old Institutions: Environment, Community, and State in the Pacific Northwest. Ph.D. dissertation, Yale, New Haven, CT.

Muths, E.E., Corn, P.S., Pessier, A.P., and Green, D.E. (2003). Evidence for disease-related amphibian decline in Colorado. *Biological Conservation* 110: 357–365.

Oscarson, D. and Calhoun, A.J.K. (2007). Developing vernal pool conservation plans at the local level using citizen scientists. *Wetlands* 27: 80–95.

Pattengill-Semmens, C.V. and Semmens, B.X. (2003). Conservation and management of the reef volunteer fish monitoring program. *Environmental Monitoring and Assessment* 81: 43–50.

Preisser, E.L., Kefer, J.Y., Lawrence, J.D., and Clark, T.W. (2000). Vernal pool conservation in Connecticut: an assessment and recommendations. *Environmental Management* 26: 503–513.

Rubec, C.D.A. (compiler). (2003). Wetland stewardship in Canada. Contributed papers from the conference on Canadian wetlands stewardship. Report No. 03-2. North American Wetlands Conservation Council, Ontario, Canada.

Savan, B. and Sider, D. (2003). Contrasting approaches to community based research and a case study of community sustainability in Toronto, Canada. *Local Environment* 8: 303–316.

Sclove, R.E. (1998). Better approaches to science policy. *Science* 279: 1283.

Sinclair, A.R.E., Ludwig, D., and Clark, C.W. (2000). Conservation in the real world. *Science* 289: 1875.

Snow, D. (2001). Coming home: an introduction to collaborative conservation. In Brick, P., Snow, D., and Van de Wetering, S. (Eds.). *Across the Great Divide: Explorations in Collaborative Conservation and the American West*. Island Press, Covelo, CA, pp. 1–11.

Stevenson, R.D., Haber, W.A., and Morris, R.A. (2003). Electronic field guides and user communities in the ecoinformatics revolution. *Conservation Ecology* 7: 3. [online] URL: http://www.consecol.org/vol7/iss1/art3.

Stuart, S.N. (2004). Status and trends of amphibian declines and extinctions worldwide. *Science* 306: 1783.

Tappan, A. (Ed.) (1997). Identification and Documentation of Vernal Pools in New Hampshire. New Hampshire Fish and Game Department, Nongame and Endangered Species Program, Concord, NH.

Tappan, A. and Marchand, M. (2004). Identification and Documentation of Vernal Pools in New Hampshire (2nd ed.). New Hampshire Fish and Game Department, Nongame and Endangered Wildlife Program. Concord, NH.

Theobald, D.M. (2003). Targeting conservation action through assessment of protection and exurban threats. *Conservation Biology* 17: 1624–1637.

Vasseur, L., LaFrance, L., Renaud, D., Morin, D., and Audet, T. (1997). Advisory committee: a powerful tool for helping decision makers in environmental issues. *Environmental Management* 21: 359–365.

Wilcove, D.S., Rothstein, D., Dubow, J., Phillips, A., and Losos, E. (2000). Leading threats to biodiversity: what's imperiling U.S. species. In Stein, B.A., Kutner, L.S., and Adams, J.S. (Eds.). *Precious Heritage: The Status of Biodiversity in the United States*. Oxford University Press, Oxford, pp. 239–254.

APPENDIX 16.1 INFORMATIONAL RESOURCES FOR CITIZEN SCIENTISTS AND MUNICIPALITIES ENGAGED IN VERNAL POOL CONSERVATION PLANNING

Vernal Pool Citizen Guides*

Brown, L.J. and Jung, R.E. (2005). An introduction to Mid-Atlantic seasonal pools. U.S. Environmental Protection Agency, Mid-Atlantic Integrated Assessment, Ft. Meade, MD. EPA/903/B-05/001.

Burne, M.R. (2001). Massachusetts Aerial Photo Survey of Potential Vernal Pools. Natural Heritage and Endangered Species Program, Department of Fisheries and Wildlife. Westborough, MA.

Calhoun, A. (2003). *Maine Citizen's Guide to Locating and Describing Vernal Pools*. 3rd ed. Maine Audubon Society, Falmouth, ME.

Calhoun, A.J.K. and deMaynadier, P. (2003). Forestry habitat management guidelines for vernal pool wildlife in Maine. Maine Department of Inland Fisheries and Wildlife. Wildlife Conservation Society Technical Paper No. 6 Rye, New York.

Calhoun, A.J.K. and Klemens, M.W. (2002). Best Development Practices for pool-breeding amphibians in commercial and residential developments. Wildlife Conservation Society Technical Paper No. 5. Rye, New York.

Colburn, E.A. (Ed.) (1997). *Certified: A Citizen's Step-by-Step Guide to Protecting Vernal Pools*. 7th ed. Massachusetts Audubon Society, Lincoln, MA.

Donahue, D.F. (1997). *Guide to the Identification and Protection of Vernal Pool Wetlands of Connecticut*. Connecticut Forest Stewardship Program, CT.

Kenney, L.P. (1995). Wicked Big Puddles: A Guide to the Study and Certification of Vernal Pools. Reading Memorial High School—Vernal Pool Association, Reading, MA.

Marchand, M.N. (Ed.) (2004). *Identification and Documentation of Vernal Pools in New Hampshire*, 2nd ed. NH Fish and Game Department, Nongame and Endangered Species Program.

Stone, J.S. (1992). Vernal Pools in Massachusetts: Aerial Photographic Identification, Biological and Physiographic Characteristics, and State Certification Criteria. M.S. thesis. University of Massachusetts, Amherst, MA.

Tesauro, J. (2004). New Jersey's vernal pools. New Jersey Division of Fish and Wildlife, Endangered and nongame species program. http://www.njfishandwildlife.com/epsp/pdf/vernalpool03.pdf.

Selected Field Guides to Vernal Pool Fauna

Bishop, S.C. (1969). *Handbook of Salamanders: The Salamanders of the United States, of Canada, and of Lower California*. Comstock Publishing Associates, Ithaca, New York.

Conant, R. and Collins, J.T. (1998). *A Field Guide to Reptiles and Amphibians: Eastern and Central North America*. 3rd ed. Peterson Field Guide Series. Houghton Mifflin Co., New York.

Cook, F.R. (1967). An analysis of the herpetofauna of Prince Edward Island. National Museum of Canada Bulletin 212.

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* Many resources are available online.

Cook, F.R. (1984). *Introduction to Canadian Amphibians and Reptiles*. National Museum of Natural Sciences, Ottawa, Ontario, CA.

DeGraaf, R.M. and Rudis, D.D. (1983). *Amphibians and Reptiles of New England: Habitats and Natural History.* University of Massachusetts Press, Amherst, MA.

Gilhen, J. (1983). *The Amphibians and Reptiles of Nova Scotia*. Nova Scotia Museum, Halifax, NS, Canada.

Gorham, S.W. (1970). The amphibians and reptiles of New Brunswick. New Brunswick Museum, Saint John, NB, Canada.

Hunter, M.L., Jr., Calhoun, A.J.K., and McCollough, M. (Eds.). (1999). *Maine Amphibians and Reptiles*. University of Maine Press, Orono, ME.

Kenney, L.P. and Burne, M.R. (2000). *Field Guide to the Animals of Vernal Pools*. Massachusetts Division of Fisheries and Wildlife, Natural Heritage and Endangered Species Program and Vernal Pool Association, Westborough, MA.

Klemens, M.W. (1993). Amphibians and reptiles of Connecticut and adjacent regions. State Geological and Natural History Survey, New York.

Massachusetts Audubon Society. (1995). *Pondwatchers: Guide to Ponds and Vernal Pools of Eastern North America*. Lincoln, MA. www.umassextension.org.

Wright, A.H. and Wright, A.A. (1949). *Handbook of Frogs and Toads of the United States and Canada*. Comstock Publishing Associates, Ithaca, New York.