$8.00

Southern Wallkill Biodiversity Plan

Balancing Development and the Environment in the Hudson River Estuary Watershed

METROPOLITAN CONSERVATION ALLIANCE

A PROGRAM OF

WILDLIFE CONSERVATION SOCIETY

MCA TECHNICAL PAPER SERIES: NO. 8

Southern Wallkill Biodiversity Plan

Balancing Development and the Environment in the Hudson River Estuary Watershed

by

Nicholas A. Miller, Michael W. Klemens, and Jennifer E. Schmitz

Metropolitan Conservation Alliance
Wildlife Conservation Society
Bronx, NY

Cover photograph: Black Meadow Creek, Orange County, NY. ©WCS/MCA, Kevin J. Ryan

Suggested citation: Miller, N. A., M. W. Klemens, and J. E. Schmitz. 2005. Southern Wallkill Biodiversity Plan: Balancing development and the environment in the Hudson River Estuary Watershed. MCA Technical Paper No. 8, Metropolitan Conservation Alliance, Wildlife Conservation Society, Bronx, New York.

Additional copies of this document can be obtained from:

Metropolitan Conservation Alliance
Wildlife Conservation Society
68 Purchase Street, 3rd Floor
Rye, New York 10580
(914) 925-9175
mca@wcs.org

ISBN 0-9724810-5-2

ISSN 1542-8133

Printed on partially recycled paper

© Linda Gette

In memory of Ann Botshon

Her tireless work to conserve the Wallkill Valley
continues to inspire us all

ACKNOWLEDGEMENTS

This project would not have been possible without the enthusiastic collaboration and support of our key partners: the towns of Chester, Goshen, and Warwick, and the Village of Warwick. These communities have helped to guide this project and have contributed to its success through outreach to their citizenry and active engagement at meetings and planning charettes. We extend thanks to all of our partners within these communities (including many elected and appointed officials, town staff, volunteer board members, and concerned citizens) who have moved this project forward and who continue to make conservation of biodiversity a priority within their towns. Valuable data and logistical assistance were shared by The Orange County Planning Department, Orange County Land Trust, OCLT's Wallkill River Task Force, NYS Department of Environmental Conservation's Hudson River Estuary Program, and New York Natural Heritage Program, among others. Generous financial support for this project was provided by NYS DEC's Hudson River Estuary Program, the Doris Duke Charitable Foundation, and Surdna Foundation.

WCS/MCA greatly appreciates the extensive efforts of the survey subcommittee in support of this project: Todd Vogel, Dan Duthie, Anita Nilon, Ann Botshon, Mayor Michael Newhard, and Supervisors Honey Bernstein, Bill Tully, and Michael Sweeton. WCS/MCA field biologists collected most of the data that serve as the foundation of this map and report; field biologists included Julian Avery, Spider Barbour, Andrew Block, Brian Houser, Tony Martinez, Kristi MacDonald, Diane Murphy, Chris Raithel, Brandon Ruhe, Kevin Ryan, Jason Tesauro, Chris Valligny, and James Vellozzi, among others. WCS/MCA also appreciates the cooperation of private landowners throughout the Southern Wallkill communities.

TABLE OF CONTENTS

INTRODUCTION

Background Information

The Southern Wallkill Biodiversity Plan (SWBP) project is a partnership between the Wildlife Conservation Society's Metropolitan Conservation Alliance (WCS/MCA), the NYS DEC Hudson River Estuary Program, and the three contiguous towns of Chester, Goshen, and Warwick, including villages and hamlets within these towns. The goal of the project is to establish a regional, multi-town approach to land use planning to promote the conservation of wildlife and habitats. This project builds upon a model developed by WCS/MCA in other towns, regions, and states. These three towns were selected because they contain an impressive diversity of wildlife and habitats, because they are under development pressures that threaten those natural resources, and because there is a growing concern within these towns about the costs of sprawl to the environment and to human health and well-being.

The Southern Wallkill Region

The portion of the Southern Wallkill Region included within this biodiversity plan encompasses the southern and central towns of Orange County, including Chester, Goshen, and Warwick. It is bounded to the west by the Wallkill River, to the south by the State of New Jersey, and to the east by the Highlands. The region comprises diverse landscapes—from black dirt agriculture and remnant cedar swamps of the valley floor, to higher elevation fields and pastures, to the forested highlands in the south and east.

This region, once containing a pastoral mix of forest, agriculture, hamlets, and villages, is experiencing rapid change. A wave of sprawl is pulsing through the region, altering historic landscapes and putting its natural resources at risk.

But vibrant habitats and diverse assemblages of wildlife are found in all three towns. There is still time to minimize and contain the effects of sprawl; but this can only be achieved by finding alternative development patterns that can strike a better balance between economic growth and environmental integrity. This balance is necessary, not only to maintain biodiversity, but to retain the diverse and scenic landscapes that are at the very core of the "sense of place" defining each of these three towns.

CONCEPTS AND ISSUES

Biodiversity in the Southern Wallkill Region

The rich tapestry of genes, species, ecosystems, and their interactions are collectively referred to as biological diversity, often shortened to "biodiversity." The Southern Wallkill towns are home to significant habitats and rich assemblages of wildlife, due to a unique convergence of factors:

1. The diverse geological variation within these towns serves as a foundation for a wide variety of habitats. Features such as limestone outcroppings, glacial till, granite escarpments, and Pleistocene lake bottoms all give rise to distinctive habitat types, which in turn support many unique and rare species.

2. The geographic position of the Southern Wallkill region is at an ecological crossroads, which contributes to the diversity of plants and animals found here. At the close of the Wisconsin glaciation (ca. 15,000 years ago) plants and animals moved into and repopulated southern New York from a variety of routes, including the Wallkill Valley, the Atlantic Coastal Plain, and from the Midwest via the Mohawk Valley. These routes converged in southeastern New York's lower Hudson Valley.

3. Low-intensity development has preserved many of the ecological treasures of the region. The pattern of small rural villages with intervening open space has fostered both scenic and biodiversity values. Although the status quo is changing rapidly in some areas, large tracts of relatively pristine habitat remain in many areas of the region.

4. The presence of active agriculture has maintained many of the important grassland and similar early-successional habitats within the region. The importance of farmland to biodiversity has only recently been recognized. Preservation of *working* landscapes is not only an issue of community character, but has tremendous value for wildlife.

5. Biodiversity within the three towns is represented by both widespread species and species that are declining in the Wallkill Valley and throughout the Northeast, including many that are on state and federal lists of endangered, threatened, and special concern wildlife. Species such as the bog turtle, marbled salamander and box turtle are near the northern limit of their natural range in the lower Hudson Valley. The stewardship of such species becomes increasingly important as the world's climate changes, potentially causing their ranges to expand northward. Stewardship of all of the region's biodiversity has conservation value that extends far beyond the towns, adding value to broader conservation efforts in New York and throughout the Northeast.

Importance of Biodiversity in this Region

It is often argued that biological diversity has its own inherent value, that it is our obligation to preserve biodiversity for its own sake. However, when development and sprawl are pitted against biodiversity concerns, land use practitioners often need more than an ethical argument based on "inherent value" to make a decision in favor of biodiversity. Therefore, it is important to note that communities directly benefit in many ways from their biological resources and that these services can often be measured in tangible terms, including economic terms and human health and welfare. The following paragraphs provide a rationale for including biodiversity as one of the fundamental foundations of sound land use decisions.

- A major benefit of biodiversity is its direct impact on human health, including the prevalence of Lyme disease. Research conducted here in southeastern New York has revealed that the diversity of small mammals (e.g., mice, moles, voles, shrews) is reduced by forest fragmentation. The small mammal that ends up dominating these isolated fragments—the white-footed mouse—is the primary reservoir (or "carrier") of the Lyme bacterium. The risk of Lyme disease is much lower in intact forest ecosystems where the infection rate is diluted by a diverse small mammal fauna. By maintaining larger tracts of interconnected forest habitat, we can maintain high biodiversity levels and simultaneously reduce human health risks (Allan et al. 2003).

- Biodiversity provides important recreational opportunities, including hunting, fishing, hiking, bird watching, and photography. Recreation opportunities often directly translate into economic gain for communities.

- Actions to protect and plan for biodiversity in the Southern Wallkill Region will aid in major, ongoing efforts to increase water quality in the Hudson River and throughout the river's watershed.

- Biodiversity provides a scenic backdrop to the daily activities of the Southern Wallkill Region's citizens. Rocky ridgelines cloaked in green forests, maple swamps glowing red as their leaves turn in autumn, grassy fields shining with dew on spring mornings—these are the stages on which we act out our daily routines. These settings can bring peace of mind back into our busy lives.

- Bees, butterflies, and other pollinators have a direct influence on agricultural crop yields and the vitality of gardens. These factors benefit the economy and human welfare.

- Forests, wetlands, fields, and associated wildlife and plant communities serve as important outdoor laboratories used by schools and nature centers.

- Research goals of the scientific community have begun to shift. Rather than focusing on the negative impacts that humans have on the environment, research is beginning to ask more pertinent and useful questions such as "do people benefit when they protect and maintain the environments in which they live?" As illustrated in the previous examples, the answer appears to be decidedly in the affirmative.

- Wetlands provide an excellent case study of how, by maintaining biodiversity, humans can reap substantial benefits. Many wetlands are extremely biologically diverse, which is sometimes a rationale provided for their protection. But wetlands protected for their biodiversity also provide a variety of ecological services to people (Smith et al. 1995). Because of their ability to temporarily store floodwaters during storms, they help to reduce and eliminate damaging floods. Wetlands uptake and store pollutants, resulting in cleaner, safer water. Their dense vegetation and unique soils store carbon, reducing global warming. Some wetlands recharge groundwater aquifers and maintain base flow in streams and rivers during drought.

The diversity of wildlife populations within a town or region is a direct measure of ecosystem health; therefore, it is also a measure of the ability of these ecosystems to provide important and cost-effective services to our communities. The benefits of maintaining the Southern Wallkill Region's biodiversity are far-reaching. Issues of water quality, water quantity, rural aesthetics, and human health are all closely intertwined with biodiversity. A biologically diverse landscape is resilient to change and provides an insurance policy that the ecological services in our communities will continue, now and into the future.

Biodiversity and Local Land Use Planning

Biodiversity receives some protection through State and Federal regulations. These laws, however, are not designed to protect the ecological function of the Southern Wallkill Region. Federal and State species protection encompasses a small subset of biodiversity—those species that are at greatest risk of disappearing. These threatened and endangered species are akin to critically ill patients. It will take an extraordinary allocation of resources to recover these species. Work by WCS/MCA has demonstrated that as much as 75% of the region's reptiles and amphibians (far more than are listed) are in long-term, non-cyclical declines. Reliance on regulations is insufficient to protect these species and increased regulatory strictures are often politically unpalatable. In addition, it is not feasible to preserve (through land acquisition or easement) the entire network of extensive, interconnected habitats that would be necessary to maintain the region's biodiversity.

We discard the premise that municipalities have only one tool—land preservation—to conserve biodiversity. This premise is based on the limited view that properties must either be completely preserved or completely destroyed through development. This premise must be replaced by one recognizing that *thoughtful* development adds value to and interconnects protected areas. In fact, even large protected areas, such as the 4,300-acre Ward Pound Ridge Reservation in Westchester County, cannot survive without appropriate planning in the surrounding privately held, developable lands (Miller and Klemens 2002a).

Therefore, ***protection of the Southern Wallkill region's biodiversity will require proactive action at the local land use decision-making level.*** Apart from sustaining biodiversity at the local level, a scientifically informed, landscape-scale approach to biodiversity management will prevent site-by-site conflicts over the ecological value of lands. This approach will help focus development into areas where it will have less impact on the ecological fabric and function of the region. By planning with nature, Southern Wallkill municipalities can create quality

communities for future generations where human progress is in greater harmony with the natural world.

Project Premises and Goals

All too often, land use decisions are made at the municipal level without the benefit of baseline biological information or without any mechanisms to integrate such information into planning processes. This occurs despite significant efforts of concerned citizens and municipal officials. The gap between information providers (scientists) and information users (local decision-makers) creates a major obstacle. WCS/MCA has identified three fundamental challenges that lead to this situation:

Baseline data are generally not available: Without such data, it is impossible to plan for economic growth while simultaneously ensuring environmental integrity. Baseline ecological data can be used to identify areas of biological significance worthy of protection *and* to identify areas of lesser significance. Development could be channeled toward the latter areas, thus reducing the level of impact on ecologically more sensitive areas. For these reasons, one of the project goals was to collect new biological data. These data have been used to generate a map, indicating areas of importance for wildlife within the Southern Wallkill Region (see Results & Discussion).

Even where data are already available, mechanisms rarely exist to translate the information into policy: To address this problem, WCS/MCA has been developing a set of tools—a "conservation toolbox"—that will aid planners and other decision-makers in the application of biological data. These tools, published as the WCS/MCA Technical Paper Series, are targeted at a broad constituency to address land use issues within the tri-state region. A list of available tools is provided in Appendix B.

Biological data and conservation tools are ineffective unless they are accepted as part of a community's goals and integrated into land use planning practices: Those concerned with the protection of biodiversity need to more fully embrace the legitimacy of competing goals and uses on the land. Environmental advocates are often very good at saying "no," but much less adept at asking "how?" How can we work together to create patterns of development that are more biologically sensitive and sustainable? WCS/MCA strives to raise awareness and understanding of biodiversity concerns among municipal officials, land trust personnel, and others who influence the patterns of development upon our landscapes. This is accomplished by serving in an advisory capacity to planning boards and other entities, providing workshops that focus on the relationship between biodiversity and land use planning, and promoting inter-municipal, cooperative efforts to plan for biodiversity.

To summarize the above statements, a primary goal of this project was to address the impacts of sprawl on natural ecosystems by: (1) providing baseline scientific information, (2) developing innovative tools, and (3) integrating those elements into the land use decision-making process. These steps will create a platform for more thorough municipal and inter-municipal discussions of opportunities and challenges.

Land Use Changes and Biodiversity

Transitions

The tri-state region surrounding New York City has undergone substantial and widespread land use changes over the past several hundred years. Before settlement by European immigrants the landscape was primarily composed of extensive, unfragmented forests, interspersed with open habitats (such as coastal plains, beaver-created wet meadows, and forest gaps created by wildfires). By the 18th and 19th centuries, most of the forested habitat had been converted to agricultural lands. During this agricultural period, areas unsuitable for farming (e.g., wetlands and very steep slopes) served as "refugia" for much of the region's wildlife communities. Although current development pressures impinge on such areas, they remain some of our most biologically rich and unique habitats. More recently, farms have been abandoned as agricultural land uses shifted to states further west. Through natural successional processes, most former farm fields have reverted back to forests; some are still in a transitional state, consisting of old field or shrubland habitat.

The key elements in the above transitions are resiliency and connectivity. As land uses changed over time, many wildlife species and other components of the natural environment were able to adapt and even thrive. For instance, with the onset of agriculture bog turtles began to make use of wet meadows maintained as open habitat through the light grazing of domestic cattle, rather than their traditional wildfire-created or beaver-maintained habitats. Certain grassland-associated birds, such as the bobolink and the eastern meadowlark, make use of hayfields as a surrogate for their native grassland breeding habitats.

Today's land use patterns are entirely different from those of historic times. Resiliency is not an option for most species. In the current wave of sprawl, permanent structures are erected. Highways, parking lots, and subdivisions fence in remaining tracts, fragment them into smaller pieces, and isolate them from other tracts. All of these factors increase the likelihood of local extinctions (i.e., extirpations) of species in the near-term. Habitat connectivity will become increasingly important in the long-term, as global warming proceeds. Species will need to migrate northward to adapt to new temperature regimes and resulting changes in habitat structure and composition; where sprawl blocks this migration, species are likely to face extirpation. The transitions that are occurring within our landscape today are more permanent than past changes and they do not accommodate our native biodiversity. The few wildlife species that have adapted to such changes are opportunistic and invasive species that thrive at the expense of a more diverse and balanced biological community (e.g., white-tailed deer, Canada geese).

Landscape configuration: Planning at the landscape level

As sprawl proceeds, large tracts of habitat within our landscape are fragmented into ever smaller components. To maintain biodiversity, we must ensure that remaining habitats are of sufficient acreage to support viable wildlife populations *and* that they are arranged in such a way to allow dispersal of animals across the landscape. Although careful planning can mitigate some of the adverse impacts of such development, most planning occurs on a site-specific scale, and does not consider the much larger landscape-scale picture. Ironically, the land review process, as practiced in the towns of the SWBP, may actually foster fragmentation by taking a "hard look" at

too small of an area, as required by the New York State Environmental Quality Review Act (SEQRA).

To ensure that development is compatible with biodiversity, core wildlife habitat areas and the corridors that connect them must be accommodated. In general, larger core areas (i.e., hubs) are better able to support healthy, viable wildlife populations than smaller areas. The connections between hubs are of paramount importance; they enable dispersal of animals among the hubs, maintaining gene pools and preventing extirpations (i.e., localized extinctions). Such connections have traditionally been referred to as "corridors." Corridor is an appropriate name because it implies movement from one area to another. However, that name may also be misleading. A wildlife corridor is not a narrow, linear green strip between habitats. It is highly unlikely that such strips, which are often associated with walking paths or bike trails, would be used by most wildlife. Instead, WCS/MCA's definition of a corridor is a broad swath of habitat that connects habitat hubs. Although these swaths may not be as pristine as the parks or the hubs that they connect, they do provide secondary habitat (in addition to their role as dispersal corridors). The movement of wildlife across the landscape could be likened to the sheet flow of water across land during a flood. Development should be located so that there are sufficient spaces for wildlife to move through and around development nodes, rather than attempting to force wildlife movements into anthropogenically-dictated linear configurations.

Because we are making permanent changes to our landscape, it is imperative to carefully identify where the matrix of wildlife habitats and corridors occurs. It is not sufficient to randomly protect small parcels of habitat across the region in the hope that they will be beneficial to wildlife. Instead, we must discover where species already occur (i.e., which habitats are best) and use this information as a template for making future land use decisions. If we apply this template to guide development patterns, it may be possible to maintain biodiversity and ecological health. Without this template to guide us, loss of biodiversity is a certainty.

This approach may sound simple, but it constitutes a 180-degree shift from the way development has been planned for, to-date. Instead of erroneously assuming that natural resources will rearrange themselves around a development, we must understand the resources by gathering data and then fit the development in appropriate places. In the long-term, this approach is both cost-effective and logical.

Agriculture and Biodiversity

While our region's ridgelines have received a great deal of attention from the conservation community—leading to extensive and much-needed protection of the Highlands—the valleys between the ridges have received much less attention (with the exception of pioneering work by the Orange County Land Trust, county and municipal governments, and a handful of other entities). This relative lack of conservation engagement in the working landscapes of the Wallkill Valley can be attributed to numerous and complex challenges. The land is divided into multiple ownerships, has increasingly high economic value, and is subject to a wide variety of competing land uses. However, conservation efforts in these agricultural lands are vital to achieve both ecological integrity and economic stability across the entire region.

The Wallkill Valley is critical for dispersal of wildlife, including area sensitive mammals such as bear and bobcat moving between ridgelines. But these valleys, because of their agricultural land use history, also support a unique assemblage of wildlife dependent on early-successional habitats. Examples include the imperiled bog turtle (which occurs almost exclusively in agriculturally-influenced lands; see Klemens 2001), grassland songbirds (e.g., upland sandpiper, eastern meadowlark, bobolink, savannah sparrow, grasshopper sparrow), ribbon snakes, leopard frogs, blue-spotted salamanders, and a host of other species that are disappearing as large blocks of land, formerly kept open by agriculture, give way to sprawling subdivisions.

While some farms and farming practices (e.g., large-scale agro-industry operations) cause damage to habitats and ecosystems, other farms (e.g., small-scale family and artisanal farms) support species that are disappearing as urban areas sprawl into rural countryside. Intensive agricultural practices within the black dirt region have eliminated many amphibian and reptile species from the landscape, leaving only the most common species associated with the region's ditches. However, some declining and state-listed bird species make use of the broad, open expanses of the black dirt region at various times of the year, particularly in black dirt areas near the Wallkill River. These include declining and state-listed species such as savannah sparrow, grasshopper sparrow, northern harrier, and migrating shorebirds. However, the fields and pastures situated at elevations between the black dirt farms and the highlands often provide exceptional biodiversity—particularly farms with moderate-intensity agricultural practices.

Traditional conservation practices that focus only on preservation are ineffective at maintaining the biodiversity of working, agricultural landscapes. The unique suite of species associated with agriculture disappears as fields succeed to second-growth forest. To conserve the Wallkill Valley's biodiversity, we must look beyond just preservation and employ a broader range of conservation techniques to ensure that farming continues. In the Wallkill Valley, a working landscape is a healthy landscape. Potential solutions include Purchase of Development Rights (PDR) programs (already employed by several towns); finding new and sustainable markets for local, biodiversity-friendly farms; and outreach programs that demonstrate the link between agriculture and biodiversity (e.g., see the partnership between WCS/MCA and Glynwood Center at www.http://www.moveablefeastforwildlifeandpeople.org).

METHODS

Building an Intermunicipal Alliance for Biodiversity

The Southern Wallkill Biodiversity Plan is founded on a long history of WCS/MCA's work in the southern Wallkill Valley. From studying the federally-threatened bog turtle, to working with partner organizations, to sponsoring programs such as the "Countryside Exchange" with Glynwood Center and the "Community Leadership Alliance Training" with Pace University's Land Use Law Center and Glynwood, WCS/MCA has worked to develop an alliance for biodiversity across these communities. Establishing an alliance of dedicated people is necessary to ensure the success and implementation of the Southern Wallkill Biodiversity Plan, and years of outreach efforts were made to foster the growth of an alliance through lectures, workshop sessions, meetings, and conversations. These efforts brought wildlife issues and the need for eco-appropriate land use planning tools to the fore in many communities of the Wallkill Valley. Over time, a cluster of neighboring towns and villages—Chester, Goshen, and Warwick—emerged with a commitment to work in partnership with WCS/MCA to develop the Southern Wallkill Biodiversity Plan.

Site Selection

WCS/MCA selected sites for field surveys based on a number of criteria. Existing landscape configuration (see previous section entitled "Landscape Configuration") is of utmost importance in the site selection process. Sites were selected based on their potential to function as habitat hubs and based on their ability to serve as ecological connectors between those hubs. Some of the major hubs in the project area are already protected (e.g., Goose Pond Mountain State Park in Chester, and portions of the Highlands); however, the long-term conservation status of some of the other major hubs (e.g., Purgatory Swamp in Goshen, Mount Eve in Warwick) is far from guaranteed. Regardless of their protection status, hubs are surveyed, where possible, to determine their effectiveness as source areas for maintaining viable wildlife populations. Another primary criterion is the probability that a given site will be developed; that is, the "at-risk" status of a site. Baseline biological information is needed at the at-risk sites, more so than at any other sites. One obstacle is that it is often difficult to obtain permission to access at-risk areas and other privately owned lands. The towns of the Southern Wallkill Region were extremely helpful in obtaining permission for WCS/MCA biologists to access private lands.

Selection of sites in the Highlands region of southern and eastern Warwick and southeastern Chester was limited. This decision was based on the fact that the conservation community has focused much attention on this biologically important area. However, lower elevations within the Wallkill Valley—which are also critical for biodiversity—have traditionally received much less attention in terms of conservation, for a variety of reasons (see "Agriculture and Biodiversity" section for further details). Corridors mapped in the Highlands region (see Figure A) are based, to a large extent, on data provided by the New York Natural Heritage Program.

The site selection process was greatly enhanced by the availability of Geographic Information System (GIS) spatial datasets. Datasets that aided in site selection contained information about soil types, distribution of wetlands and waterbodies, land use/land cover, existing open space coverage, density of development, locations of roads, bedrock geology, elevation, and others. Digital aerial photography (orthophotography) was also crucial for selecting sites and for later analysis of data.

Access to Field Sites – A Coordinated Partnership

Significant and intact biodiversity resources persist in these communities, spanning an imaginary jigsaw puzzle of property lines and town borders. WCS/MCA conducted intensive field surveys on public and private lands in order to understand these resources at a multi-town landscape scale. Earlier in the project, efforts were focused on surveying protected land parcels, including town, county, and state parks and also lands owned by other organizations such as land trusts. Protected areas, if they are large enough, will often serve as "biodiversity hubs" and support a diversity of plant and animal communities. Yet in order for core protected areas to sustain healthy populations of local flora and fauna, connecting areas must exist between them to support the movement of wildlife and to ensure the overall health of the ecosystem. Private, unprotected lands can provide this support if land uses are planned in a way that maintains their ecological connections to core protected areas. Thus, gathering wildlife information on private lands is especially important in our efforts to develop ecologically-appropriate land use planning recommendations.

Efforts to survey privately-owned areas were coordinated through a partnership between one or two volunteers from each town (a "survey subcommittee") and WCS/MCA. The subcommittee worked closely with WCS/MCA to contact landowners and to request permission to conduct biodiversity surveys on their property. This coordinated partnership strengthened the Southern Wallkill Biodiversity Project in many ways—by introducing wildlife issues and related planning initiatives to local leaders and the wider community, and by fostering the development of a core group of individuals who took ownership of the project and will likely promote biodiversity concerns over the long-term.

Field Data Collection

Field surveys commenced in 1997, with major efforts occurring in 1998, 2000, 2002, 2003, and 2004.

Bird surveys occurred during the spring breeding season (mid-May through early July) in the early morning hours (commencing within a half hour of dawn) under relatively fair weather conditions (winds less than 10 mph, no rain). Species detection rates are maximized at these times and under these conditions. Transect methods were used in order to increase survey coverage throughout each site and to survey each major habitat type within the sites.

Reptile and amphibian surveys were conducted between March and October, with concentrations in March-April, May-June, mid-summer, and September. Survey techniques

included night searches (road-running), live-trapping with minnow/turtle traps, turning of cover objects, and larval dip-netting and identification.

Additional datasets were obtained to improve the quality of this Biodiversity Plan. The New York Natural Heritage Program made available their database of significant natural communities and rare, threatened and endangered species for use in this project. The Orange County Planning Department provided wildlife distribution data compiled during the creation of the Orange County Open Space Plan.

Field Survey Outreach

Besides collecting information on wildlife, field surveys additionally served as opportunities to provide outreach to local officials and the wider community. Through the site selection and survey process, the Southern Wallkill Biodiversity Project was introduced to a large audience of people across various sections of the community. At the conclusion of the field season, interim summary reports were distributed to local leaders which encouraged interest in local wildlife and pride in the natural diversity found in the community's own backyard.

The Focal Species Approach (FoSA)

WCS/MCA concentrates survey efforts on wildlife species, or species assemblages, that respond specifically to development impacts, including habitat loss and habitat fragmentation. Such species are termed "focal taxa," and can be further divided into two broad categories. Many focal taxa experience population declines as a result of urbanization. These species, referred to as "development-sensitive" focal species, are usually habitat specialists, with very specific habitat requirements that are compromised by development. Examples include many of the Neotropical migrant bird species and many of the vernal pool-breeding amphibians. Such taxa tend to disappear from the landscape as their habitats are altered or fragmented. Populations of other focal taxa increase in response to urbanization. These species, referred to as "development-associated" focal species, are usually habitat generalists, with much less specific habitat requirements. They tend to occur in areas that have already been degraded; human alterations to landscapes favor, or subsidize, these generalists. Avian examples of such species include Corvids (crows and jays) and Canada geese; an amphibian example is the bullfrog. White-tailed deer are also development-associated. As urbanization proceeds, development-associated species tend to increase and often replace development-sensitive species, resulting in an overall loss of biodiversity (i.e., species richness).

Both of these focal taxa categories provide valuable information about ecosystem health. It is the relative proportion, or "mix," of these two categories that reveals the most about the ecological integrity of any given site. WCS/MCA refers to the process of evaluating this mix, and its implications for ecosystem health and land use, as a "Focal Species Approach," or "FoSA." The results of a FoSA can enhance planning efforts by assessing the importance of individual sites for conservation. For example, development should be discouraged within areas that support healthy populations of development-sensitive focal species, and redirected toward sites that are already degraded (i.e., those that are dominated by development-associated species).

FoSA represents an innovative departure from traditional conservation efforts. By expanding the scope of investigation beyond State or Federally listed threatened and endangered species, we are able to more proactively conserve natural resources. There are many species, currently unlisted and unprotected, whose populations are declining in response to urban sprawl. At the current pace of urbanization, these species are highly likely to be candidates for official listing in the near future. Rather than waiting until they are on the brink of extinction (when recovery efforts are not only dangerously uncertain, but also very expensive), it makes better sense to attempt to address their habitat requirements and to stabilize their populations now. In addition, ecosystems contain complex interactions among many species. FoSA evaluates systems more reliably by considering a broad range of species and their relative abundances, as opposed to basing land use recommendations on a single threatened or endangered species. FoSA methods are not intended to replace existing and necessary efforts to conserve threatened and endangered species; instead, they add value to ongoing conservation efforts.

Lists of development-sensitive focal species vary from region to region because species ranges, habitat requirements, and responses to development also vary. The creation of the Southern Wallkill focal species list (Appendix A) was based on a review of literature that addressed development-sensitivity within the New York/New England region (e.g., Andrle and Carroll 1988, Klemens 1990, Klemens 1993, Bull 1998, Klemens 2000) and on observations of species distribution trends in the field. WCS/MCA focused, in particular, on birds, reptiles, and amphibians. Besides being particularly "reactive" to development pressures (and therefore good indicators of ecosystem condition), the presence and status of these taxa can be rapidly assessed in a relatively cost-efficient manner using established field techniques.

Data Management

All original field data were entered and stored in a Microsoft Access relational database. ArcView shapefiles were created to store locations of survey sites and species observations.

Much information is gained from site-specific, on-the-ground surveys. However, the purpose of this project was to plan for biodiversity at a scale that transcends individual sites—by evaluating conditions at a landscape scale. The field data collected as part of this project were very useful for our analyses, but it is critical to understand that they are not intended as a substitute for biological surveys in site-specific development proposals. All data collected during this project are available to each of the three towns, but rigorous standards should be applied during creation and review of development proposals. See the "Recommendations" section for further details.

Data Analysis

Mapping analyses for this project were conducted in ArcView using the following procedures.

1. *Focal Species Analysis (FoSA)*

   All focal species were displayed at each site (coded in two categories: development-sensitive and development-associated). At each site, the ratio of these two groups was assessed to determine the relative health and condition of the habitat. Sites were categorized as potential core (hub) habitat, corridor (linking) habitat, or overly degraded based on this assessment.

2. *Distribution and requirements of development-sensitive species*

   Development-sensitive species were displayed in ArcView on an observation-by-observation, site-by-site basis. For each observation, the total habitat likely to be required by the species was delineated. For example, spotted turtles move seasonally between a variety of habitat types (vernal pools, nesting habitat, semi-permanent ponds, upland forest, and red maple swamps); therefore, where spotted turtles were observed, an area encompassing all of these habitat types was delineated. Forest-interior, area-sensitive birds require large, contiguous tracts of forest; this was taken into consideration when delineating areas for these species. All of the resulting delineated areas were merged together; resulting composite areas were strongly considered for inclusion in the final maps.

3. *Extrapolation*

   Additional areas were delineated that have the potential to support development-sensitive focal species. This was accomplished with knowledge of the specific habitat, area, and geo-physical requirements of each development-sensitive species, combined with collateral datasets (soils, surficial geology, etc.). Extrapolations were performed conservatively to avoid over-estimating the portions of each town that are needed to sustain biodiversity. Proximity to known species locations factored heavily into this stage of the analysis.

4. *Analysis of protected and unprotected areas*

   This step was, in essence, a mini "gap" analysis. All known protected areas were displayed in ArcView, along with the polygon coverages generated in all of the previous steps. This was done to determine if there are particularly diverse habitat hubs that are currently unprotected. These areas are prime candidates for land preservation efforts (see "Recommendations" section).

5. *River and stream corridors*

   A 1,000-foot-wide corridor was delineated along each major stream or river (500 feet from each side). Stream corridors can serve as primary habitat or as dispersal routes for wildlife. Although not all streamside habitats are in pristine condition, great potential exists to connect biodiversity hubs via stream corridors. Certain portions of stream corridors were not included in the analysis due to an existing high level of development (e.g., the portion of Wawayanda Creek flowing through the Village of Warwick).

6. *Connectivity analysis*

   All of the coverages generated in the previous steps were viewed simultaneously with coverages that indicate the presence and extent of sprawl (e.g., land use/landcover, roads, orthophotography). Swaths of habitat that could potentially link together habitat hubs, biodiversity hotspots, and preserved areas were delineated. Breaks that could potentially sever corridors included dense development and heavily-trafficked roads. Corridors are excellent areas to apply new land use planning tools (see "Recommendations" section); where connections are tenuous, land preservation efforts may be advisable.

7. *Composite map*

   All results and coverages from previous steps were combined—and further interpreted—to create a composite map (Figure A) that serves as the template for the Southern Wallkill Biodiversity Plan. This composite map includes habitat hubs, many preserved habitats, and the corridors that link these habitats.

Nurturing the Alliance – Technical Advisory Assistance and Capacity-Building

In addition to producing the Southern Wallkill Biodiversity Plan, WCS/MCA has worked across diverse fronts to help incorporate wildlife issues into local and regional planning initiatives. Many of these efforts have been undertaken in partnership with local and regional organizations and state agencies. For example, WCS/MCA assisted the Orange County Planning Department in the development of an Open Space Plan; in addition, WCS/MCA is currently assisting the Orange and Ulster Soil and Water Conservation Districts in the development of a Wallkill River Management Plan. A biodiversity map and site ranking strategy were developed in partnership with Goshen's Open Space and Farmland Preservation Committee; this information was integrated into Goshen's recently adopted Open Space and Farmland Preservation Plan. WCS/MCA has also coordinated intermunicipal workshops and meetings in an effort to build a local knowledge-base regarding biodiversity and to discuss challenges and opportunities to conserve it. Through more specific interactions, WCS/MCA supplied recommendations and information to local decision-makers as requested when issues concerning wildlife and planning efforts arose. All of these collateral efforts strengthened the growing alliance for biodiversity across the southern Wallkill Valley communities and will foster further implementation activities.

RESULTS AND DISCUSSION

Overview

As a result of our field inventories, we conclude that the Southern Wallkill Region contains a diverse array of species and habitats, and that this biodiversity is in need of greater protection. But the region is also experiencing rapid economic growth and development. These two factors—biodiversity and development—are generally considered to be in direct opposition. Therefore, the environmental community has often indiscriminately opposed all development, regardless of where or how it is placed within the landscape. Developers, in expectation of this opposition, often exclude environmental stakeholders from discussions concerning development proposals. The resulting combative climate is detrimental to both the economic vitality of our communities and the environmental integrity on which our communities ultimately depend.

The primary conclusion of this project is that both biodiversity and development can coexist within these three towns. The solution lies in the scale at which we view the problem. Rather than dealing with development-related environmental concerns solely on a site-by-site, reactive basis, we must also proactively plan for those resources within a broader, landscape-scale context. By understanding where biodiversity exists within the three towns, we can begin to plan around those resources. Areas of lesser importance for biodiversity are more suitable for development.

In the following discussion, we identify portions of the three towns that are critical for biodiversity (also see Figure A). This information can serve as a template, to be integrated into town land use planning practices. Potential mechanisms for this integration are presented in the next major section, "Recommendations for Implementation."

Definition of Terms: Biodiversity Areas

The Southern Wallkill Region contains developed areas, developable areas, and areas important for biodiversity. We have identified several major types of biodiversity areas within this region, defined as follows.

Biodiversity hub—These ecological units serve as potential "source" habitats, meaning that biodiversity within them can help to replenish the biodiversity of nearby habitats. Therefore, if connectivity with other habitats is maintained these hubs may help to sustain biodiversity outside of their borders, throughout the Southern Wallkill communities. Key aspects of a biodiversity hub include (1) adequate acreage to support species that require large expanses of habitat; (2) relatively high quality, non-degraded habitat conditions; and (3) linkages to other landscape units, enabling movement among them (dispersal, migration). **Biodiversity hubs of the Southern Wallkill Region have been identified and labeled in Figure A; corresponding descriptions of these hubs are provided in the following section.** Biodiversity hubs do not necessarily need to exclude people; if development is carefully planned within hubs, they may be able to support people, wildlife, and habitats in harmony. In some cases, large parks and

reservations make excellent biodiversity hubs; however, many preserves lack connectivity with other habitats and cannot function as hubs. In other cases, a biodiversity hub may consist entirely of privately owned, relatively undeveloped land, or of a small park that is surrounded by high-quality, privately owned habitats. In all of these cases, the Southern Wallkill towns should strive to maintain valuable resources within biodiversity hubs by:

(1) better protecting these areas through land acquisition, conservation easements, or innovative approaches to local land use planning (see "Recommendations" section).
(2) carefully managing parks and preserves within them (protected areas are often managed in a way that negatively impacts biodiversity), and
(3) maintaining connectivity with other biodiversity hubs and corridors.

Biodiversity corridor—A corridor connects biodiversity hubs, often at a scale that encompasses multiple towns. Corridors that benefit wildlife are broad swaths of habitat that link hubs together; these expansive corridors often provide habitat in their own right. Rivers and streams—along with adjacent upland and wetland habitats—are often used by wildlife as dispersal corridors or as primary habitat; if maintained in a natural condition, they can provide excellent linkages between biodiversity hubs. Narrow, linear stretches of habitat (e.g., narrow strips of habitat surrounding hiking trails or along rail corridors) do not qualify as biodiversity corridors; development-sensitive wildlife cannot make use of these strips. Biodiversity can make use of corridors that contain some degree of development, but special effort should be made by the towns to maintain connectivity. For example, within corridors, best management practices (BMPs) and best development practices (BDPs) should be applied. The overall goal within corridors should be to maintain the "porosity" of the habitat, so that plants and animals can disperse through them unimpeded. **In Figure A, corridors appear as swaths of habitat that connect the labeled biodiversity hubs.**

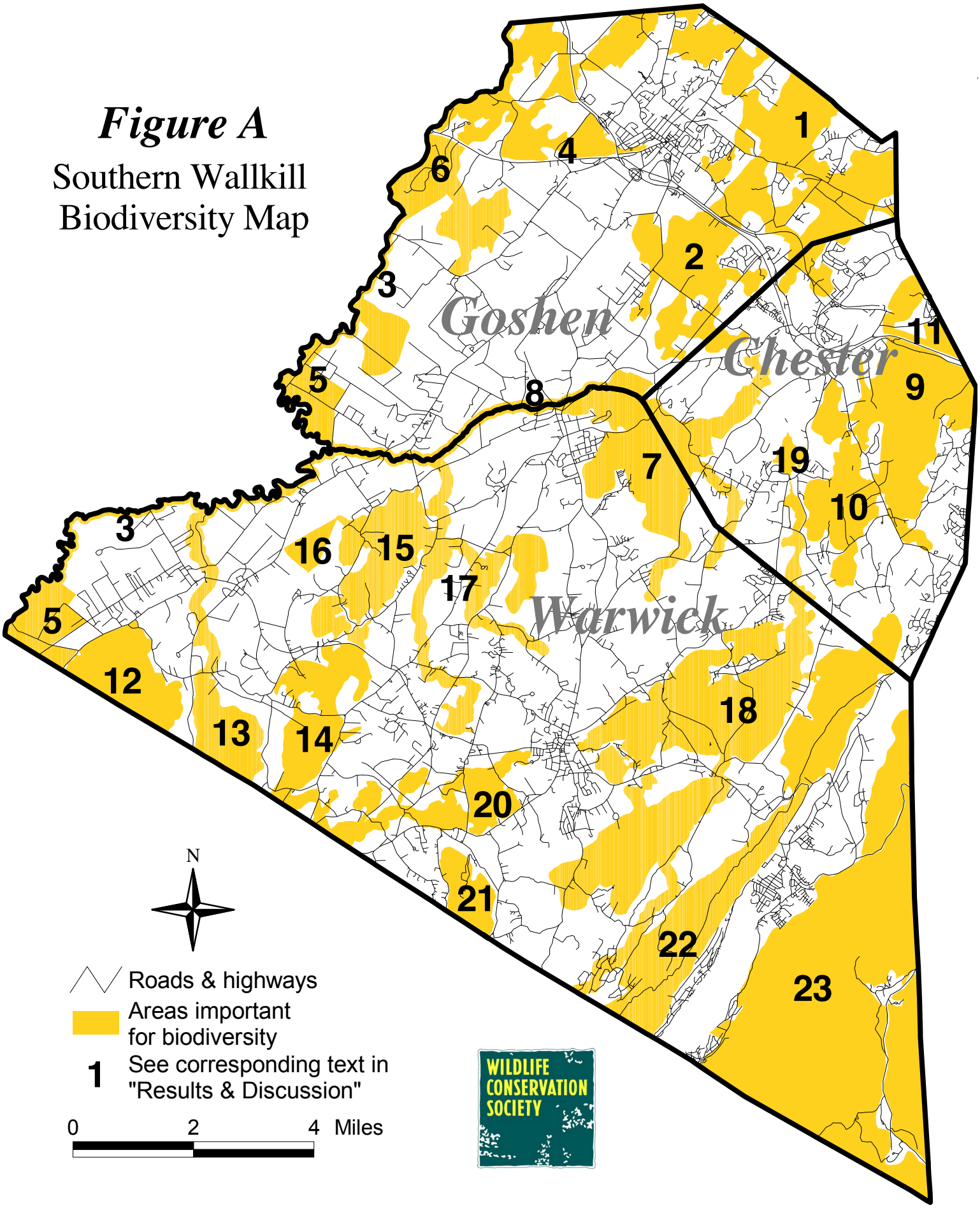
Constriction point—Constriction points are portions of biodiversity corridors where habitat connectivity is particularly tenuous. This may be due to a variety of factors, including encroachment of development, subdivision site designs that impede wildlife movement, or increasing amounts of traffic on roads. **In Figure A, constriction points are evident where roads and highways bisect corridors or hubs, and also where corridors become narrow or fragmented by increased development.** Towns should very carefully plan for these areas, to avoid fragmenting and isolating biodiversity hubs from each other.

Important Biodiversity Areas of the Southern Wallkill Region

The following numbered sections contain descriptions of important biodiversity areas throughout the three towns. The numbered areas in Figure A correspond to these sections. The data that were used to delineate these areas include locations of rare, sensitive, and declining species; in some cases, these species are at risk due to collecting for the wildlife trade. Rather than endangering wildlife species further by revealing their locations in this report, the information will be shared with the towns in a confidential format so that the species' requirements can be factored into towns' land use planning and management decisions.

Figure A

Southern Wallkill Biodiversity Map



1. *Purgatory Swamp*—This diverse wetland system provides some of the most important wildlife habitat in the Town of Goshen. Many wildlife species live in this swamp, including State-listed, declining, and rare amphibians, reptiles, and birds. Protection of this swamp using a combination of techniques described in the recommendations section—combined with protection of the uplands adjacent to the swamp—would yield significant conservation benefits.

2. *Otter Creek*—This biodiversity hub encompasses Otter Creek, which flows through the Town's reservoir system, feeds into Purgatory Swamp, and is host to significant biodiversity. Portions of this habitat system are at risk from dense residential development.

3. *Wallkill River*—The Wallkill River is an important natural resource for Chester, Goshen, Warwick, and many other towns of the Wallkill Valley. Water quality and habitat values of this river could be increased dramatically by revegetating the banks and surrounding uplands, using a combination of native trees, shrubs, and ground layer plants. Portions of the river have been diverted and channelized; although restoration of the natural water regime would be very costly, it is likely that this would result in ecological benefits.

4. *Heritage Trail*—The Heritage Trail (formerly the Erie Railroad) traverses significant wildlife habitats, particularly west of the Village of Goshen. The large wetland system on the trail (portions of which are protected), located between 6 ½ Station Road and the Village is particularly valuable, as it is home to a diversity of listed and declining marshland species. Although the Heritage Trail is too narrow in some more heavily developed areas to provide quality connectivity opportunities, it does provide landscape-scale connectivity for wildlife where it is surrounded by natural habitats.

5. *Black Dirt*—Much of the black dirt region has been too heavily disturbed (through drainage, substrate compaction, and other factors) to support a diversity of species. However, the black dirt farms along the Wallkill River, in the western portion of the tri-town region, host an impressive diversity of State-listed and declining bird species. This area is important for grassland-associated species that set up breeding territories here, and also for migrating birds that use the area as stop-over habitat. Although land preservation would help to maintain these species, preservation alone is not enough. These grassland-associated species are here because of farming activities; without farming, they would disappear. Therefore, it is highly recommended that any conservation efforts in the black dirt farmlands include plans for maintaining the habitats in an early-successional stage. The most cost-effective way to achieve this would be to ensure continued wildlife-friendly farming practices on these lands. Adoption of further wildlife-friendly farming practices could increase the amphibian and reptile fauna, which is impoverished in this area.

6. *Landfill*—This landfill and surrounding areas, located south of Route 17M between the old and new channels of the Wallkill River, provide habitat for rapidly declining grassland bird species. The current land use degrades the habitat in a number of ways, but it is crucial that these grasslands and similar habitats be maintained. Preservation of the habitats—following capping of the landfills—would benefit the avian species and associated biodiversity.

7. *Glenmere Lake/Black Meadow Creek*—Because this biodiversity area spans all three of the Southern Wallkill towns, it presents an excellent opportunity for intermunicipal collaboration. The area is very important due to the presence of a thriving population of a rapidly declining state-listed amphibian. Development in northwestern Chester threatens connections along Black Meadow Creek.

8. *Quaker Creek*—Quaker Creek and its tributaries have the potential to provide connectivity among the Glenmere Lake/Black Meadow Creek habitat, the Wallkill River-associated habitats, and other habitats. Although portions of this stream corridor are degraded or partially developed, excellent opportunities exist for restoration of streambank vegetation. Quaker Creek forms the boundary between Goshen and Warwick, providing opportunities for intermunicipal collaboration.

9. *Goose Pond Mountain*—Goose Pond Mountain State Park and surrounding privately-owned lands provide excellent habitat for wildlife. The biodiversity of this park is due, in part, to its undeveloped status. If possible, we strongly recommend that the park remain undeveloped. If, however, recreational development does occur, we recommend that a Unit Management Plan be prepared that incorporates all available biodiversity data and emphasizes biodiversity protection as the primary goal.

10. *Sugarloaf*—As it forms a scenic backdrop for the citizens of Chester, Sugarloaf Mountain forms the center of this important biodiversity area. Rocky outcrops, expanses of forest, rocky summit grassland, and steep elevation gradients all combine to make this an important natural feature of Chester. The slopes, particularly in the eastern portion, have received significant residential development pressures. We recommend that further development of this area be discouraged by the Town.

11. *Confluence of Young's Brook & Seely Brook*—This confluence, in combination with the large and high-quality wetland to the north and east, is biologically significant, as indicated by the amphibian species that occur here. U.S. Highway 6 is essentially routed through this confluence, which raises concern for the continued viability of these habitats. Young's Brook and its associated wetland complex provide important ecological linkages with the Town of Blooming Grove, as does Seely Brook further downstream. We recommend that, in order to maintain this important habitat, Blooming Grove be invited to join into any intermunicipal agreements initiated by Chester.

12. *Pochuck Neck*—The northernmost portion of Pochuck Mountain extends into southern Warwick, providing significant forest tracts that continue into New Jersey. These extensive forests are home to a diverse and rare array of Neotropical migrant forest birds, one of which is at the extreme northern end of its range here. Because of this—and other—important ecological connections, opportunities should be explored to establish interstate planning initiatives with New Jersey.

13. *Pochuck Creek*—Pochuck Creek extends from Sussex County, New Jersey, through the western portion of the Town of Warwick, and empties into the Wallkill River. Along the way, its banks and surrounding uplands provide important habitat for diverse wildlife. We recommend deterring further development along this stream corridor and restoration of native vegetation along the streambanks in areas where it has been removed.

14. *Blooms Corners Swamp & adjacent uplands*—This important wetland-upland complex is constricted at its southern end (where it extends into New Jersey), in its middle portion (at Newport Bridge Road) and terminates at Route 1. These habitats are home to some very important declining, range-edge, and state-listed amphibian and reptile species. Maintaining connectivity is important for these species, so special attention should be paid to the tenuous connections.

15. *Mounts Adam and Eve*—This pair of hills in the middle of the Wallkill Valley provide important "stepping stone" habitat for wide-ranging animals that move from ridge to ridge, such as black bear and bobcat. In addition, the forested hills and contiguous areas serve as refugia for amphibians, reptiles, and birds. Lower-lying wetlands to the southwest are also important. We recommend minimizing development within this area to the greatest extent possible.

16. *Atlantic White Cedar Swamp*—Although once abundant, Atlantic white cedar swamps are very rare in this region due to ditching and draining for agriculture. Remnant patches, such as this patch, should be maintained rather than converting to agriculture. The linkage between this swamp and Mount Adam, to the west, is tenuous at best.

17. *Wheeler/Stony Creek*—This stream complex offers habitat for a variety of declining and listed turtle species, in addition to other taxa. It also connects the Mount Adam/Mount Eve biodiversity area northward to other habitats. Much of the streamside habitats are rural and only lightly developed, but care should be taken to minimize further impacts related to development.

18. *Eastern Wawayanda Creek/Wickham Lake*—These wetlands and fields along Wawayanda Creek contain some of the most important biodiversity in the entire Southern Wallkill Region, for a variety of taxa. Impacts to wetlands and other habitats in this area should be minimized to the greatest extent possible. Farms should incorporate practices that are beneficial to grassland-dependent birds.

19. *Wetlands of Central Chester*—Due to historic observations of declining and listed species, wetlands within central Chester should be conserved, along with adjacent upland habitats.

20. *Western Wawayanda Creek*—The western portion of Wawayanda Creek is similar in terms of biological importance to the portion east of the Village of Warwick. Recommendations are also similar.

21. *Southern Warwick/New Jersey border*—These habitats, lying at the edge of the Highlands, connect with larger expanses of habitat in New Jersey. This site represents another opportunity to collaborate with neighbors in New Jersey.

22. *West Highlands Corridor*—In addition to the wildlife habitats provided by the extensive forests along this ridge, the Natural Heritage Program has identified numerous significant ecological communities. Preservation efforts in the Highlands should continue in order to conserve these habitats.

23. *East Highlands Corridor*—As with the west Highlands corridor, the forests in this southeastern-most portion of Warwick provide extensive contiguous habitat for Neotropical migrant birds and a variety of other species. In addition, this area also contains significant ecological communities identified by the Natural Heritage Program.

RECOMMENDATIONS FOR IMPLEMENTATION

The following sections outline tools and techniques that can be employed to achieve the goal of this biodiversity plan—a sustainable balance between development and conservation within the Southern Wallkill towns. Some of these tools and techniques have already been implemented by one or more of the Southern Wallkill towns. To maximize conservation effectiveness at a regional scale, we recommend that all three towns adopt similar tools and techniques.

For discussion of specific areas within the towns, see the "Results and Discussion" section entitled "Southern Wallkill Biodiversity Hubs."

Important Considerations and Caveats

a. *Mapped areas are not being recommended solely for land preservation.*

   Preservation of all of the mapped habitat hubs, biotic planning units, and connecting corridors is not feasible, nor do we recommend such measures. Many of the mapped areas are privately owned lands that contain homes and contribute, through taxes, to the economic health and sustainability of the towns. Instead, within the mapped areas we propose a balanced approach to conservation and development that incorporates the diverse suite of land use planning and conservation tools and incentives presented below.

b. *Development outside of the delineated biodiversity areas on the maps needs to remain mindful of environmental and land use issues.*

   Exclusion from a mapped zone does not give "carte blanche" for development activities. The maps are intended for broad-scale planning efforts by the three towns, both individually and collectively. They are *not* intended for development planning and review at a site-specific scale. Regardless of location, individual development proposals—both inside and outside of the mapped areas—should undergo careful review and consideration of potential biological impacts.

c. *Conservation opportunities may occur outside of the delineated areas on the maps.*

   Small or isolated habitats outside of the mapped areas may contain significant species or natural communities that have high conservation value (e.g., a fen, bog, or remnant patch of

old-growth forest). They may have been excluded from our maps because (1) no connectivity could be established with a larger ecological corridor or system, or (2) they were not detected during surveys and analyses. While careful planning within the mapped areas will contribute significantly to the long-term maintenance of biodiversity at a regional scale, additional conservation opportunities throughout the three towns should be considered.

Recommendations for Future Development and Economic Growth

To balance development with the conservation goals of this project, we propose that it continue to be concentrated in areas outside of those identified as important for biodiversity (Figure A). In particular, we recommend encouraging new development in and around existing development nodes (i.e., villages and hamlets). By doing this, it may be possible to alleviate development pressures in areas that are critical for biodiversity. Previously developed areas contain the infrastructure (roads, sewage lines, etc.) and services (schools, health care facilities, etc.) to support further development in a cost-effective manner. Conversely, development that sprawls into biodiversity areas would have both ecological costs and economic costs for all three towns. We must reiterate that development does not necessarily need to be excluded from biodiversity areas; instead, the towns should attempt to focus development in areas that have already experienced such growth, and simultaneously reduce the "footprint" of development in more rural areas. Recommendations to achieve these goals are made in the following sections.

Recommendations for Land Preservation

Although the focus of the SWBP is on conservation through an expanded scale and scope of local land use planning, under certain circumstances land preservation remains the best route to maintaining biodiversity on select parcels.

a. *Attempt to add area—through fee simple purchase or easement—to existing protected areas.*

   This buffers the existing habitat hubs from externally caused degradations (e.g., runoff of polluted water from roads and parking lots, noise pollution). It also reduces "edge effects," (e.g., changes in vegetation structure, temperature, predation levels, parasitism levels, and other factors near habitat edges), all of which can negatively impact area-sensitive species. In addition, the buffers will often serve as additional habitat.

b. *Attempt to preserve (through acquisition or easement) areas that are currently unprotected and have significant levels of biodiversity, or that contain populations of imperiled species.*

   The locations of biodiversity "hotspots" that are currently unprotected are provided in the "Results and Discussion" section.

c. *Partner with local and regional land trusts (e.g., Orange County Land Trust), the Orange County Department of Parks, Recreation and Conservation, and others to protect areas identified in this report.*

d. *Develop an open space preservation plan for your town that incorporates biodiversity issues or integrate biodiversity criteria, through amendments, into your existing open space plan.*

   To begin this process, you may want to seek partnerships with land trusts. The maps provided in this report can be incorporated directly into open space plans.

e. *When considering proposals to subdivide and develop parcels, always opt for open space reservation and conservation easements instead of fee-in-lieu payments or other buyouts.*

   Place conservation easements over open space reservations and have those easements held by a land trust or municipality instead of a homeowner's association. As part of the approval process, towns should consider requiring applicants to set aside funds in escrow or in a small endowment to cover the costs of monitoring the conservation easement. Attempts should be made to consolidate the portions under easement, because one large protected area is more valuable from a conservation standpoint than numerous small, fragmented protected areas. If possible, the portion of a property to be protected in this manner should be selected based on its biodiversity value in relation to other portions. All of these protections are best considered and implemented as part of the approval process, rather than after the fact.

Recommendations for Local Land Use Planning

The following recommendations (including procedures, steps, and tools) can help to maintain biodiversity in areas where land preservation is not feasible or desirable. These recommendations are not listed in order of priority.

a. *Avoid large-lot zoning.*

   Increasing the size of buildable residential lots is often perceived as a "quick fix" to sprawl. These zoning changes result in development patterns that *appear* to be "green," with fewer houses and more trees visible. In reality, however, this practice spreads the impacts of development and sprawl across a much larger area, destabilizing and often eliminating local populations of development-sensitive species. Statistics show that while the human population in the New York metropolitan region increased by only 8% between 1970 and 1990, land consumption during the same period increased by 65% (Diamond and Noonan 1996). It is no surprise that wildlife, habitats, and ecosystem integrity are disappearing. A shift from large-lot zoning to a more centralized, compact pattern of development is critical to maintain the biodiversity and ecological health of our region.

b. *Consider novel types of development, including Traditional Neighborhood Designs (TNDs) and conservation subdivisions.*

   By clustering housing, it is possible to reduce the amount and impact of associated infrastructure, such as roads, and to reduce the overall "footprint" of developments. This has ecological as well as economic benefits. To maximize the ecological benefits, individual clusters should be sited based on knowledge of relative biodiversity levels and proximity to other developments. See Arendt (1999) for further details and suggestions about conservation subdivisions.

TNDs consist of developed nodes combined with large areas of open space that enable wildlife to circumvent developed areas. Creating TNDs—with real conservation value—may require modification of existing municipal regulations, zoning codes, and procedures in order to harmonize the goals of tight clusters with existing municipal standards, and to make incentives available to developers that create these types of subdivisions.

c. *Pass a conservation area overlay ordinance (e.g., WCS/MCA Technical Paper #3, see Appendix B).*

Although this is not as effective as purchasing land (or obtaining easements to land) it does minimize and mitigate the impacts of development within designated zones. It is valuable, in particular, for maintaining wildlife habitat connectivity in developable parcels located between habitat hubs. It is a useful tool that allows towns, through home rule authority, to influence patterns of development within their borders in a way that minimizes impacts to wildlife and habitats.

d. *Integrate the recommendations and maps in this report into your town's Master/Comprehensive Plan.*

WCS/MCA staff would welcome the opportunity to work with individual towns in this regard. We have assisted other New York towns with their Comprehensive Plan updates. It is important to note that Comprehensive Plans can be amended at any point, even after an update has occurred, so it is possible to incorporate the findings and recommendations of this report into the plans of all three towns.

Comprehensive Plans need to be more than a shopping list of community desires; for each goal, a clear pathway to attaining that goal must be laid out. For example, if a community desires to encourage TNDs, it must amend many of its regulations and procedures. The specifics of these changes should be detailed in the Comprehensive Plan.

e. *Formalize inter-municipal relationships with other towns in the Southern Wallkill Region (and beyond) by:*

- establishing an inter-municipal council, and
- adopting an inter-municipal agreement.

This inter-municipal council should focus on a broad array of land use issues (affordable housing, transportation, economic development, recreation opportunities, tourism, and others). Biodiversity conservation will not be successful unless it is carefully woven into a broader tapestry of land use issues, approaches, and solutions.

f. Encourage the extension and application of biodiversity and planning concepts, tools and mapped areas into towns adjacent to the Southern Wallkill communities.

Conservation efforts in neighboring towns can add value to those in the SWBP. This is particularly important for adjacent towns that share ecological linkages (e.g., Blooming Grove, Hamptonburgh, and even New Jersey townships).

g. Encourage better SEQRA reviews by:

- Taking a hard look at impacts beyond individual project sites (that is, considering cumulative impacts of individual development proposals on town- and region-wide scales).

- Encouraging use of the GEIS process. This is a planning process wherein the town creates an environmental impact statement for a large block of land. Then, as individual development projects are proposed, they are evaluated against the findings of the GEIS. The town recovers the costs of the GEIS through a pro-rated fee assigned to each development project.

- Requiring standards for wildlife surveys to ensure that adequate effort is being expended—at appropriate times of year and using established techniques—to assess wildlife resources for preparation of development proposals at specific sites. WCS/MCA has prepared standards to this effect that have already been adopted by towns in New York.

h. Seek out biodiversity training workshops and other educational forums for your town's land use decision-makers.

An informed group of decision-makers is empowered and motivated to ensure that their town's natural resources can be maintained. Training and educational programs available in this region are offered by WCS/MCA and by our partner organizations, such as Hudsonia Inc., Glynwood Center, and Pace University's Land Use Law Center. NYS DEC's Hudson River Estuary Program coordinates a variety of training and educational opportunities.

i. Develop and support approaches and programs to educate the general public, within your town, about the importance of biodiversity.

An informed citizenry is a constituency that can empower elected officials to make decisions that benefit both people and the environment.

j. Adopt a strong local wetlands ordinance or amend your existing ordinance to better protect wetland biodiversity.

Many of the wetlands within this region, along with the uplands adjacent to them, tend to be biodiversity hotspots. However, they often are not adequately protected in New York where, typically, wetlands smaller than 12.4 acres are not under the State's regulatory jurisdiction. In addition, wetland regulations are usually written to protect water quality, among other issues,

but rarely include language to protect the wildlife that require wetland habitats. WCS/MCA staff would welcome the opportunity to assist towns in the development of new wetlands ordinances or to review existing ordinances.

k. *Formally adopt and apply "Best Management Practices" and "Best Development Practices" that can help to reduce impacts to biodiversity during both town-wide planning and individual site review processes.*

An example of such a manual is WCS/MCA Technical Paper #5 (Calhoun and Klemens 2002), which provides guidelines for protecting vernal pool species in areas being developed. Additional BMPs from other organizations and agencies may also prove to be useful. WCS/MCA continually seeks new issues and opportunities for the Technical Paper Series that can improve land use planning; ideas and suggestions are always welcome.

l. *Consider developing and adopting a Rare, Threatened, and Endangered species list that is specific to your town.*

Federal and State lists do not take into account the decline or extinction of species at the scale of individual towns, groups of towns, watersheds, or counties. Some counties in New York have developed lists, but they have no jurisdiction outside of county parks. We recommend that towns develop and adopt their own lists (in consultation with conservation organizations and local naturalists), and that towns require listed species to be considered during review of development proposals. Town lists would not be regulatory in nature but would instead help to guide discussions and generate options in development proposals (e.g., where to locate open space areas created as part of the site approval process).

m. *Ensure that all environmental regulations within your town are adequately enforced.*

Unenforced environmental regulations are, for the most part, ineffective. Enforcement should be a major focus of communities attempting to preserve their biodiversity resources. Enforcement can be expensive and time-consuming; communities with limited funds and time should consider hiring enforcement officers on cost-share and time-share bases with neighboring communities (this position could be administered through an inter-municipal council).

n. *Revise the formula used by your town to calculate housing density yields.*

Residential housing density yields are typically calculated by dividing total property acreage by lot size, as established in zoning codes. However, this does not account for areas within properties that are not buildable due to environmental constraints and associated regulations. Density yields should be calculated only after subtracting wetland area and other non-buildable areas (such as steep slopes) from the total property acreage. Of the resulting lots, a subset should be perc-tested to see if they can sustain septic systems. The final yield of a site should include only those lots that can be sustained via septic and other services. Subdivision regulations should stipulate these procedures. See Arendt (1999) for further details.

o. *Consider mapping vernal pools and other small wetlands within your town.*

Because these wetlands are small, broad-scale wetlands maps often fail to identify them and they tend to "slip" through regulatory cracks. However, these wetlands often support a unique assemblage of biodiversity that never occurs in larger wetlands. To protect these resources, it is important to first understand where they occur on the landscape. Procedures and considerations for mapping vernal pools on a town-wide basis are provided in WCS/MCA Technical Paper #5 (Calhoun and Klemens 2002). In addition, WCS/MCA staff is experienced in this type of project and is available to advise towns.

p. *Strive to make the land use planning and review processes as inclusive and transparent as possible.*

Land use planning and review procedures are often fraught with mistrust and tension, resulting in decisions that satisfy few or none. All interested parties should be included as early as possible in this process to incorporate the needs and goals of developers, landowners, local governments, agencies, environmentalist advocates, affordable housing advocates, and private citizens. Through inclusiveness and transparency, irresolvable differences may be avoided and acceptable solutions can be achieved.

q. *Include the maintenance of biodiversity as a major goal in the management plans of parks, preserves, and other protected areas within biodiversity areas.*

Most parks and preserves are protected for a variety of reasons, including recreation, aesthetics, protection of water supplies, biodiversity, and others. Park development and management activities that target one of these goals may come at the expense of the others. For instance, clearing shrubs and groundlayer vegetation to improve views within a park will negatively impact water quality, biodiversity, and other factors. Such clearing may be appropriate for a small park within an urbanized area, where primary goals include picnicking and walking. However, parks and preserves within biodiversity hubs and corridors should be carefully managed to ensure that biodiversity can persist. With careful planning, this may be accomplished in harmony with all of the other goals listed above.

r. *Consider opportunities for restoration of ecological connectivity when upgrading and maintaining roads and highways.*

Roads and highways sever ecological connections. Where they cross important biodiversity hubs and corridors, as indicated in Figure A, these ecological connections should be improved during the upgrading and maintenance of the roads. For example, to enhance amphibian passage across roads, it is possible to build an underpass. To ensure that the passage is used by wildlife, it should be square in cross-section, a minimum of 2 feet on each side, and daylighted from the top via installation of gratings. Stream corridors can form natural connectivity across roads; culverts should be designed and installed to maximize this connectivity potential. For a complete discussion of road impacts on wildlife, along with potential solutions, see Forman et al. (2003).

s. Conserve farms that contribute to biodiversity, using innovative approaches.

Farms often provide quality habitats for wildlife and are also attractive alternatives to other land uses, such as sprawl. To maintain farm-related biodiversity, preservation alone is an insufficient conservation tool. Purchase of Development Rights (PDR) programs are already active in some towns of the Wallkill Valley. They should be initiated, funded, and applied in all of the Southern Wallkill towns. PDR programs should, in particular, target farms that demonstrate a high level of biodiversity; such farms may occur inside or outside of the mapped corridor in Figure A.

LITERATURE CITED

Allan, B.F., F. Keesing, and R.S. Ostfeld. 2003. Effect of forest fragmentation on Lyme disease risk. Conservation Biology 17:267-272.

Andrle, R.F. and J.R. Carroll (eds.). 1988. Atlas of breeding birds in New York State. Cornell University Press, Ithaca, NY.

Arendt, R. 1999. Growing greener: Putting conservation into local plans and ordinances. Island Press, Washington, D.C.

Bull, J.L. 1998. Bull's birds of New York State. E. Levine (ed.). Cornell University Press, Ithaca, NY.

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

Diamond, H.L. and P.F. Noonan. Land use in America. Island Press, Washington, D.C.

Forman, R. T. T, D. Sperling, J. A. Bissonette, A. P. Clevenger, C. D. Cutshall, V. H. Dale, L, Fahrig, R. France, C. R. Goldman, K. Heanue, J. A. Jones, F. J. Swanson, T. Turrentine, T. C. Winter. 2003. Road ecology: Science and solutions. Island Press, Washington, D.C., USA.

Klemens, M.W. 1990. The herpetofauna of southwestern New England. Ph.D. dissertation, University of Kent, Canterbury, UK.

Klemens, M.W. 1993. Amphibians and reptiles of Connecticut and adjacent regions. State Geological and Natural History Survey of Connecticut, Bulletin 112.

Klemens, M.W. 2000. Amphibians and reptiles in Connecticut: A checklist with notes on conservation, status, identification, and distribution. Connecticut Department of Environmental Protection, Bulletin 32.

Klemens, M. W. 2001. Bog turtle (*Clemmys muhlenbergii*), northern population, recovery plan. U.S. Department of the Interior, Fish and Wildlife Service, Hadley, Massachusetts, USA.

Miller, N. A. and M.W. Klemens. 2002a. Eastern Westchester Biotic Corridor. MCA Technical Paper No. 4, Metropolitan Conservation Alliance, Wildlife Conservation Society, Bronx, NY.

Smith, R.D., A. Ammann, C. Bartoldus, and M.M. Brinson. 1995. An approach for assessing wetland functions using hydrogeomorphic classification, reference wetlands, and functional indices. Army Corps of Engineers. Washington, D.C.

Appendix A

Focal Species of the Southern Wallkill Region

Development-Associated Focal Species

Amphibians	
Northern two-lined salamander	*Eurycea bislineata*
American toad	*Bufo americanus*
Northern spring peeper	*Pseudacris crucifer*
Bullfrog	*Rana catesbeiana*
Green frog	*Rana clamitans*
Reptiles	
Common snapping turtle	*Chelydra serpentina*
Painted turtle	*Chrysemys picta*
Eastern milk snake	*Lampropeltis triangulum*
Northern water snake	*Nerodia sipedon*
Northern brown snake	*Storeria d. dekayi*
Eastern garter snake	*Thamnophis s. sirtalis*
Birds	
Canada goose	*Branta canadensis*
Rock dove	*Columba livia*
Blue jay	*Cyanocitta cristata*
American crow	*Corvus brachyrhynchos*
European starling	*Sturnus vulgaris*
Brown-headed cowbird	*Molothrus ater*
House finch	*Carpodacus mexicanus*
House sparrow	*Passer domesticus*
House wren	*Troglodytes aedon*

*Development-Sensitive and Listed Focal Species**

		Federal Status	State Status	Audubon WatchList Status
Amphibians				
Blue-spotted salamander	*Ambystoma laterale*		SC	
Jefferson X Blue-spotted salamander	*Ambystoma jeffersonianum X laterale* hybrid		SC	
Spotted salamander	*Ambystoma maculatum*			
Marbled salamander	*Ambystoma opacum*		SC	
Northern dusky salamander	*Desmognathus fuscus*			
Long-tailed salamander	*Eurycea longicauda*		SC	
Northern red salamander	*Pseudotriton ruber*			
Gray treefrog	*Hyla versicolor*			
Northern cricket frog	*Acris crepitans*		E	
Chorus frog	*Pseudacris triseriata*			
Southern leopard frog	*Rana sphenocephala*		SC	
Wood frog	*Rana sylvatica*			
Reptiles				
Spotted turtle	*Clemmys guttata*		SC	
Wood turtle	*Clemmys insculpta*		SC	
Bog turtle	*Clemmys muhlenbergii*	T	E	
Eastern box turtle	*Terrapene carolina*		SC	
Northern five-lined skink	*Eumeces fasciatus*			
Worm snake	*Carphophis a. amoenus*		SC	
Northern black racer	*Coluber c. constrictor*			
Black rat snake	*Elaphe obsoleta*			
Eastern hognose snake	*Heterodon platirhinos*		SC	
Northern red-bellied snake	*Storeria o. occipitomaculata*			
Eastern ribbon snake	*Thamnophis s. suaritus*			
Northern copperhead	*Agkistrodon contortrix mokasen*			
Birds				
American black duck	*Anas rubripes*			D
American bittern	*Botaurus lentiginosus*		SC	
Great egret	*Ardea alba*			
American woodcock	*Scolopax minor*			D
Spotted sandpiper	*Actitis macularia*			
Northern bobwhite	*Colinus virginianus*			
Northern harrier	*Circus cyaneus*		T	
Sharp-shinned hawk	*Accipiter striatus*		SC	
Cooper's hawk	*Accipiter cooperii*		SC	
Red-shouldered hawk	*Buteo lineatus*		SC	
American kestrel	*Falco sparverius*			
Barred owl	*Strix varia*			
Yellow-billed cuckoo	*Coccyzus americanus*			
Black-billed cuckoo	*Coccyzus erythropthalmus*			

*Federal & State status: E=Endangered, T=Threatened, SC=Special Concern; WatchList status: D=Declining; DR=Declining Rapidly

Development-Sensitive and Listed Focal Species (Concluded)*

		Federal Status	State Status	Audubon WatchList Status
Belted kingfisher	*Ceryle alcyon*			
Red-headed woodpecker	*Melanerpes erythrocephalus*		SC	D
Northern flicker	*Colaptes auratus*			
Eastern kingbird	*Tyrannus tyrannus*			
Eastern wood-pewee	*Contopus virens*			
Acadian flycatcher	*Empidonax virescens*			
Willow flycatcher	*Empidonax traillii*			D
Least flycatcher	*Empidonax minimus*			
Horned lark	*Eremophila alpestris*		SC	
Bobolink	*Dolichonyx oryzivorus*			
Eastern meadowlark	*Sturnella magna*			
Baltimore oriole	*Icterus galbula*			
Savannah sparrow	*Passerculus sandwichensis*			
Grasshopper sparrow	*Ammodramus savannarum*		SC	
Field sparrow	*Spizella pusilla*			
Eastern towhee	*Pipilo erythrophthalmus*			
Rose-breasted grosbeak	*Pheucticus ludovicianus*			
Scarlet tanager	*Piranga olivacea*			
Bank swallow	*Riparia riparia*			
Black-and-white warbler	*Mniotilta varia*			
Prothonotary warbler	*Protonotaria citrea*			D
Worm-eating warbler	*Helmitheros vermivorum*			D
Blue-winged warbler	*Vermivora pinus*			D
Northern parula	*Parula americana*			
Cerulean warbler	*Dendroica cerulea*		SC	DR
Chestnut-sided warbler	*Dendroica pensylvanica*			
Black-throated green warbler	*Dendroica virens*			
Prairie warbler	*Dendroica discolor*			D
Ovenbird	*Seiurus aurocapilla*			
Northern waterthrush	*Seiurus noveboracensis*			
Louisiana waterthrush	*Seiurus motacilla*			
Kentucky warbler	*Oporornis formosus*			D
Yellow-breasted chat	*Icteria virens*		SC	
Hooded warbler	*Wilsonia citrina*			
Canada warbler	*Wilsonia canadensis*			D
American redstart	*Setophaga ruticilla*			
Brown thrasher	*Toxostoma rufum*			
Marsh wren	*Cistothorus palustris*			
Wood thrush	*Hylocichla mustelina*			D
Veery	*Catharus fuscescens*			

*Federal & State status: E=Endangered, T=Threatened, SC=Special Concern; WatchList status: D=Declining; DR=Declining Rapidly

Appendix B

WCS/MCA Technical Paper Series

Croton-to-Highlands Biodiversity Plan, **WCS/MCA Technical Paper #7.** The Croton-to-Highlands Biodiversity Plan was developed out of a partnership between WCS/MCA and the four contiguous New York towns of Cortlandt, New Castle, Putnam Valley, and Yorktown. The report provides policy and planning recommendations to support a multi-town approach to conserve wildlife and habitats and includes a map highlighting priority areas for conservation. By Nick Miller and Michael W. Klemens, MCA, 2004. **$8.00**

Habitat Management Guidelines for Vernal Pool Wildlife, WCS/MCA Technical Paper #6. This document provides habitat management guidelines for maintaining vernal pool biodiversity in forested landscapes, especially in the commercially-harvested forests of northern New York and New England. By Aram J. K. Calhoun and Phillip deMaynadier, MCA, 2004. **$8.00**

Best Development Practices: Conserving Pool-Breeding Amphibians in Residential and Commercial Developments in the Northeastern United States, WCS/MCA Technical Paper #5. This paper contains techniques to guide local and state land use decision-makers as they attempt to conserve vernal pool habitats and wildlife. It provides a pragmatic approach to conservation that encourages communities to attain a more complete understanding of their vernal pool resources, gather information that enables them to designate exemplary pools worthy of protection efforts, and develop strategies to protect them. By Aram J. K. Calhoun and Michael W. Klemens, MCA, 2002. **$10.00**

Eastern Westchester Biotic Corridor, WCS/MCA Technical Paper #4. The Eastern Westchester Biotic Corridor (EWBC) is a partnership between MCA and the three contiguous New York towns of North Salem, Lewisboro, and Pound Ridge. This report provides science-based information and tools to support a regional, multi-town approach to conserve wildlife and habitats. By Nick Miller and Michael W. Klemens, MCA, 2002. ***Available in Acrobat format (.pdf): www.wcs.org/mca***

Conservation Area Overlay District: A Model Local Law, WCS/MCA Technical Paper #3. This document provides an innovative tool for improved land use planning—a model ordinance that can be adopted by municipalities to delineate a conservation area overlay district. The ordinance seeks to reduce habitat fragmentation, maintain biodiversity, and protect significant natural features across ecologically sensitive areas. It is based upon New York State law, but can be adapted for use in other states that have strong home rule authority. Prepared for MCA by Pace University, 2002. ***Available in Acrobat format (.pdf): www.wcs.org/mca***

Open Land Acquisition: Local Financing Techniques Under New York State Law, WCS/MCA Technical Paper #2 . This paper describes the authority that local governments have to raise revenues to purchase or otherwise protect open space. It explores the types of programs that have been established using these techniques. It is intended to assist communities interested in PDR (purchase of development rights) and to decide which of several potential funding mechanisms would be most appropriate. Prepared for MCA by Pace University, 2000. ***Available in Acrobat format (.pdf): www.wcs.org/mca***

A Tri-State Comparative Analysis of Local Land Use Authority: NY, NJ, & CT, WCS/MCA Technical Paper #1. This paper investigates the local land use authority that towns within the tri-state region have to protect natural landscapes while making land use decisions and to collaborate with one another on an inter-municipal basis. The document lists and describes statutes and cases that empower municipalities to plan and regulate across municipal lines; to adopt floating zones, overlay districts, and natural resource protection ordinances; and to provide incentives to encourage environmentally-sound development patterns. Prepared for MCA by Pace University, 1999**. $5.00**

Other publications by MCA staff

Turtle Conservation. This book provides a comprehensive analysis of threats to turtles and tortoises worldwide, and considers the most significant problems facing these species. It includes contributions by experts on turtle biology and conservation and reviews the outlook for marine, freshwater, and terrestrial species. Michael W. Klemens (ed.). Smithsonian Institution Press, 2000. **$35.00**

Amphibians and Reptiles in Connecticut: A Checklist with Notes on Conservation Status, Identification, and Distribution. This list describes the native species of amphibians and reptiles in Connecticut, both common and uncommon. It also provides distributional information and discusses the conservation status of each species. Michael W. Klemens. CT Department of Environmental Protection, 2000. **$12.00**

Bog Turtle *(Clemmys muhlenbergii)*—Northern Population Recovery Plan. This recovery plan describes actions that can lead to the protection and recovery of the Federally-listed northern population of the bog turtle. It also presents guidelines for conducting bog turtle surveys. Michael W. Klemens. U.S. Fish and Wildlife Service. ***Available in Acrobat format (.pdf): www.wcs.org/mca***