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Croton-to-Highlands Biodiversity Plan

Balancing Development and the Environment in the Hudson River Estuary Catchment

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Croton-to-Highlands Biodiversity Plan

Balancing Development and the Environment in the Hudson River Estuary Catchment

by

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INTRODUCTION

Background Information

The Croton-to-Highlands Biodiversity Plan (CHBP) project is a partnership between the Wildlife Conservation Society's Metropolitan Conservation Alliance (WCS/MCA) and the four contiguous towns of Cortlandt, New Castle, Putnam Valley, and Yorktown in northwestern Westchester County and southwestern Putnam County, New York. 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 four 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 Croton-to-Highlands Region

The Croton-to-Highlands region encompasses the northwestern-most towns of Westchester County (Cortlandt, New Castle, and Yorktown) and the contiguous Town of Putnam Valley in southwestern Putnam County. It is bounded to the west, for much of its length, by the Hudson River. As its name implies, the region comprises diverse landscapes, from the hills and valleys of the Croton River watershed in the south to the forested ridges of the Hudson Highlands in the north.

This region, once composed of forests and fields interspersed with hamlets, villages and other urban centers, is experiencing rapid change. A wave of sprawl is pulsing through the region, from south to north. The directional nature of this sprawl has created a similar gradient in relative biodiversity; the most development-sensitive species persist only in the north.

But vibrant habitats and diverse assemblages of wildlife are found in all four 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 four towns.

CONCEPTS AND ISSUES

Biodiversity in the Croton-to-Highlands Region

The rich tapestry of genes, species, ecosystems, and their interactions are collectively referred to as biological diversity, often shortened to "biodiversity." The Croton-to-Highlands 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. Wetlands, streams, and elevation gradients combine to create many distinctive habitat types, which in turn support unique and rare species. The region's biodiversity is influenced by both the Hudson Highlands and the more low-lying river valleys.

2. The geographic position of the Croton-to-Highlands 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.

3. Putnam County and northern Westchester County have historically experienced relatively lower-density development than communities closer to New York City. Because of this, many of the ecological treasures of the Croton-to-Highlands region are still intact. The pattern of small hamlets with intervening open space composed of wetlands and second growth forest has fostered both scenic and biodiversity values. Although we recognize that the *status quo* is changing rapidly in many areas, large tracts of relatively pristine habitat remain in portions of this four-town region.

4. Biodiversity within the four towns is represented by both widespread species and species that are declining in Westchester and Putnam counties and throughout the Northeast, including many that are on New York State's list of endangered, threatened, and special concern wildlife. Species such as the marbled salamander and box turtle are at 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 Croton-to-Highlands region will complement efforts to protect the Croton Reservoir, safeguarding the health and welfare of millions of people. Those same actions will maintain and improve water quality in tributaries to the Hudson River, aiding in major, ongoing efforts to increase the Hudson River Estuary's water quality.

- Biodiversity provides a scenic backdrop to the daily activities of the Croton-to-Highland communities' citizens. Rocky ridgelines cloaked in green forests, maple swamps glowing red as their leaves turn in the 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. An excellent local example is found in the diverse habitats and quality education programs offered by Teatown Lake Reservation.

- 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 often 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 Croton-to-Highlands' 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 limited protection through State and Federal regulations. These laws, however, are not designed to protect the ecological function of the Croton-to-Highlands 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 extensive, interconnected habitats that would be necessary to maintain the region's biodiversity.

We discard the premise that towns 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 Westchester County's largest protected area, 4,300-acre Ward Pound Ridge Reservation, cannot survive without appropriate planning in the surrounding privately held, developable lands (Miller and Klemens 2002a).

Therefore, ***protection of the Croton-to-Highland 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, the four towns can create quality communities for future generations where human progress is more in 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 those 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 four towns (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; 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 CHBP, 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.

METHODS

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 focal species vary from region to region because species ranges, habitat requirements, and responses to development also vary. For example, in a predominantly rural landscape, a red-spotted newt may be commonplace and relatively unaffected by existing development pressures; newts would not be considered a focal species in such a setting. However, in a more heavily urbanized landscape (such as the Croton-to-Highlands region), red-spotted newts are disappearing rapidly due to existing development patterns and trends. The relevance of this species is elevated under such conditions. The status of newts is directly tied to development here (due to their need for extensive upland habitats during their multi-year terrestrial dispersal stage); this species is therefore considered a development-sensitive focal species in the CHBP. On the other hand, a few individuals of several warbler species (e.g., blackburnian warbler, black-throated blue warbler) were observed during field surveys. Although these could be considered focal species in some regions, they were not included in our analyses because in these four towns the birds were likely migrating individuals, vagrants, or otherwise outliers. Land use and management decisions should target conservation of well-established, locally indigenous species and should not be based on outlier data.

The creation of the Croton-to-Highlands 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.

Site Selection and Access

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. Many of the major hubs in the project area are already protected (e.g., Fahnestock State Park, Blue Mountain Reservation, Teatown Lake Reservation); however, the long-term conservation status of some of the other major hubs (e.g., Camp Smith Military Reservation, NYC DEP lands surrounding the Croton Reservoir, and Clear Lake Reservation) is not indefinitely 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. Obviously, 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 Croton-to-Highlands region were extremely helpful in obtaining permission for WCS/MCA biologists to access private lands.

Selection of sites in the Town of New Castle was limited to the western portion of the town. This decision was made based on the request of the Town. The dashed line in Figure A shows the extent of investigations within New Castle for this project. Sites throughout the other three towns were considered for selection.

The site selection process was greatly enhanced in Westchester and Putnam counties due to 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, bedrock geology, elevation, and others. Digital aerial photography (orthophotography) was also crucial for selecting sites and for later analysis of data.

Field Data Collection

Bird surveys occurred during the spring breeding season (mid-May through early July) in the early morning hours (within a half hour of dawn through 9:30 am) 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. Bird surveys were conducted over a four-year period during the spring seasons of 2000 through 2003.

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), minnow/turtle traps, turning of cover objects, and larval dip-netting and identification. Intensive herpetological surveys occurred over a four-year period, concluding in the autumn of 2003. However, select herpetological data collected as far back as 1990 were included (Klemens 1993; Klemens, unpublished data).

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.

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 four 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, wood frogs are known to require forested habitat extending 1,500 feet out from the vernal pools in which they breed. Therefore, a circle of these dimensions was delineated around each wood frog breeding pool. 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 areas ("polygons" in GIS terms) were merged together ("dissolved"); resulting 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. *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.

6. *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 Croton-to-Highlands Biodiversity Plan. This composite map includes habitat hubs, many preserved habitats, corridors that link these habitats, and "biotic planning units" (BPUs). BPUs are large tracts of habitat (at least 1,000 acres), containing significant species, that are isolated from other habitat hubs and corridors by development and roads. BPUs are large enough to potentially meet the habitat and area requirements of many of the less mobile, development-sensitive species they contain. For the most part, similar disjunct habitats that are smaller than 1,000 acres were not included in the composite map. Although they may have contained a diversity of development-sensitive species, these smaller habitat tracts are much less likely to be able to sustain the wildlife they contain. In the interest of striking an appropriate and scientifically defensible balance between development and conservation, these areas were, with a few notable exceptions, excluded from further consideration in this plan.

Outreach and Municipal/Inter-municipal Implementation

Throughout the course of this project, "municipal walks" occurred within each of the four towns. These outreach activities, also known as "survey walks," addressed local land use decision-makers (e.g., municipal staff and elected officials, land trust personnel, non-governmental conservation organizations, and concerned citizens). Attendees accompanied WCS/MCA staff to local sites and participated in field surveys. Species observed during these surveys were added to the overall project database. Those observations also served as a springboard for discussions about species' habitat and landscape requirements, and how various human land uses affect wildlife populations. In particular, the positive impact of better planning was discussed. The intent of these walks was to introduce biodiversity concepts to people whose decisions have a direct influence on biodiversity within the four towns.

WCS/MCA staff has interacted with the four towns in a variety of other ways. We have convened project planning and update meetings at various stages throughout the project. In addition we have interacted individually with town staff, elected officials, board members, and land trust personnel on a variety of issues in the four-town region, ranging from comprehensive plan updates to land preservation to provision of field data for review of individual development proposals.

RESULTS AND DISCUSSION

Overview

As a result of our field inventories, we conclude that the Croton-to-Highlands 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 four 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 four 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 four 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 Croton-to-Highlands 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 “sink” habitats. Therefore, if connectivity with other habitats is maintained these hubs may help to sustain biodiversity outside of their borders, throughout the Croton-to-Highlands towns. Key properties of a biodiversity hub include (1) adequate acreage (at least 1,000 acres) 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 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 are instead designated in this report as “biotic planning units” (defined below). In other cases, a biodiversity hub may consist entirely of privately

owned, relatively undeveloped land, or of a small park (less than 1,000 acres) that is surrounded by high-quality, privately owned habitats. In all of these cases, the Croton-to-Highlands 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. Biodiversity hubs may also be embedded within a broader corridor. Narrow, linear stretches of habitat (e.g., narrow strips of habitat surrounding hiking trails) 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.

Biotic planning unit (BPU)—BPUs are high-quality habitats greater than 1,000 acres, which therefore have the potential to support development-sensitive species in the long-term. They are defined in exactly the same way as biodiversity hubs with one key exception—they are fragmented and isolated from other habitats by heavily-trafficked roads, high-density development, or other factors. Although they are not part of larger corridors, BPUs contain high levels of biodiversity that should be planned for. In fact, management within BPUs is particularly important because if species with lower dispersal capabilities (e.g., amphibians, reptiles, many plant species) become extirpated from them, their populations will not be replenished from outside "source" habitats due to the lack of habitat connectivity.

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. Towns should very carefully plan for these areas, to avoid fragmenting and isolating biodiversity hubs from each other.

Habitat fragment of concern—Some areas that contain high-quality habitats and exemplary biodiversity lack connectivity to other habitats and are too small to be considered BPUs. Several of these areas were identified during the course of this project; because of their value to landscape-scale biodiversity, they merit consideration and are discussed in this report.

Croton-to-Highlands Biodiversity Areas

The following numbered sections contain descriptions of areas throughout the four towns that are important for biodiversity. The mapped numbered areas in Figure A correspond to these sections. Each section contains a description of location and landscape setting, a rationale for inclusion (including a listing of representative wildlife species), and general recommendations. Some of the turtle species detected in these areas are at risk because they are often collected for the wildlife trade. Rather than endangering these species further by revealing their locations in this report, a confidential appendix will be provided to the four towns, so that their requirements can be factored into towns' land use planning and management decisions.

1. *Biodiversity corridor: Canopus Hollow to Fahnestock*

   This corridor, containing many significant habitat hubs, runs along the western edge of Putnam Valley, including the length of Canopus Hollow, continuing north along the western slopes of Candlewood Hill to the northwest portion of the Town, including a large area of Fahnestock State Park. This is one of the most biodiverse areas within the entire four-town region. Species of particular significance that were observed in this area include Jefferson and dusky salamanders. Although all of these species appeared to have healthy, thriving populations in this portion of Putnam Valley, they have all but disappeared from Westchester County.

   Because these and a host of other noteworthy species occupy this corridor (including, but not limited to, northern black racer, sharp-shinned hawk, common raven, Canada warbler, hooded warbler, black-throated green warbler, and a host of other forest-interior birds), it should receive special attention to ensure that large blocks of contiguous habitat are maintained. In particular, extensive tracts of interconnected forest (on ridges and in valleys), interspersed with streams and vernal pools should be maintained.

2. *Constriction point: Cortlandt to Putnam Valley*

   This is the only portion of Putnam Valley that maintains a substantial (although tenuous) degree of habitat connectivity with its Westchester neighbors. Because of this connection, it has the potential to serve as source habitat that continues to keep habitat hubs in Cortlandt's Hudson Highlands Gateway Park (#6) and Camp Smith Military Reservation (#5) abundant with wildlife. But this connection is tenuous. In Westchester, the only real connection is along the Catskill Aqueduct and nearby stream corridors. The majority of potential connections run through the Town of Philipstown, which is not, to date, part of the Croton-to-Highlands Biodiversity Plan. As mentioned in the "Recommendations" section, any inter-municipal conservation and land use planning efforts should include Philipstown, as this is the only hope for assuring continued ecological linkages between Putnam Valley and Westchester County.

3. *Biodiversity corridor: North-central to eastern Putnam Valley*

   This corridor, and associated habitat hubs, accomplishes the vital role of connecting two disjunct portions of Fahnestock State Park. It also includes large privately owned parcels in-between and to the south of these preserved areas. It is bounded along its northeast edge by

the Taconic State Parkway, which acts as an effective barrier to most wildlife movement. Besides containing wildlife and habitats considered imperiled by the New York State Natural Heritage Program, a variety of development-sensitive species were observed in this corridor, including marbled salamanders and other mole salamanders, northern slimy salamanders, eastern ribbon snakes, gray treefrogs, barred owls, and a diversity of forest-interior, area-sensitive songbirds, among others. As with Biodiversity Corridor #1, an emphasis should be placed on land preservation and on land use planning that attempts to maintain large tracts of contiguous, mature forest interspersed with wetlands (large and small).

4. *Biodiversity corridor: East-central to southern Putnam Valley*

   This corridor covers much of Peekskill Hollow Brook (except for areas already developed), includes the southeastern slopes of Granite Mountain, and continues south along Piano Mountain into a small, undeveloped portion of north-central Yorktown. Although this corridor has sustained somewhat more development than #1 and #3, it continues to support a broad diversity of important species such as northern slimy salamanders, gray treefrogs, wood frogs, black rat snakes, black-and-white warblers, worm-eating warblers, hooded warblers, pileated woodpeckers, ovenbirds, Louisiana waterthrushes, and an array of birds associated with more open habitats (eastern bluebird, blue-winged warblers, chestnut-sided warblers, indigo buntings, and prairie warblers), among others. Conservation of habitats in and surrounding Peekskill Hollow Brook is particularly important. Conservation of habitats along Piano Mountain is important for both Putnam Valley and Yorktown; this is an opportunity for inter-municipal collaboration on land use planning and management.

   Much of Granite Mountain, and continuing north to Prospect Hill (an area that lies outside of the delineated corridor) consists of large, undeveloped privately owned parcels. Although WCS/MCA did not collect data in this area and wildlife data from other sources were also lacking, conservation efforts would be merited here due to the extent and undeveloped status of the habitat.

5. *Biotic planning unit: Camp Smith Military Reservation and vicinity*

   Camp Smith Military Reservation and adjacent areas, occupying the northwestern-most corner of Cortlandt, contain a unique assemblage of habitats and species, including five-lined skinks, worm snakes, northern slimy salamanders, black-throated green warblers, prairie warblers, and others. Although WCS/MCA data for the military reservation itself is limited, datasets from other agencies and organizations corroborate the conclusion that this area is important for biodiversity. For example, the New York State Natural Heritage Program has identified a number of significant ecological communities in the vicinity, in addition to significant plants and wildlife. This BPU is bordered to the east by heavily-trafficked Route 9. The Hudson River and Route 6 deter wildlife movement to the south and west. However, connectivity with Putnam County habitats (including the mapped corridors in Putnam Valley) is still possible through the Town of Philipstown (see the constriction point referred to in #2, above). If Philipstown is brought into inter-municipal collaborations with Cortlandt and Putnam Valley, biodiversity within this BPU could benefit immensely; this isolated BPU could then be considered a biodiversity hub within a larger corridor.

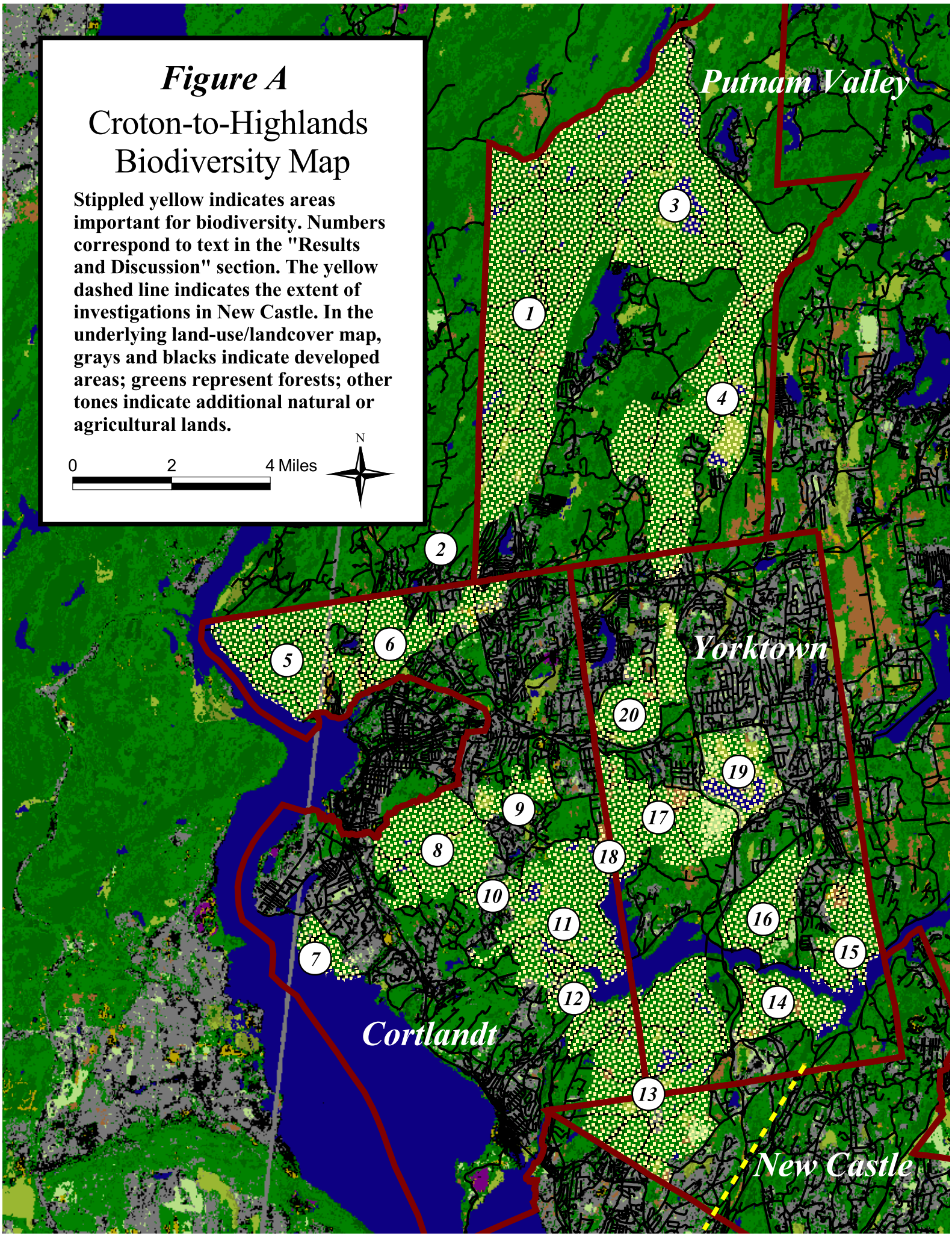
Figure A
Croton-to-Highlands Biodiversity Map
Stippled yellow indicates areas important for biodiversity. Numbers correspond to text in the "Results and Discussion" section. The yellow dashed line indicates the extent of investigations in New Castle. In the underlying land-use/landcover map, grays and blacks indicate developed areas; greens represent forests; other tones indicate additional natural or agricultural lands.
0
2
4 Miles
N
Putnam Valley
Yorktown
Cortlandt
New Castle
1
2
3
4
5
6
7
8
9
10
11
12
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19
20

6. *Biotic planning unit: Hudson Highlands Gateway Park to Peekskill Hollow Brook*

   WCS/MCA developed biodiversity management recommendations for Cortlandt's Hudson Highlands Gateway Park (Miller and Klemens 2002b), and has therefore conducted numerous surveys in the area. Amphibians of conservation concern in this area include spotted salamander, marbled salamander, slimy salamander, gray treefrog, red-spotted newt, and wood frog. Reptiles include worm snake, black racer, black rat snake, and northern copperhead. Bird diversity is also high, including barred owls, Cooper's hawks, and a variety of songbirds associated with interior forests and also with early successional habitats. Preservation of this biodiverse park was an excellent decision by the Town of Cortlandt and Scenic Hudson, Inc. Hognose snakes and black racers—both species that are highly significant in Westchester County—were recorded in the eastern end of this BPU, in habitats along Peekskill Hollow Brook that have since been developed for recreational purposes. Special effort should be made to ensure that these species continue to breed here.

   This area is bounded to the west by Route 9 (a barrier to most wildlife species) and in most other directions by development. This BPU has an extremely tenuous and narrow connection to Putnam Valley's biodiversity corridors—along the Catskill Aqueduct and then through Philipstown. Not all species will be able to make use of this constricted corridor; efforts should be made to maintain and widen the corridor. See #2 for more details about this constriction point.

7. *Habitat fragment of concern: George's Island and vicinity*

   Although this area, at less than 400 acres, falls below the threshold for designation as a BPU, we have included it for several reasons. It contains an interesting array of biodiversity, including wood frogs, and many birds associated with healthy, extensive forests that are structurally and hydrologically diverse (e.g., Canada warbler, northern waterthrush, wood thrush, black-throated green warbler, and eastern towhee). A species of significant conservation concern has also been recorded in this vicinity by the NY Natural Heritage Program. The presence of some of these species, normally associated only with larger forest blocks, might be attributed to the fact that, rather than being surrounded completely by development, it is bordered by open river to the west. The southern half of the area is designated as a Westchester County park; conservation easements and other opportunities for private stewardship in the northern portion would add significant value to the existing parkland.

8. *Biodiversity hub: Blue Mountain Reservation and vicinity*

   The size of this reservation, and the fact that it contains an assemblage of species that indicate high-quality habitat in the northern suburbs, make it a significant biodiversity hub. Amphibians and reptiles observed here include spotted salamanders, marbled salamanders, red-spotted newts, gray tree frogs, wood frogs, and black rat snakes. A host of forest birds depend on these habitats, including barred owls, pileated woodpeckers, wood thrushes, ovenbirds, and Louisiana waterthrushes, among others. Most of this area is adequately preserved. It should continue to be managed for its biodiversity values. Expansion of the boundaries of the protected area would be beneficial, whether through easement or direct purchase, although such opportunities may be limited in this area.

9. *Habitat fragment of concern: Pleasantside wetlands and associated uplands*

   This area is east of Blue Mountain Reservation, and lies south and east of Pleasantside. The habitat here is too small to be considered a biodiversity hub or BPU. However, the area is noteworthy for several reasons. It contains remnant populations of development-sensitive species (e.g., black rat snakes, gray treefrogs, Canada warblers, pileated woodpecker, worm-eating warbler, and others). It contains the headwater wetlands of Furnace Brook (some of which is protected locally as a park). It also includes a diversity of wetlands (including ponds, forested wetlands, shrub swamps, and emergent marsh). Most of these wetlands have been ringed tightly by development. Wetland-rich landscapes such as this are particularly important for biodiversity; development in such areas should be planned carefully to avoid further impacts to wetland biota.

10. *Constriction point: Blue Mountain to Salt Hill*

    Part of the connecting corridor between Blue Mountain Reservation and the Salt Hill/Colabaugh Pond area has been protected by the County Parks Department as the Briarcliff-Peekskill Trailway (which connects through the Salt Hill area and all the way through Teatown Lake Reservation). Such efforts to connect larger preserved areas are commendable and can be highly beneficial to wildlife. We recommend widening the trailway, where feasible, so that it can better facilitate wildlife dispersal among biodiversity hubs. Unfortunately, Watch Hill Road and Furnace Dock Road act as barriers to many species of wildlife. Solutions should be sought to lessen these road-associated impacts.

11. *Biodiversity hub: Salt Hill, Colabaugh Pond, and vicinity*

    This area is bounded to the east by the Croton Reservoir, is otherwise surrounded by dense residential development, and forms the nexus of a major corridor that ecologically links Cortlandt with Yorktown. Like its neighbor, Blue Mountain Reservation, this biodiversity hub contains an excellent wildlife community typical of large tracts of habitat of the area. In addition to the expected spotted salamanders, black rat snakes, wood frogs, and gray treefrogs, WCS/MCA biologists observed Fowler's toads. A portion of this area is slated for development; site designs should minimize impacts to these resources by clustering the development and placing conservation easements over critical habitats. Birds typical of large expanses of deciduous and mixed forests were also observed. Reports of pied-billed grebes were also taken into account for this area. This impressive diversity was observed despite the fact that much of the land is privately owned and we were able to access only portions of it. Collateral datasets indicate that most of this area is likely to support high levels of biodiversity. This area has additional importance because it lies at the nexus of several biodiversity hubs: Teatown Lake Reservation (#13), Blue Mountain Reservation (#8), and Hunter Brook (#17). To ensure that crucial links are maintained between all of these biodiversity hubs, we recommend application of land use planning tools in this area (see "Recommendations" section), in addition to land preservation efforts.

12. Constriction point: Salt Hill to Teatown

This is a particularly tenuous connection for several reasons. Residential development has already encroached upon habitats within this constriction point. This area also includes a break in the Briarcliff Peekskill Trailway. In addition, the area is crossed by a number of roads, including Highway 129. We recommend land preservation efforts to bridge the gap in the Trailway, combined with efforts to reduce residential development within the constriction point.

13. Biodiversity hub: Teatown Lake Reservation and vicinity

Teatown Lake Reservation, combined with its associated protected areas, provides excellent wildlife habitat. Besides the Reservation's protection of biodiversity, the education programs at the Reservation help to raise awareness of the importance of these issues throughout the region. Environmental education of the region's citizens can ultimately support and justify ecologically sound land use decisions made by elected officials. The Reservation is important for another reason: it occurs at the juncture of three of the region's towns (New Castle, Yorktown, and Cortlandt). It could therefore serve as a foundation for inter-municipal planning and cooperation. Although several roads cross through this area, it continues to function as an ecological unit. WCS/MCA conducted a separate biodiversity study of the area (in collaboration with the Reservation and funded by Westchester Community Foundation) in which specific recommendations were made to sustain biodiversity (Miller and Klemens 2003). That document contains detailed lists of species observations and landscape-scale recommendations for maintaining biodiversity that pertain to New Castle, Yorktown, and Cortlandt.

14. Biotic planning unit: Stayback Hill and Kitchawan Preserve

Stayback Hill and Kitchawan Preserve lie east of Teatown Lake Reservation and south of the Croton Reservoir, and cover just over 1,000 acres. Unfortunately, this area has been functionally isolated from Teatown by the Taconic State Parkway; hence its designation as a distinct BPU. The area contains a diversity of important snake species, including black rat snakes and northern copperheads (very significant in this area, given the context of development). The area is also home to osprey and a combination of both forest interior songbirds and birds of fields and shrublands. Much of this area is protected, but some of the snake habitats have been degraded by off-road vehicles. Management plans should be devised to maintain high-quality habitats within the preserved areas.

15. Biotic planning unit: Hilltop Hanover Farm and vicinity

This BPU, at just over 1,000 acres, contains the Westchester County Parks Department's Hilltop Hanover Farm at its north end and is bounded to the east by Somers, to the south by the Croton Reservoir, and to the west by residential development. Amphibians and reptiles found at the site include slimy salamanders, gray treefrogs, and wood frogs, among others. Bird species include a combination of development-sensitive species of early-successional habitats (blue-winged warblers, eastern bluebirds, indigo buntings, etc.) and area-sensitive forest birds (hooded warblers, Louisiana waterthrushes, worm-eating warblers, etc.). This area is being encroached upon by development from both Yorktown and Somers. However,

significant habitat that functions as part of this ecological unit can be found in Somers. We recommend that discussions be initiated with the Town of Somers to include them in inter-municipal planning efforts.

16. *Biotic planning unit: Turkey Mountain and vicinity*

The Turkey Mountain BPU covers 1,000 acres and is bounded to the east by Highway 118 and to the west by the Taconic State Parkway and Underhill Avenue. It contains a variety of species, including gray treefrogs, wood frogs, black rat snakes, barred owls, pileated woodpeckers, yellow-throated vireos, ovenbirds, black-throated green warblers, and others. Portions of the property are protected at Town or State levels; however, this property contains significant habitats that are important for both biodiversity and the protection of Croton Reservoir water quality. We recommend that the area be further protected through preservation or the application of land use planning tools (see "Recommendations" section).

17. *Biodiversity corridor: Hunter Brook to Mohansic*

Hunter Brook, and the habitats that surround it, arguably provide some of the most important wildlife habitat south of Putnam Valley. Additional early-successional habitats are provided in the contiguous Mohansic Park and Golf Course. This biodiversity hub is bounded to the east by the Taconic State Parkway and to the north and south by residential development. Although an ecological connection northward to the wetlands, streams, and upland forests of Sylvan Glen (see #20) would have been very beneficial, this connection has already been severed by development and by Crompond Road (Highway 202). Land acquisition and conservation easements would be particularly helpful in this area. This hub spans the border between Yorktown and Cortlandt, and therefore provides another justification for inter-municipal planning efforts. Habitats at the Mohansic Park and Golf Course support birds that are associated with early-successional habitats, including blue-winged warblers, eastern bluebirds, and brown thrashers, which are rapidly declining throughout this portion of their range. We recommend that mowing and other management activities in and around the golf course be carefully designed to encourage the continued use of this area by these species.

18. *Constriction point: Hunter Brook to Salt Hill*

This corridor is constricted where it is dissected by Croton Avenue. In addition to problems associated with this road crossing, wildlife dispersal is impeded here by encroaching residential development. Given the high biodiversity and species composition of the Hunter Brook area, combined with the quality and extent of habitat in the Salt Hill area, maintaining this corridor for wildlife dispersal should be a high priority.

19. Habitat fragment of concern: Roosevelt State Park and vicinity

This area contains development-sensitive species and quality habitats, including a variety of wetland types. However, it is cut off from the nearby biodiversity corridor by the Taconic State Parkway, other highways, and development. It is approximately 900 acres in extent, and therefore falls below the size threshold for designation as a BPU. However, almost all of these acres are currently preserved by the Town of Yorktown and New York State; the key issue at this site is habitat management within the parks.

20. Biotic planning unit: Sylvan Glen and vicinity

At just under 1,200 acres, the Sylvan Glen BPU lies at the western end of Yorktown just north of Crompond Road/Highway 202 and ranges north to the preserved Shrub Oak Wetlands. A diverse assemblage of development-sensitive species are found here, including spotted and slimy salamanders, red-spotted newts, gray treefrogs, wood frogs, pileated woodpeckers, black-and-white warblers, ovenbirds, northern and Louisiana waterthrushes, and wood thrushes. This BPU currently contains significant, unfragmented habitats. Town-owned preserved areas lie at its north and south ends. Poorly planned development of privately owned lands in between these preserved areas would fragment this BPU into smaller habitats that would be unable to support the focal species currently found there. Protection of privately owned portions (through preservation or land use planning tools) should be a priority.

RECOMMENDATIONS FOR IMPLEMENTATION

The following sections outline tools and techniques that can be employed to achieve the goal of this report—a sustainable balance between development and conservation within the Croton-to-Highlands towns. For recommendations that relate to specific areas and sites within the towns, see the "Results and Discussion" section entitled "Croton-to-Highlands Landscape Units."

Important Considerations and Caveats

1. *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.

2. *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 four 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.

3. *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 four 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). 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 four 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 CHBP 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.

1. *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.

2. *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.

3. *Partner with local and regional land trusts (e.g., Westchester Land Trust, Hudson Highlands Land Trust, and others); the Westchester County Department of Parks, Recreation, and Conservation; and the Putnam County Department of Parks and Recreation to protect areas identified in this report.*

4. *Consider developing 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.

5. *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 (i.e., 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.

1. *Avoid large-lot zoning.*

   Up-zoning (i.e., increasing residential lot sizes) is often perceived as a "quick fix" to sprawl. Up-zoning results 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.

2. *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.

3. *Consider passing 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 biotic planning units (BPUs) and 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.

4. *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 already assisted Yorktown with their Comprehensive Plan update and started a dialogue with Cortlandt. It is important to note that Comprehensive Plans can be amended at any point, even after an update has occurred, so it would be possible to incorporate these findings and recommendations into the plans of all four 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.

5. *Consider formalizing inter-municipal relationships with other towns in the Croton-to-Highlands region (and beyond) by:*

   a. establishing an inter-municipal council, and

   b. 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.

6. *Encourage the extension and application of biodiversity and planning concepts, tools and mapped areas into towns adjacent to the Croton-to-Highlands communities.*

   Conservation efforts in neighboring towns can add value to those in the CHBP. This is particularly important for adjacent towns that share ecological linkages, such as Philipstown and Somers.

7. *Encourage better SEQRA reviews by:*

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

    b. 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.

    c. 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 the Town of Cortlandt. A version of these standards will soon be published as a WCS/MCA Technical Paper and made available to other towns.

8. *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.

9. *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.

10. *Consider adopting a strong local wetlands ordinance or amending 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.

11. *Consider applying and formally adopting "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.

12. *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. Westchester County has developed a list, but it has 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).

13. *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).

14. *Consider revising 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.

15. *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.

16. *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.

17. *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.

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Appendix A

Focal Species of the Croton-to-Highlands Region

Development-Associated Focal Species

Amphibians
Northern two-lined salamander
American toad
Bullfrog
Green frog

Reptiles
Common snapping turtle
Painted turtle
Red-eared slider
Northern water snake
Eastern garter snake

Birds
Canada goose
Rock dove
Blue jay
American crow
European starling
Brown-headed cowbird
Common grackle
House finch
House sparrow
House wren

Development-Sensitive and Listed Focal Species

	New York Status	Westchester County Status	Audubon WatchList Status
Amphibians			
Jefferson salamander	Special Concern	Threatened	
Blue-spotted salamander	Special Concern	Threatened	
Spotted salamander			
Marbled salamander	Special Concern		
Northern dusky salamander		Threatened	
Northern slimy salamander		Special Concern	
Red-spotted newt			
Fowler's toad			
Gray treefrog			
Wood frog			
Reptiles			
Spotted turtle	Special Concern	Threatened	
Wood turtle	Special Concern	Endangered	
Eastern box turtle	Special Concern	Threatened	
Eastern fence lizard	Threatened	Threatened	
Northern five-lined skink		Special Concern	

Development-Sensitive and Listed Focal Species (Continued)

	New York Status	Westchester County Status	Audubon WatchList Status
Reptiles (Cont'd)			
Worm snake	Special Concern	Special Concern	
Northern black racer			
Black rat snake			
Eastern hognose snake	Special Concern	Special Concern	
Eastern ribbon snake		Threatened	
Northern copperhead		Special Concern	
Timber rattlesnake	Threatened	Endangered	
Birds			
American black duck		Special Concern	Declining
American woodcock		Threatened	Declining
Sharp-shinned hawk	Special Concern		
Cooper's hawk	Special Concern	Endangered	
Northern goshawk	Special Concern	Endangered	
Bald Eagle	Threatened	Endangered	
Osprey	Special Concern	Endangered	
Barred owl			
Pileated woodpecker			
Least flycatcher			
Common raven		Threatened	
Swamp sparrow			
Eastern towhee			
Indigo bunting			
Yellow-throated vireo			
Black-and-white warbler			
Worm-eating warbler		Special Concern	Declining
Blue-winged warbler			Declining
Chestnut-sided warbler			
Black-throated green warbler			
Prairie warbler		Special Concern	Declining
Ovenbird			
Northern waterthrush			
Louisiana waterthrush			
Kentucky warbler		Endangered	Declining
Hooded warbler			
Canada warbler		Special Concern	Declining
Brown thrasher			
Wood thrush		Special Concern	Declining
Veery			
Eastern bluebird			

Appendix B

WCS/MCA Technical Paper Series

Habitat Management Guidelines for Vernal Pool Wildlife, MCA Technical Paper #6. This manual provides habitat management guidelines for maintaining vernal pool biodiversity in forested landscapes. It is intended for application in extensively forested regions, such as northern New York and New England, to harmonize timber harvest activities with vernal pool resources. By Aram J. K. Calhoun and Phillip deMaynadier, 2004. *$8.00*

Best Development Practices: Conserving Pool-Breeding Amphibians in Residential and Commercial Developments, MCA Technical Paper #5. This manual contains techniques to guide local and state planners, officials, and other 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 pools that are exemplary or worthy of protection efforts, and then develop strategies to fulfill that protection. By Aram J. K. Calhoun and Michael W. Klemens, 2002. *$10.00*

Eastern Westchester Biotic Corridor, MCA Technical Paper #4. The Eastern Westchester Biotic Corridor (EWBC) is a partnership between MCA and the three contiguous towns of North Salem, Lewisboro, and Pound Ridge in northeastern Westchester County, NY. This report provides science-based information and tools to support the establishment of a regional, multi-town approach to the conservation of wildlife and habitats. This report will also serve as a model for other multi-town initiatives. By Nicholas A. Miller and Michael W. Klemens, 2002. *Available in Acrobat format (.pdf).*

Conservation Area Overlay District: A Model Local Law, MCA Technical Paper #3. This provides an example of a model ordinance that can be adopted by municipalities to delineate conservation area overlay districts. The ordinance is based upon New York State law, but can be adapted for use in other states that have strong home rule authority. Within ecologically sensitive areas, it seeks to reduce habitat fragmentation, maintain biodiversity, and protect significant natural features. This model law enables towns to develop a template not only for ecological protection, but also for the siting of future development. Prepared for MCA by Pace University, 2002. *$7.50*

Open Land Acquisition: Local Financing Techniques Under New York State Law, 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), to help them decide which of several potential funding mechanisms would be most appropriate. Prepared for MCA by Pace University, 2000. *Available in Acrobat format (.pdf).*

A Tri-State Comparative Analysis of Local Land Use Authority: NY, NJ, & CT, 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. For example, it 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*