

Vernal Pool Conservation in Connecticut: An Assessment and Recommendations

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ABSTRACT / Vernal pools, a variety of ephemeral wetlands, are threatened in many areas of the United States. As habitat fragmentation and degradation increase, some vernal pool

amphibian species are declining in numbers. Uneven implementation of state regulations further hampers effective conservation. To prevent further species decline and vernal pool loss, we evaluated alternatives for improving vernal pool conservation. We used transcripts from a recent vernal pool conference, interviews with members of relevant interest groups, and a literature review to determine opportunities for and constraints on improving vernal pool conservation policy. Participants from different interest groups had very diverse views about appropriate protection strategies. We have examined these different perspectives and alternatives and offer policy recommendations on both the state and local level. These recommendations can foster awareness of vernal pools as unique habitats, increase protection of these areas, and expand citizen participation in the vernal pool regulatory process.

Wetland protection has become an increasingly heated issue in recent years, leading to a growing knowledge of the role of wetlands in hydrologic function, ecosystem dynamics, and biodiversity conservation. With this increased awareness, public attitudes have shifted from largely negative to positive, corresponding to an increased interest in preventing wetland degradation and regulating development (Vileisis 1997). Despite this general trend, many wetlands continue to be lost to development. Especially hard hit are ephemeral wetlands known as vernal pools, which fill with water during the spring and often dry out by summer (Kenney 1995). For many years, ephemeral wetlands were not recognized as significant. Wetland regulations were typically written to protect permanent waterbodies or seasonally saturated soils that surveyors could detect regardless of season. Regulations of this sort are often insufficient to protect vernal pools from degradation. In Connecticut, recognition of the habitat value of vernal pools has led to regulatory protection administered at the local level. Despite this effort, effective conservation of these areas has been hampered by a lack of consistent local knowledge concerning the

importance of vernal pools. Varying local attitudes toward vernal pool protection have made statewide consensus difficult.

This paper (1) describes vernal pools as units of conservation, enumerates their biodiversity values, and characterizes Connecticut's history of vernal pool conservation; (2) identifies current management problems, highlights our efforts to improve vernal pool management and policy, and considers our partners in this effort; and (3) offers recommendations to improve vernal pool conservation.

Study Area and Methods

Study Area

Connecticut contains thousands of vernal pools of varying sizes. Most of these pools were originally formed 10,000 years ago, at the time of glacial retreat. After glaciation, large ice blocks remained on the denuded landscape. As these blocks melted, they formed depressions surrounded by sandy rims. Many of these glacial depressions persist today as vernal pools, occurring primarily throughout Connecticut's Central Valley along floodplains and glacial lake bottoms (Donahue 1996). Other vernal pools were created where topography and soil/bedrock created appropriate conditions for seasonal water retention and drainage. The seasonal intersection of local water tables and ground level, sometimes combined with an impermeable layer of soil,

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produced vernal pools throughout the state (Donahue 1996). Despite their relative abundance, their ephemeral nature and generally small size often exclude vernal pools from town wetlands maps; thus, their exact number and distribution are unknown.

Methods

We hoped to improve vernal pool conservation by identifying ways to improve protection in Connecticut and to communicate these alternatives to a diverse audience. We had three objectives: (1) to raise the public profile of vernal pool conservation; (2) to bring participants in the vernal pool policy process together in a community-building policy exercise; and (3) to prepare and distribute a summary report containing recommendations for improving vernal pool conservation.

Our approach was based on the policy sciences, which provide a comprehensive "stable frame of reference" for examining complex policy issues (Lasswell 1971). This approach is problem oriented and contextual (Clark 1992, 1997). It requires decision-makers and other policy participants to explicitly consider a problem's history, causes, and practical alternatives before selecting appropriate policies for implementation. The policy sciences consider the diverse perspectives and values of all participants affected by natural resource decisions (Clark and Brunner 1996, Clark and Wallace 1998). Because of its holistic nature, the policy sciences are an effective tool to clarify ecosystem management issues (e.g., Brunner and Clark 1997).

Our research was conducted in 1998. First, we reviewed transcripts from the vernal pool conference series titled "Our Hidden Wetlands: Vernal Pools in Connecticut." The conference series, jointly sponsored by the Center for Coastal and Watershed Systems and the Connecticut Department of Environmental Protection, was held in November 1997 and January 1998 at Wesleyan University in Connecticut. Seventeen authorities spoke at the two conferences, discussing vernal pool science, policy, and resource management.

Second, we identified nine broad constituent groups involved in vernal pool protection and targeted representatives from each constituency (Table 1). We interviewed 36 people from this contact list, asking questions about the individual's previous involvement in vernal pool protection, their perspective about existing regulatory policies, their favored strategies for vernal pool protection, and future prospects for vernal pools under the status quo. Interviews, averaging 45 minutes in length, were conducted with willing participants. Results of the interviews were transcribed and reviewed.

Third, the results were compiled in a report and distributed to the interviewees for preliminary review.

After revisions were incorporated, the results were presented to 26 participants at a day-long vernal pool symposium held in May 1998 at Yale University in Connecticut. This seminar included a presentation of the report, opportunities for discussion, and role-playing on a variety of vernal pool management issues.

The role-playing exercise required representatives from different constituent groups to discuss controversial scenarios and determine appropriate solutions. The group was divided into six teams, each discussing a different scenario. At the close of the exercise, each group appointed a spokesperson to present the situation and their solutions to the larger group for discussion. The recommendations from this symposium were incorporated into the final report, which was sent to all Connecticut Conservation and Inland Wetland and Watercourse (IWW) commissions. This document provides baseline knowledge for the decision-makers who influence vernal pool policy and implementation.

Vernal Pools, Biodiversity Values, and the History of Ephemeral Wetland Conservation in Connecticut

The valuation of vernal pools has changed sharply from the early settlement period in Connecticut to the present; most people and organizations have only recently begun to recognize the importance of biodiversity. By considering the values currently placed on vernal pools in light of historic developments, a clearer formulation of the vernal pool policy problem can be developed.

What are Vernal Pools?

Vernal pools are ephemeral waterbodies that dry out for part of the year. If they do not dry regularly, organisms that survive in permanent aquatic environments (e.g., fish) may dominate the ecosystem. The absence of fish allows other species (e.g., salamanders) to use vernal pool habitats (Downer 1992). Another defining feature is the existence of a confined basin and the lack of a permanent outlet, distinguishing vernal pools from marshes or streams. Vernal pools of biological significance must contain water for at least two months during the spring, allowing organisms to complete their development prior to the pool's drying (Donahue 1996).

Biodiversity Values

Vernal pools are of interest largely due to the biological diversity they support. Although many organisms use these areas, amphibians are often the focal

Table 1. Constituent group perspectives on and approaches to vernal pool conservation

Constituent group	Constituent group characteristics			Desired outcome and effects
	Sample contacted organizations	Involvement	Policy mechanism	
National government	Environmental Protection Agency (EPA)	Jurisdiction over interstate wetlands	Clean Water Act, Section 404	Regulated development on a national scale
State government	Army Corps of Engineers (ACE) Department of Environmental Protection (DEP) Department of Transportation (DOT)	Jurisdiction over state-agency impacts	State Conservation/Development plans, CT Environmental Policy Act	Regulation of state-level development
Local government	Redding Conservation Commission Milford Inland Wetlands & Watercourses Commission (IWWC)	Jurisdiction over local development	Inland Wetland and Watercourses Act, Town conservation/development plans	Maximize conservation, economic, recreational, aesthetic values
Legal/policy/land-use organizations	Pace University Land-Use Law Center Connecticut Association of Inland Wetland and Watercourses Commissions (CAIWWC)	Advocates land-use tools for local leaders	Education, workshops	Knowledgeable and effective local leaders
Environmental organizations	The Nature Conservancy (TNC) Southern New England Herpetological Association (SNEHA)	Conservation of environment and resources	Education, public pressure, lawsuits	Environmental and natural resource conservation
Consultants	VHB Associates REMA Ecological Services	Hired for land-use monitoring and mitigation research	Education, conservation strategies	Effective job performance, new contracts
Developers	National Association of Homebuilders CT Homebuilders Association	Increasing or modifying the built environment	Advocacy groups, economic growth	Increased development and changes in tax base
Scientists	Science Center of CT Yale University	Advocate for biodiversity conservation	Education	Preservation of natural diversity until more is known
Educators/media	Tufts University Yale Alumni Magazine	Educate/inform public for increased awareness	Media, education	Increase in awareness and corresponding growth in conservation efforts

point of conservation efforts. Many amphibians are dependent on these environments for successful breeding. Obligate vernal pool amphibians include the wood frog *Rana sylvatica*, the Eastern spadefoot toad *Scaphiopus h. holbrookii* (a Connecticut endangered species), the spotted salamander *Ambystoma maculatum*, marbled salamander *Ambystoma opacum*, and Jefferson salamander *Ambystoma jeffersonianum* (a Connecticut species of special concern). Adult salamanders often breed in a single pool throughout their reproductive lives while living in surrounding upland areas. After reproducing, adult salamanders disperse an average of 125 m into the upland habitat surrounding the breed-

ing pools (Semlitsch 1998). Juvenile salamanders and frogs may wander, respectively, as far as 670 and 1000 m from their birth site (J. Victoria personal communication, Berven and Grudzien 1990) and can select pools other than their birthplace for breeding. This juvenile dispersal makes landscape connectivity essential: young amphibians must be able to locate alternative breeding habitats. Additionally, populations in isolated pools may decline if immigration from neighboring pools is prevented (Gill 1978). Connectivity preserves the genetic diversity of small amphibian populations while providing the necessary upland habitat for adults (Reh and Seitz 1990).

There is considerable concern about amphibian population decline in Connecticut vernal pools. Habitat fragmentation and degradation of areas surrounding the pools can hasten species loss. Over a 20-year period, wood frogs disappeared from forest patches smaller than 40 ha (C. Raithel unpublished data). Hybridization between the blue-spotted salamander (*Ambystoma laterale*) and the endangered Jefferson salamander increases with habitat fragmentation, diminishing the species' genetic integrity (Bogart and Klemens 1997). Vernal pool amphibians often exist as metapopulations within a wetland landscape, supporting the need for habitat connectivity (Gill 1978). Roads fragment the landscape and act as barriers (Reh and Seitz 1990) while contributing to direct mortality (Fahrig and others 1995). Kuhn (1987, quoted in C. Raithel personal communication) estimated that an average traffic density of 24–40 vehicles/hr was sufficient to kill 50% of migrating *Bufo bufo* (review in Fahrig and others 1995 and Andrews 1990). A shift of native herpetofauna to species that specialize in disturbed environments in fragmented and degraded habitats is occurring throughout the northeastern United States (M. Klemens personal communication). In order to fully protect native amphibians, knowledge of the effects of local- and landscape-level disturbances on vernal pools needs to be incorporated into conservation.

Connecticut's History of Vernal Pool Conservation

Within Connecticut, efforts toward vernal pool conservation have developed in response to both state and local concerns. A comprehensive analysis of vernal pools should consider Connecticut's changing landscape, the evolution of public interest in vernal pools, and provisions of state laws (Table 2).

Human activity has significantly altered the condition of many vernal pools. Early settlers cleared the land for agriculture, increasing solar radiation and evaporation from the pools. Most farmers left the "unproductive" boggy land around the pool's periphery untouched, however, reducing these potential impacts (H. Gruner personal communication). During the 18th and 19th centuries, vernal pools were thus forested islands amid expansive pastures. Later development has had a much greater impact on vernal pools. Housing projects and roads have fragmented the landscape, inhibiting amphibian movement (Gibbs 1998, Reh and Seitz 1990). Runoff from development has also impaired water quality, potentially polluting vernal pools (Connecticut DEP 1997).

Vernal pool protection has been shaped by a historic lack of interest. The public has traditionally undervalued ephemeral wetlands, and government officials and

Table 2. Developments in vernal pool protection and their consequences

Historical development	Consequences for vernal pool protection
Fragmentation of upland habitat	Impedes migration; reduces available upland habitat; increased likelihood of local species extirpation
Growing awareness and interest in vernal pools (and amphibians)	Historic lack of interest necessitates education; any policy should build upon this growing interest
IWWA enforced independently by each municipality	Inconsistent protection reduces developer certainty; potential for regulatory "race to the bottom"
Differential education and funding among commissions	Inconsistent protection reduces developer certainty; potential for regulatory "race to the bottom"
Ad-hoc decision-making	Different projects may be regulated differently in a single municipality
Increased local authority granted for upland protection	Commissions have the potential to protect vital migratory corridors and terrestrial habitat; buffer protection varies dramatically by municipality
1995 amendments add 'vernal' to the IWWA	Potential to increase vernal pool protection; tremendous flexibility of interpretation (may be a safety net or a loophole)

developers have often allowed vernal pools to be drained, filled, or otherwise degraded.

Recently, however, interest in vernal pool protection has increased. This can be partly attributed to growing media attention to issues of ecosystem health and amphibian deformities and population declines (e.g., Fantle 1998). At the same time, science has begun to recognize the importance of vernal pools. For example, the Connecticut Amphibian Monitoring Program and the Massachusetts vernal pool certification program have raised interest in Connecticut's ephemeral wetlands. These activities have generated an awareness of vernal pools and growing support for their protection.

The Inland Wetlands and Watercourses Act (IWWA) of 1972 regulates vernal pools in Connecticut based on their soil drainage class. Each municipality enforces the IWWA through a local Inland Wetlands and Watercourses Commission (IWWC). Thus, each of the 169 towns in Connecticut enforces (and interprets) the IWWA independently, although they receive state guidance. While IWWCs have always had jurisdiction over vernal pools, the word "vernal" was not explicitly included in the IWWA until 1995. At this time, the IWWCs were given control over "all other bodies of

water . . . , vernal or intermittent . . .” (§22a-38 of the General statutes).

Because IWWCs have jurisdiction over all activities that affect a wetland, they are free to regulate surrounding upland areas. Although 80% of IWWCs exercise some authority over upland areas, the extent of their review varies considerably. In 1997, the Connecticut Department of Environmental Protection (DEP) issued a guidance document recommending a 33-m upland review area for all wetlands, including vernal pools (Connecticut DEP 1997). Some commissions have opted for even larger review areas. For instance, the town of Redding has established a 115-m review area around vernal pools as well as examining all of the surrounding lands that drain into the vernal pool (D. Hoskins personal communication). These large review areas enable local IWWCs to review and comment on most land-use proposals.

Commissions have a number of options for enforcing the IWWA, including fines of up to 2000/day and six months of imprisonment for criminal violations. Although courts may require the defendant to reimburse the municipality for legal fees if the commission wins the case, the IWWC is not reimbursed if they lose. Because of this restriction, commissions seldom pursue vernal pool violations. Even if a local commission is particularly vigilant, the difficulties of vernal pool identification may preclude effective sanctions.

The presence of vernal pools seldom prevents development. For instance, although an IWWC rejected a golf course proposal because of vernal pool impacts, the developer subsequently acquired an additional 26 ha in another location in order to leave the vernal pools and surrounding uplands undisturbed without blocking the development (J. Sipperly personal communication). More frequently, commissions recommend revisions to development proposals to reduce potential impacts. Roads or driveways may be reconfigured to avoid vernal pools, but the project as a whole will be approved.

Constituencies in the Ephemeral Wetland Policy Process and Current Constraints to Vernal Pool Protection

It is impossible to formulate effective prescriptions for vernal pool conservation without considering the current policy context. This context consists of both the groups affected by the policy issue and the constraints on possible solutions. Effective policy must consider as many perspectives as feasible. Understanding the constituent groups involved in wetland conservation, while

considering ecological, social, and policy variables, allows the creation of broad-based and realistic policy alternatives.

Constituencies and Their Perspectives

Diverse people and organizations participate directly in vernal pool conservation. We identified nine constituent groups (Table 1). Understanding how these groups interact is a first step to finding common ground and determining how to improve conservation. From our interviews, we were able to determine the general perspectives of each interest group regarding vernal pool conservation and generate a broad statement of that group's position. This information provides an understanding of the local policy context. Knowledge of the constituencies concerned with vernal pools is essential for policy selection and effective implementation.

National government. The Environmental Protection Agency (EPA) and US Army Corps of Engineers (US ACE) have jurisdiction over most wetlands and vernal pools under Section 404 of the Clean Water Act. Their role as administrators of Section 404 is twofold: (1) to issue or deny permits for activities proposed in wetlands or waters that trigger jurisdiction, and (2) to enforce regulations against nonpermitted activities.

There are two categories of permits under the US ACE regulatory program: category 1 for wetlands under 470 m² and category 2 for wetlands ranging from 470 m² to 0.4 ha. Category 1 wetlands are automatically permitted if a corresponding Connecticut Inland Wetland permit is issued, unless the proposed activities will impact federally endangered species or critical habitats. Category 2 projects receive expedited review. During this review process, the US ACE, DEP, EPA, and Fish and Wildlife Service must all agree that minimal impacts are expected from the proposed development. Public review is not required.

If a larger impact is anticipated, the developer must obtain an individual permit. This procedure involves public review and must ensure that the proposed activity avoids wetland impacts, minimizes adverse effects, and compensates for any unavoidable adverse impacts. An individual permit also triggers the need to ensure that a proposed activity will not violate state water-quality standards. Most vernal pools are considered special resources or areas of concern and normally require individual rather than general permits.

State government. Although direct regulatory authority has shifted to individual towns, initiatives like the Connecticut Environmental Protection Act, the Open Space Act, and statewide conservation and development plans have made the state a key player in vernal

pool protection. State responsibility for this issue is concentrated in the DEP's Inland Water Resources Division (DEP-IWRD). The DEP-IWRD regulates the impacts of state-level development, while serving as a resource for town commissions and residents. While the DEP-IWRD is primarily a state-level regulatory force, it also views itself as a facilitator of local decision-making.

Local government. In Connecticut, the power to regulate vernal pools primarily belongs to each municipality. This power is centered in each town's Inland Wetland and Watercourses Commission (IWWC). This commission has the ability to accept, reject, or modify development proposals that impinge upon wetland areas or their buffers. In addition, IWWC and the conservation commissions approve the design and implementation of mitigation/minimization strategies while ensuring consistency with local conservation and development plans.

The amount of permitted development ranges widely among towns. Upland review areas range from 10 m in some towns to 220 m in others, and state-level recommendations have no legal authority and can be ignored. Many communities perceive wetland regulations as a useful control on excessive development, while others value the economic benefits of growth and seek to reduce regulation. Many towns also consider aesthetics, recreation, and property values when designing their regulatory framework.

Legal, policy, and land-use organizations. Although law firms, policy, and land-use organizations lack regulatory power, these organizations can influence decision-making by providing expert advice and counsel, becoming intervenors in local permit proceedings (through the Connecticut Environmental Protection Act), and supplying educational resources. They are often focused on a state- or landscape-level planning process, working with towns to facilitate these larger goals.

Environmental organizations. Local- and national-level environmental groups have considerable power in the vernal pool protection process. By raising conservation issues to local commissions, they can propose modifications to inappropriate development and encourage stricter standards. In addition, they increase awareness of wetlands and vernal pool issues by educating the public through outreach programs. Finally, these groups can initiate suits if they believe that local or state law is being ignored in the permitting process.

Consultants. Consultants are often hired to provide expert guidance to commissions and developers. They bring knowledge and experience to the planning process, allowing decisions to reflect the latest science and planning strategies. They are hired to do town-level wetland inventories and delineation, design monitor-

ing programs to assess an area's health, or act as expert voices in development planning. Their work can help avoid lawsuits over improper development and generate a more proactive planning process at the local level.

Development groups. Development groups seek to enhance or modify the built environment. They serve as a stimulus for growth and development. Developers convey their concern about overly restrictive laws and improper mitigation and minimization strategies by lobbying town commissions and maintaining national advocacy organizations. Although they are not opposed to wetland protection, developers are concerned about the inconsistencies of IWWA enforcement and emphasize the need for uniform standards.

Scientists. Scientists and amateur naturalists are interested in understanding the interactions between different parts of natural systems. Vernal pool research ranges from information on amphibian behavior and development to nutrient cycles and vernal pool hydrology. To influence the vernal pool policy process, scientists rely mostly on increasing public awareness. This can be done through publications, lectures, conferences, and the recruitment of volunteers for fieldwork.

Educators and the media. Educators and the media are interested in vernal pools as a means to teach people about the environment. Through newspaper articles, school lessons, and outreach programs, educators seek to increase awareness and public interest in vernal pool protection. Classroom work and nature walks create enthusiasm that may develop into a movement for wetland conservation.

Current Constraints to Vernal Pool Protection

Vernal pool protection is constrained by several factors, which fall into two broad categories: ecological (problems related to vernal pool biology and technical elements), and social/policy (including legal and governmental concerns as well as social issues). Ecological hindrances to vernal pool protection include the difficulty in identifying ephemeral wetlands and the need for upland protection. Social/policy problems include the lack of explicit protection in existing legislation and the resultant lack of consistent implementation, a general distrust of government, and the difficulty of proactively identifying vernal pools—especially on private land.

Ecological Factors

Vernal pools are important because of their unique hydrology, ephemeral nature, and rich species assemblage. These factors allow pools to support tremendous amphibian diversity. Unfortunately, their ephemeral nature often makes them difficult to identify. Most

commissions consult town wetlands maps (derived from US Department of Agriculture Natural Resource Conservation Service soil classification maps) when trying to identify vernal pools. These maps identify wetlands based on soil drainage; unfortunately, they do not delineate wetlands by category. The maps typically use a coarse resolution that often overlooks vernal pools. Consequently, on-site assessment is the only sure means of identification. Many proposals escape site-specific review if vernal pools are not identified on the town wetland map—the developer may never come before the IWWC. To address this, several towns have begun to proactively identify vernal pools. By demarcating the pools in the spring, commissions can be more responsive to development permits as they are submitted.

Juvenile amphibians may disperse >1 km from vernal pools (Berven and Grudzien 1990), necessitating upland protection. It is estimated that upland areas 10–20 times larger than the vernal pool must be protected to ensure species survival (M. Klemens personal communication). Upland protection is also critical for adult amphibians, which spend most of their lives in the surrounding terrestrial habitat. Barriers to their movement include large bodies of water, row-crop agriculture, roads, and railroad berms. The habitat that must be protected is species- and site-specific: home range, slope, soils, forest cover, distance from other pools, and proximity to roads determine appropriate buffer sizes (Semlitsch 1998). Upland protection, coupled with site-specific determinations, may influence vernal pool policy.

Social/Policy Factors

Although the term “vernal” was explicitly added to the IWWA in 1995, it is not defined in the Act itself. By regulating watercourses that are “vernal or intermittent,” the IWWA simply extends jurisdiction to ephemeral bodies of water. This lack of specificity could lead to greater protection, providing a safety net that could potentially capture any facet of a vernal pool (e.g., obligate organisms, drainage patterns, and hydrophilic vegetation) if it is used broadly. The flexibility of the IWWA definition might also act as a filter, removing potential vernal pools from consideration if they do not fit a few narrowly defined criteria. The precise definition of a vernal pool in future regulation will significantly impact protection efforts.

Because the IWWA is implemented independently by each of the 169 towns in Connecticut, regulatory standards vary widely. These variations follow political rather than environmental boundaries. Some of this inconsistency may be attributed to differences in funding and education. While some commissions are fully staffed, others rely on part-time employees. Similarly, a

commissioner may be formally educated in wetland conservation (e.g., a soil scientist), an enthusiastic layperson, or merely have a political interest in the topic. The permitting process is consequently unpredictable, and developers cannot anticipate what a particular commission will require. This inconsistency may lead to a “race to the bottom” as developers target municipalities with reduced wetland protection (J. Luzier personal communication). Over time, communities with strict wetland regulations may therefore see their economic base diminish. Although inconsistent protection can be reduced through a uniform statewide policy, local politics may limit the efficacy of this alternative. While municipalities are often unable to protect vernal pools, local empowerment is extremely important to many commissions that may resent state government intervention.

Another constraint on stricter legislation is a general distrust of government and regulation. Landowners resent the multistage process required for authorizing development and the public is unlikely to support additional regulations. Policies that streamline the process are likely to enjoy public approval and support. Regulatory resistance may be lowered if legislation is supported by scientific and factual evidence (P. Tevino personal communication).

Vernal pool identification restricts protection policies in the policy arena as well. To ensure protection, pools should be identified before development proposals are submitted. Any effective policy must address the limitations of wetland maps, the lack of rigorous identification by many municipalities, and the inadequate education of commissioners about dry-season pool identification. The current regulatory structure may simultaneously lead to over- and underregulation. For example, commissioners may overprotect seasonally flooded, yet ecologically unremarkable bodies of water while overlooking biologically valuable vernal pools.

In addition, even towns that undertake a comprehensive springtime survey may encounter difficulties with private-property access. Restricted access may also create problems when surveying a site for development: vernal pools present beyond the property line will remain undetected during most site assessments. Regulators may create an incentive for landowners to allow access, however, by clarifying the potential benefits of having private property assessed at the town’s expense (D. Hoskins personal communication).

Suggested Strategies and Recommendations to Improve Vernal Pool Conservation

The policy sciences recommend thoughtful consideration of all possible solutions before selecting the

most effective alternative for implementation. The most suitable prescription can only be determined by studying all potential solutions. The best alternatives will vary according to the situation, the constituencies served, and current features of the policy process. The selection process can be difficult, but the contextual and problem-oriented policy science framework offers a rational approach.

Alternative Conservation Strategies

Before selecting a specific policy, it is important to consider as many alternatives as possible. Given the particular constraints, constituent interests, and other factors, decision-makers can then identify the most feasible solutions. As expected, many of the constituent groups interviewed offered very different alternatives for improving current vernal pool conservation. Although many of their suggestions are complementary, others overlap or even contradict each other. Together, they reflect the diversity of opinions on this complex issue. Below, we highlight the main alternatives proposed during our discussions with different constituent groups.

Some constituents recommended a laissez-faire strategy for vernal pool protection. They reason that local awareness about vernal pools appears to be increasing. Similarly, the likelihood of vernal pool conservation is also growing. However, suburban development and habitat fragmentation will also continue. These conflicting pressures and weak or uneven local regulations render the continued viability of native amphibian populations questionable unless action is taken. In areas where development and habitat fragmentation has occurred, even strict laws regarding vernal pool protection have not prevented species loss and the invasion of disturbance-tolerant species (M. Klemens personal communication).

Many constituents recommended changing state regulations. Some participants maintained that it would help standardize variable levels of vernal pool protection. Others said that this would be time-consuming, expensive, and politically unpopular. One option would be to add a clause to the IWWA standardizing upland buffer widths using either a prohibitive or negotiable buffer. State officials suggested that a legislative guideline could reduce conflicts, while commissioners believe local autonomy will be undermined if buffer width is mandated (V. DeMasi personal communication). Scientists also had reservations about a uniform guideline, maintaining that site sensitivity varies according to soils, topography, and species composition (E. Jokinen personal communication). If the revised guidelines were more stringent, developers and

property-rights advocates might also organize and lobby against them.

Another potential regulatory change would place the burden of proof on developers, denying permit approval unless they can show that an area is not a vernal pool ecosystem. This can be done by mandating that consultants inspect the area during the amphibian-breeding season. This alternative eliminates the need to proactively identify vernal pools. However, delaying the development process for up to ten months on sites that may or may not have a vernal pool would be extremely unpopular. Additionally, spring site-analysis may not be necessary, as professionals are able to determine whether an area is likely to support obligate vernal pool species regardless of the season.

Most groups supported increasing education and outreach. A strategic plan might include both general awareness-raising activities for a diversity of audiences along with technical support for land-use planners at various levels. Since many resources currently exist, there would be little need to develop new materials. Connecticut also has a strong and diverse network of formal and informal science education organizations that could be an important resource (e.g., the Connecticut Amphibian Monitoring Project). These existing resources could be used to achieve the determined awareness, technical support, and education goals.

Several constituent groups suggested increasing vernal pool research. Unfortunately, this approach relies on sufficient funding and the availability of professional researchers, some of whom may be unable to assume new responsibilities. Suggestions for important research topics included: (1) amphibian metapopulation dynamics of vernal pool and upland ecosystems (extirpations, genetics, barriers to connectivity, juvenile dispersal, etc.); (2) upland habitat use by adult/juvenile amphibians (migratory distances, site fidelity, the effect of topography on migration, etc.); (3) the impact of mitigation measures, such as differential buffer zones or silt fencing, on amphibians; and (4) the effects of fragmentation on vernal pool species diversity. *Ambystoma* sp. salamanders can be tracked using radiotelemetry techniques, providing the ability to answer many of the above questions (H. Gruner personal communication).

Directing resources toward this research might require a cooperative effort involving universities, The Nature Conservancy, the State Department of Environmental Protection, and environmental organizations. Several groups suggested the formation of a research task force consisting of representatives from these organizations. The task force would recruit students, interns, and consultants for specific research efforts. This

task force might serve as a clearinghouse for their findings and link to other efforts.

Many groups suggested methods of increasing vernal pool protection without changing state regulations. Their suggestions included: (1) evaluating protection measures needed for vernal pools on a case-by-case basis (specific requirement will vary depending on soils, topography, and road proximity); (2) protecting intact landscapes rather than isolated pools that may suffer attrition of species diversity and habitat quality over time; and (3) building partnerships. Partnerships already exist between scientists, consultants, planners, and commissioners. Developers and landowners have also developed partnerships with consultants and commissioners, although they are more likely to favor property rights. Municipal leaders and commissioners throughout Connecticut can learn from each other's knowledge and experience.

Another suggestion was proactive identification of vernal pools. Aerial photography, complemented by ground-truthing of selected areas, has a greater than 90% success rate in vernal pool identification (S. Jackson personal communication) and could effectively achieve this goal. Although this might be expensive, towns could reduce development conflicts if vernal pools were identified and protection prioritized. With this information, developers can design site-sensitive plans from the outset. However, some individuals rejected this alternative, maintaining that project-by-project surveys are effective and far less expensive. There was an overall consensus that vernal pool identification methods should be made more reliable and widely known.

Incorporating vernal pools into zoning and land-use planning was a controversial alternative, since the level of proactive planning varies widely across the state. Mechanisms for incorporating vernal pool considerations into planning included: (1) prioritizing the protection of intact vernal pool habitat over individual pools; (2) conservation and development plans that consider watersheds as well as political boundaries; and (3) allowing for a developer's flexibility and creativity in approaching wetland protection (J. Nolon personal communication). Vernal pool preservation might be integrated into open-space planning at the local, regional, or state level. A statewide approach might allow the preservation of vernal pool ecosystems that are representative of Connecticut's ecological diversity.

Recommendations for Effective Conservation and Management

An evaluation of the proposed alternatives leads to what we believe is a practical protection strategy. Be-

cause policy selection and implementation for land-use planning occurs at both the municipal and state level in Connecticut, effective policies involve changes in both areas.

State-level efforts are needed to create a cohesive network of vernal pool regulations. State Conservation and Development plans could be amended to distinguish vernal pools from other types of wetlands, thus increasing awareness. Vernal pools could also be identified as state critical habitats, allowing for increased protection.

To coordinate protection across town boundaries, some form of linkage between vernal pool interest groups is recommended. This vernal pool association could take a number of forms. The group could be structured as a formal organization with periodic meetings, exist as a series of loosely connected committees focused on vernal pool issues, or simply be a contact list of interested people and organizations to whom questions could be directed. Without some form of organization willing to take a leadership role, the momentum for regulatory improvement will likely remain unfocused and only affect issues at a local scale.

At the local level, planners can work with existing regional, state, and national groups that support resource protection. If local funding for vernal pool identification, open-space acquisition, or conservation easements is lacking, municipalities may choose to share resources with neighboring towns. Neighboring commissions often provide an important source of information, technical expertise, and enthusiasm. To this end, we recommend that town planners, conservation commissioners, and IWW commissioners improve conservation planning by organizing local focus-groups that address the following issues:

1. *Assessment of vernal pool protection at the municipal level.* The focus group should determine if the status quo is acceptable to each constituency. If the group opts to change existing policy, it should first identify common interests shared by the different participants. For instance, members can work together to improve the quality of life for town residents or to enhance local enjoyment of natural resources.
2. *Education, outreach, and partnership building.* If vernal pool ecosystems are being fragmented or otherwise degraded, the local causes of this degradation should be determined. The group should identify target audiences for an education campaign or outreach effort. Successful examples can be used by other municipalities to improve wetland protection.

3. *Strategies for vernal pool identification and prioritization.* Connecticut is overflown for aerial photographs every five years when the trees are leafless. A professional can detect vernal pools in these photographs with reasonable accuracy; this could be an important and low-cost resource for proactive town planning.
4. *Land-use planning and zoning alternatives.* Constituent groups can come together to provide creative alternatives for land-use planning and zoning. The focus groups convened to deal with these issues should include representation from the following categories: (a) scientists, consultants, and environmental advocates; (b) state-level representation from the DEP and the US Department of Agriculture Natural Resource Conservation Service; (c) local government representatives, including commissioners and town planners; and (d) developers and property rights advocates. Although it may be difficult to coordinate involvement from each of these categories, a focus group will be more effective if it includes representatives from all constituencies. Members should be flexible, willing to negotiate, and share a commitment to the overall process of vernal pool protection. It may be beneficial to begin the process by having the group explicitly define local problems with vernal pool protection, and use this information to identify a shared goal. By focusing on the agreed-upon goal, the group should be able to discover common ground that can be used as a foundation. If the process is in danger of being dominated by special interests, the group may wish to appoint a neutral and trusted facilitator to guide them toward agreement on acceptable vernal pool protection strategies.

We assembled interdisciplinary teams similar to the focus groups proposed above during the one-day vernal pool symposium held in May 1998. Each team included participants with diverse perspectives about vernal pool protection in the state. Different constituencies worked together to identify solutions to complex scenarios. The teams first highlighted the conflicts presented by each situation and then proposed policy alternatives that might enable them to address these competing interests.

Participants judged this exercise to be very successful. By encouraging discussion, traditionally adversarial groups identified common interests and worked cooperatively. By forcing participants to identify how other constituencies would be affected by their solution, the teams learned to work together. This problem-solving

exercise led to creative and thoughtful solutions that considered all interest groups. Such an understanding of the complex issues presented would have been unlikely had the teams been more homogeneous.

By using informal working groups, as above, diverse constituents can find ways to identify effective solutions. A town may choose to implement this kind of proactive planning activity as an integrated part of an existing conservation and development planning process. Alternatively, towns may choose to organize a separate vernal pool committee in order to remain task-focused. Regardless of the group's composition, the structured participation of diverse interests in the planning process should result in vernal pool protection strategies that reflect consensus as well as conservation.

Conclusion

Vernal pool conservation in Connecticut is a problem whose solution requires a variety of approaches. Each of the constituent groups interviewed had legitimate concerns, values, and suggestions for dealing with this complex issue; however, many of them fought each other rather than working together to identify a common interest. In suggesting ways to deal with this issue, it is important first to understand the historical trends that have shaped current laws and attitudes. Next, the constraints on the current situation, which determine the range of possibilities, need to be evaluated. Only then can each constituent group's strategies be evaluated and recommendations produced. By working to include, rather than exclude, participants, an initiative at both the state and local level may have its best chance of success. Ephemeral wetland conservation is dependent on many different factors, and only by building partnerships between groups can effective protection be achieved.

Although our effort resulted in the useful creation of partnerships between widely different constituencies, problems remain that need to be addressed. In particular, a leader did not emerge to follow through on the suggestions made in our final report. Although participants were enthusiastic about our recommendations, implementation requires considerable work and dedication. Without a contact person or organization to provide leadership and technical support, inertia may prevent most of our recommendations from being adopted. In addition, constraints to vernal pool protection, such as a lack of effective financing, the difficulty of identifying vernal pools, and the varied nature of policy implementation, have not changed and will have to be dealt with on a local level. Despite these concerns, however, sufficient interest and technical ability exist to

implement many of our suggestions. By building partnerships between the different constituencies, it is hoped that consensus rather than confrontation will mark the future of vernal pool conservation in Connecticut.

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