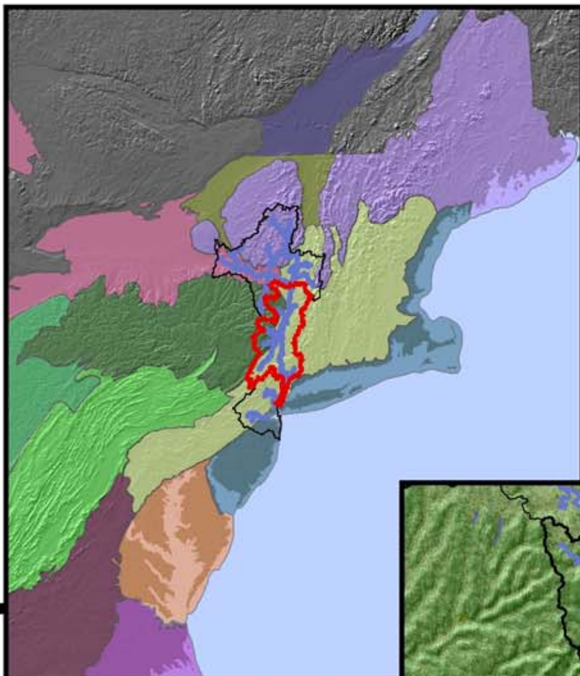
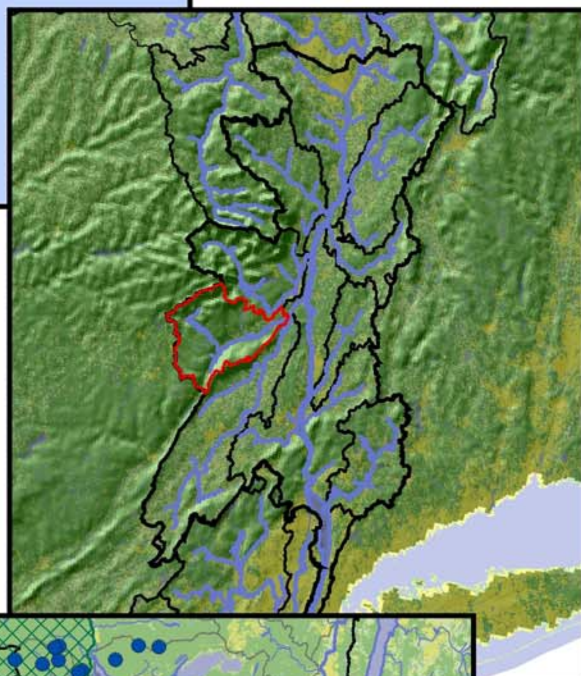
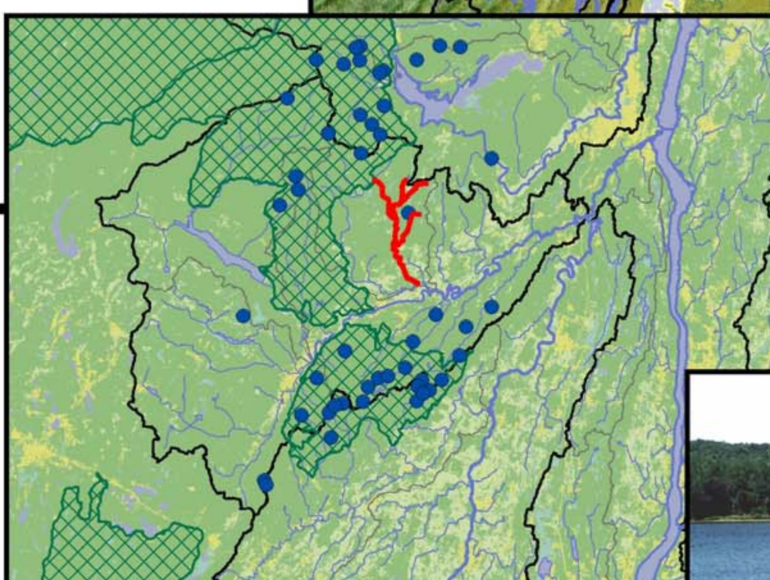


Identifying Conservation Priorities in the Hudson River Estuary Watershed



Linking Perspectives Across Multiple Scales



The Nature Conservancy

SAVING THE LAST GREAT PLACES ON EARTH

Identifying Conservation Priorities in the Hudson River Estuary Watershed:
Linking Perspectives Across Multiple Scales

Initial Draft for Review

January 2005

The Nature Conservancy
Eastern New York Chapter
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TNC publications and other supporting documents may be found online in the Eastern New York Chapter Conservation Planning Resource (ftp://ftp.tnc.org/ENY/Conservation_Planning).
Please feel free to browse these files, or follow the footnotes throughout the document to find the location of certain documents within this directory.

Executive Summary

The purpose of this report is to present the Conservancy's first attempts to identify ecological priorities in the Hudson River Estuary watershed. This is a necessary first step toward our end goal – determining the conservation needs of the Hudson River Estuary and its watershed. As the Conservancy launches a series of workshops over the next few months to achieve this goal, this document describes the state of our knowledge. As we expect there to be gaps in our knowledge, we are soliciting feedback on this initial assessment and analysis in order insure we have the best information possible for the workshops.

We present the results of two sets of analyses. The first is a subset of terrestrial and aquatic assessments that are relevant to the Hudson River Estuary watershed, which were conducted by the Conservancy and its partners across *ecoregions*. Ecoregions are relatively large areas of land and water that contain geographically distinct habitats sharing species and ecological processes in common, and can serve as *effective conservation units* at continental and global scales. Due to their large-spatial scale, ecoregional assessments are well suited to identify *where* the most important areas of biological diversity are found. The Conservancy ideally uses this relatively coarse information as the starting point for answering the next important question in conservation - *how* should conservation efforts be carried out. The Conservancy relies on following a second, separate assessment process to determine *how* conservation is best carried out at specific places by developing strategies, taking action, and measuring their success. Over the next few months, the Conservancy will conduct a series of workshops that will follow this second assessment process, relying on both the information available from the ecoregional assessments, and the knowledge provided by the participants. In this way, coarser ecoregional information can be combined with the site-specific knowledge of the participants to enhance our ability to determine the needs of the Hudson River Estuary and its watershed.

The second analysis we present is a synthesis of nine existing intermediate-scale ecological assessments of the estuary and watershed, in order to explore where they do, or do not, overlap with the results of the ecoregional assessments. Nineteen large and moderate sized tributaries in the Estuary watershed were identified as ecoregional priorities by the Lower New England/Northern Piedmont ecoregional assessment. This portfolio of ecoregional priority watersheds captured significantly more of the conservation priorities identified by the other assessments than did those watersheds not selected by the ecoregional process. However, the ecoregional priority watersheds captured less than half of the priority species and vegetation community occurrences identified by our own ecoregional planning process. This suggests that while the conservation of ecoregional priority watersheds would significantly benefit the biological diversity already identified as important in the watershed, these watersheds alone are not sufficient to conserve the full array of representative biological diversity in this ecologically rich and diverse estuarine watershed.

It is hoped that this report will serve as a valuable ecological synthesis of existing information to help support the upcoming series of collaborative workshops focused on answering the "how" question in conservation. The Conservancy's workshop process is designed to work with partners to identify the conservation needs of the Hudson River Estuary and its watershed. The identification of priority natural resources called "conservation targets" is central to this effort. Conservation targets are selected across varying levels of biological organization to *represent* biological diversity and the processes that sustain them. It is through the judicious selection of conservation targets that appropriate and effective conservation strategies, actions and measures will be developed. It is our hope that the information in this document will aid this process.

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From “Local to Global” in conservation: How do we get there?

Conservation concepts and perspectives from The Nature Conservancy

Over the past 50 years, The Nature Conservancy has evolved in many ways that mirror advances in the conservation world. What began as a small, not-for-profit land trust right here in eastern New York has grown to be one of the world’s largest conservation organizations. This metamorphosis reflects advances in our ecological knowledge, our understanding of the roles that humans play in ecological systems, and our commitment to an active, participatory role in sustaining our planet for future generations. A brief history illustrates this evolution, and provides a necessary context to our current approach to conservation in the Hudson River Estuary watershed.

In the early 1950’s, a group of scientists broke from the Ecological Society of America to take a more active role in conservation, and formed The Nature Conservancy. When the Eastern New York Chapter was incorporated as The Nature Conservancy’s first official Chapter in 1953, it was primarily motivated by the urgent need to preserve land from development. The Conservancy purchased its first preserve in New York at Mianus Gorge and launched a core conservation strategy that has remained a mainstay of the organization - and the conservation community - until now. However, as single and constant as land preservation has been as a conservation strategy, the perspectives and concepts that drive conservation have been diverse and dynamic. Perhaps most importantly, our progressive understanding of the infinitely complex ecological world of which we are all a part has shaped conservation efforts over time. What began as simple land protection to stem a local threat has expanded into an ever-increasing awareness of the direct links among local, regional, continental, and global threats that provides the context for conservation today.

During this period of dynamic change, the Conservancy has adapted its approach accordingly to keep pace with the rapidly increasing understanding of the scale and scope of conservation needs. Ten years ago, the Conservancy launched a strategic plan, *Conservation by Design: A Framework for Mission Success,* in which it embraced its new mission:

…to preserve the plants, animals, and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive.

A clear departure from simply preserving land from development, this broad and expansive mission was a response to the increasing recognition that the loss biological diversity was the most urgent issue to address in conservation. It acknowledged that many of the natural processes and human-induced threats that dramatically influence biological diversity occur at much larger spatial scales than the preserves or areas we wish to conserve. This mission demanded new approaches to conservation in order to be successful. Specifically, the Conservancy published the first edition of *The Geography of Hope* in 1996 (revised later as Groves et al. 2000), in which it dramatically altered the organizational structure to make ecoregions, not political boundaries, the framework for shaping conservation efforts. Ecoregions are relatively large areas of land and water that contain geographically distinct habitats sharing species and ecological processes in common, and can serve as *effective conservation units* at continental and global scales (Fig. 1). To achieve this broad mission, a specific conservation vision emerged to:

…conserve portfolios of functional conservation areas within and across ecoregions. Through this portfolio approach, we will work with partners to conserve a full array of ecological systems and viable species.

Figure 1. Ecoregions of North America with the Lower New England/Northern Piedmont ecoregion (#61), which contains the majority of the Hudson River Estuary and its watershed, outlined by the red oval

Ecoregional assessments, or plans, are used to determine where the most important areas of biodiversity are found, from which the Conservancy develops a course of action for specific conservation areas through an iterative four-step process called the *Conservation Approach*[1]. Through this conservation approach, local actions are identified that help to sustain target species, communities, and ecosystems over the long-term within key priority areas in each ecoregion. In turn, each ecoregion serves as a critical "piece of the global puzzle" intended to directly link local conservation efforts to global conservation success.

Applying key conservation concepts to the Hudson River Estuary ecosystem

The Conservancy recently completed a first draft of the Lower New England/Northern Piedmont Ecoregional assessment[2]. Using this assessment and an additional aquatic assessment conducted since the assessment was published, a set of priority watersheds within the Hudson River Estuary watershed was identified. This assessment provides an important information base for the next steps in the conservation process – identifying appropriate conservation strategies, actions, and measures of success. It also provides an important context for assessing conservation priorities, as ecoregional assessments are one of *the largest spatial scale biodiversity conservation assessments* available to us that include the Hudson River Estuary and its watershed.

[1] More information available at http://nature.org/aboutus/howwework/cbd/science/art14305.html
[2] Conservation Planning Resource: Ecoregional_planning/Plans/LNE

Ecoregional Priorities in the Hudson River Estuary

How does the Hudson River Estuary relate to ecoregions?

The Hudson River Estuary occurs predominantly within the Lower New England / Northern Piedmont (LNE/NP) ecoregion (Fig. 2). The Hudson River Estuary is influenced by the entire Hudson River watershed, with an expansive geographic reach that extends into four additional ecoregions. The headwaters of the Estuary's western tributaries drain from the edge of the High Allegheny Plateau (HAL) ecoregion and the Estuary's mouth is in the North Atlantic Coast ecoregion. The headwaters of the Hudson River drain from the Northern Appalachian / Boreal Forest ecoregion to the north, while its largest tributary – the Mohawk River – enters from the Great Lakes ecoregion to the west.

For the purposes of this report we will only consider the Estuary portion of the Hudson River watershed. This limits our assessment to the portion that is tidal, from the mouth of the Hudson River up to the Troy Dam. In this context, the primary influence is the LNE/NP ecoregion, which contains the majority of the estuary watershed.

We recognize the important ecological connections between the upper and lower portions of the watershed, and that conservation efforts to protect the Hudson River ecosystem must ultimately consider the entire watershed. However, the scope and availability of existing information varies considerably throughout the watershed, as comparatively little ecological information is available for the upper versus lower watershed. Similarly, the criteria by which we would evaluate priorities above and below the Troy Dam would be quite different as a result of this inconsistency. Finally, the ENY Chapter has jurisdiction over Conservancy activities in the lower portion of the watershed, which is an important consideration in strategy development and implementation.

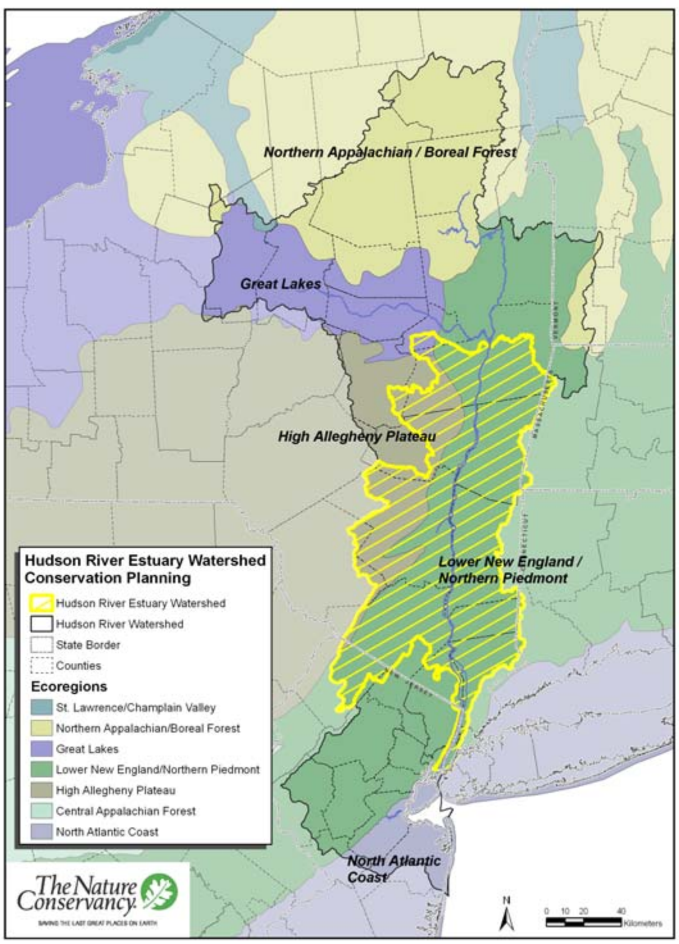

Figure 2. The watersheds of the Hudson River and the Hudson River Estuary in relationship to The Nature Conservancy ecoregions.

What is an ecoregional priority?

The Conservancy's intent is to identify a network of conservation areas that, over time, with appropriate management, could ensure the long-term survival and function of the native species, vegetation communities, and ecosystems representative of each ecoregion (Groves et al. 2000, 2002, Groves 2003). Through the selection of priority areas that "represent the diversity of life on earth", the Conservancy directly relates on-the-ground actions to overall mission success. Central to this process, and different from other conservation approaches, is the conscious emphasis on the conservation of *representative* ecosystem types. This approach is specifically designed to prevent more species from becoming imperiled, rather than focusing solely on reversing the trends of species that are already imperiled.

Achieving adequate representation is an admittedly challenging task. The Conservancy has embraced what is referred to as the "coarse-filter/fine-filter" approach (e.g., Hunter et al. 1988, Noss and Cooperrider 1994, Groves et al. 2002[3]). This method is built on the assumption that conserving the full representation of all habitats will adequately support the vast majority of species. In this way, representation of all native ecosystems types and communities within conservation areas constitutes the initial "coarse-filter." A second assumption is that some elements of biodiversity – in particular rare and vulnerable species and natural communities - would be inadequately captured by this initial filter. Therefore, a second "fine-filter" would be necessary to achieve sufficient conservation.

The adequacy of representation is enhanced by selecting conservation targets across three levels of biological organization: 1) species (e.g., plant, vertebrate, and invertebrate), 2) ecological communities (i.e., natural terrestrial vegetation communities and aquatic communities), and 3) larger, regional-scale ecosystems (e.g., large, relatively unfragmented forest "blocks," and aquatic systems).[4] The species targets selected for ecoregional plans include globally imperiled species, along with those species whose regional status is declining. All natural vegetation community types in the ecoregion, regardless of their level of endangerment, were also included as targets (see Fig. 3 for selected species and community occurrences). See Appendix 1 for a list of the LNE/NP ecoregional targets with known occurrences in the Hudson River Estuary watershed. Methods to identify and classify ecosystems were developed, along with ranking and screening processes (see below).

A critical terrestrial ecosystem conservation target in the Northeast United States is the mixed broadleaf deciduous forest. An assessment of the largest, most unfragmented areas of forest was conducted to identify forest conservation priorities for this expansive ecosystem target.[5] Seven large forest blocks that lie at least partly within the Hudson River Estuary watershed were identified as critical conservation priorities in both of the intersecting ecoregions (Fig. 3).

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[3] Conservation Planning Resource: Groves et al. 2002 can be found under Ecoregional_Planning/Methods

[4] Conservation Planning Resource: Details on the selection process for these targets may be found in the LNE/NP and HAL ecoregional plans under Ecoregional_Planning/Plans. The species and community targets for the LNE/NP and HAL ecoregions that are within the Hudson River Estuary watershed can be found in Appendix 1.

[5] Conservation Planning Resource: The scientific foundation for the use of these forest blocks is laid out in the TNC document "*Determining the Size of Eastern Forest Reserves*" (TNC 2004), which can be found under Ecoregional_Planning/Terrestrial_Assessment/Matrix_Forest_Blocks.

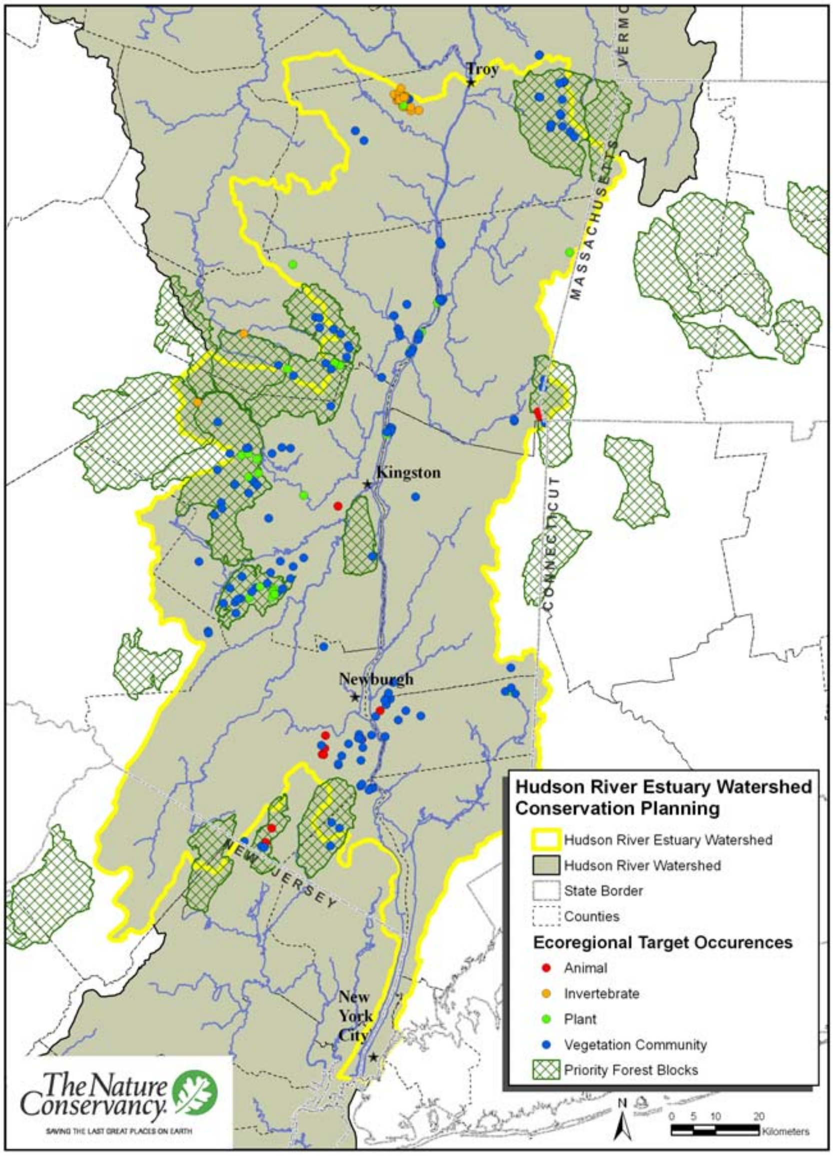

Figure 3. Portfolio occurrences of ecoregional terrestrial conservation targets (terrestrial and aquatic species, terrestrial vegetation communities, and forest blocks) within the Hudson River Estuary watershed.

Aquatic ecosystems are defined and described more effectively by watersheds than by ecoregions. Consequently, watersheds were used as the fundamental unit of analysis in ecoregional aquatic assessments. As watersheds often extend beyond ecoregional boundaries, the Conservancy developed a large-scale planning process that parallels the process conducted for terrestrial species and ecosystems, yet relies on ecological drainage units (EDUs), rather than ecoregions, to provide the scope of the analysis (Higgins 2003, Higgins et al. 2005). Ecological drainage units are aggregations of watersheds that share ecological and biological characteristics with similar ecological patterns *(e.g., hydrologic regime, species distribution, etc.)* (Fig. 4). They provide stratification for identifying environmental gradients, and are based on patterns of USFS Fish Zoogeographic Subregions, USFS ecoregions and subsections, and major drainage divisions[6]. The results of aquatic assessments conducted within EDUs are reported according to the ecoregion that captures the majority of the watershed.

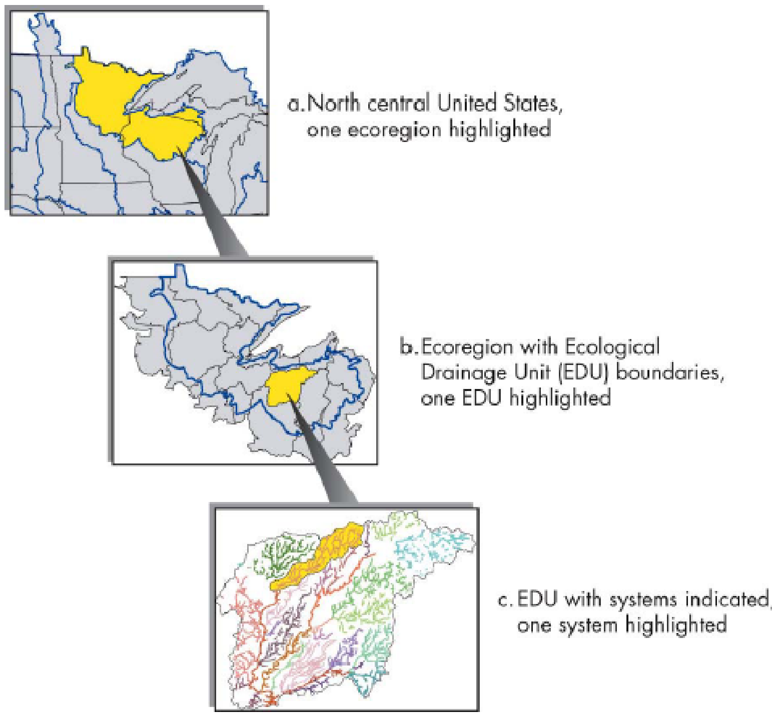

Figure 4. Hierarchy of aquatic systems within ecoregions and EDUs. From, Smith et al. 2002.

The Hudson River Estuary watershed falls within both the Upper Hudson and Lower Hudson EDUs (Fig. 5). Within the Hudson EDUs, contained primarily by the LNE/NP ecoregion, watersheds were first divided by watershed size into four categories: very large (>1,000 mi^2, i.e. the Hudson River), large (1,000-200 mi^2), moderate (200-30 mi^2), and small systems (<30 mi^2). An aquatic system classification was developed for each of the size classes to differentiate among the examples. This classification relied on multivariate statistics (i.e., TWINSPAN analysis) to separate aquatic systems into distinct groups based on large-scale physical environmental gradients in surficial geology, elevation, and landform across the EDUs[7]. Each watershed was screened to select the highest-quality examples of each type based on a GIS assessment of land cover, roads, dams and point sources. Nominations of high-priority areas for conservation were provided by a variety of experts[8], which were used to supplement the GIS assessment to select watersheds as targets. In total, 19 watersheds within the Hudson River Estuary watershed, in addition to the mainstem of the Hudson River itself, were selected as priority aquatic ecosystem-level conservation targets (Fig. 6). This subset of watersheds was selected to meet minimalist conservation goals[9] (i.e., at least one example of each watershed type), and included five large tributary watersheds and 14 moderate-sized tributaries and sub-watersheds[10].

[6] Conservation Planning Resource: Ecoregional_Planning/Methods/Aquatic_Assessment/EDU
[7] Conservation Planning Resource: Ecoregional_Planning/Methods/Aquatic_Assessment/LNE-NP_Plan
[8] Thanks to Colin Apse, Robert Daniels, Greg Edinger, Karen Riva-Murray, Martin Rosenfeld, Robert Schmidt, Ken Soltesz, David Strayer, John Thompson, Mark Vian, Leslie Zucker
[9] Conservation Planning Resource: Ecoregional_Planning/Methods/Goal_Setting
[10] Conservation Planning Resource: A list of these watersheds and the rationale for their selection can be found at Project_Planning/Projects/Hudson_River_Estuary

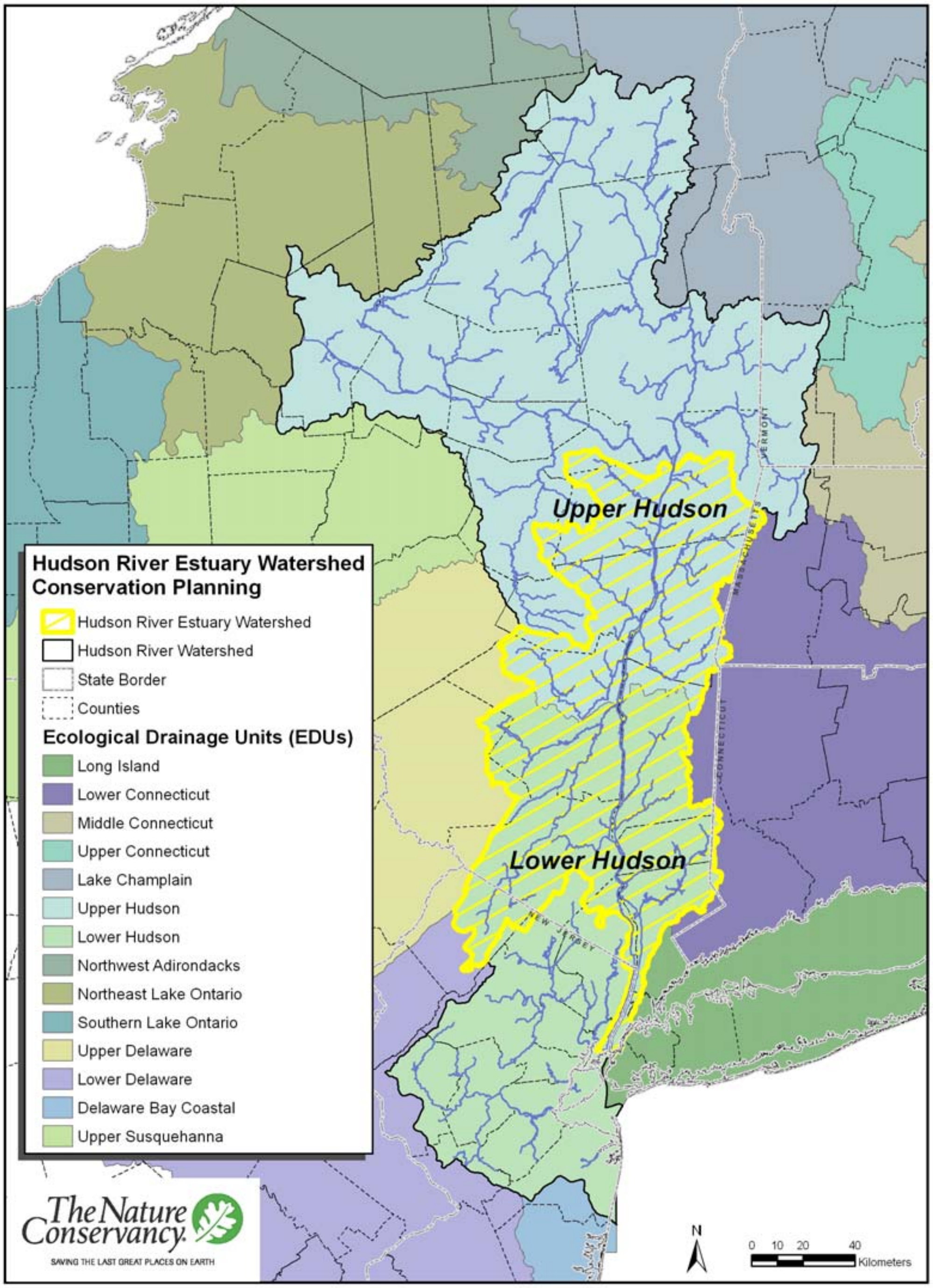

Figure 5. The watersheds of the Hudson River and the Hudson River Estuary in relationship to Ecological Drainage Units.

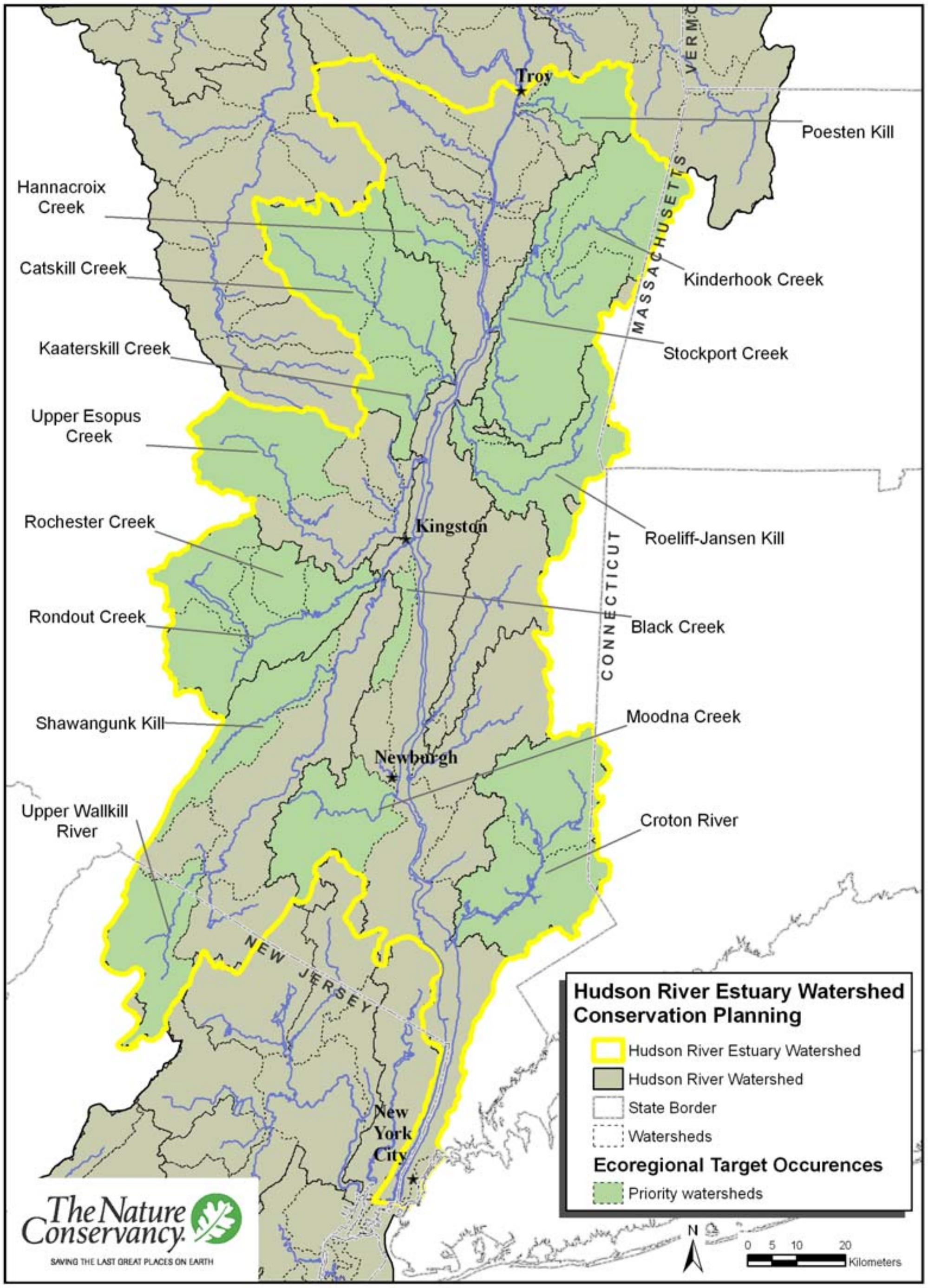

Figure 6. Portfolio occurrences of ecoregional aquatic conservation targets (priority watersheds) within the Hudson River Estuary watershed.

How do we know if conservation targets are being conserved?

One standard for ecoregional planning in the Conservancy is to set quantitative goals for each conservation target – at all levels of biological organization and degrees of endangerment. These goals are used to assess if the targets are being adequately conserved. The portfolio of conservation areas within each ecoregion is designed to maximize the chances that all conservation targets will persist over the long-term by possessing three characteristics: *representation*, *redundancy,* and *resiliency* (following Shaffer and Stein 2000). The selected suite of priority areas should *represent* the full range of biological variation in the region, spread across the range of environmental conditions in which the target occurs. In addition, each target should have a sufficient number of occurrences that are purposefully *redundant* to withstand the random catastrophic events (both natural and human-induced) that are likely to occur over the long-term and reduce the target's chance of persistence. Finally, each occurrence should be "healthy" enough to be *resilient* over time in the face of predictable and unpredictable threats.

The "health" or resilience of each target is assessed through the screening process. Again, three criteria are used to broadly characterize health – the size, condition, and landscape context of the target occurrences. For each criterion, an assessment is conducted, either quantitative or qualitative depending on the information available. These assessments are combined to determine whether the target is "viable" or not in the long-term. The Natural Heritage Programs in each state track many of these targets, with methods to rate each species or vegetation community (known as "element occurrences" or "EOs"). The Conservancy further screens each of these target occurrences for their ability to persist over time (based primarily on the ranking system already assigned in the Heritage database). The highest quality occurrences are included in the portfolio (Fig. 3), and are counted toward achieving quantitative goals for the target. The most resilient portfolios are ideally constructed of only those target occurrences that are determined to be "viable" by such a screening process.

To evaluate adequate representation and redundancy, quantitative goals are established for each target species, community, and ecosystem. The goal set for each target depends on how common and widespread it is. The quantitative goals for each target have two related components: abundance and distribution. Abundance goals establish the minimum total number of populations or occurrences considered necessary for a target to persist within the ecoregion (e.g., 10 viable populations of a bog turtle). In essence, abundance goals define the *redundancy* necessary within the ecoregion to achieve conservation success. However, if all populations occur in one small area, then conceptually the target would still have a high risk of catastrophic destruction (e.g., tornado/hurricane) and would not adequately represent the genetic and environmental diversity of the target or its evolutionary potential. Therefore, distribution goals are set to ensure that the necessary, *representative* set of populations are conserved across the target's entire geographic range (e.g., at least one viable occurrence of the target in each ecoregional subsection or large watershed where it occurs).

We readily acknowledge that currently, quantitative goal setting in conservation is in its infancy. Efforts are underway to advance this important component of conservation work. In many cases we lack sufficient information to be sure that achieving these quantitative goals will result in the continued existence of the target. However, they do provide an essential, transparent benchmark defining our current "best guess" of what is necessary. They are useful for gauging the degree of confidence that a target will persist over time, and the extent to which conservation efforts contribute to the conservation target's chances of persistence. Quantitative goals are applied in this context[11].

How do these ecoregional priorities relate to other priorities?

An example applying ecoregional planning at a smaller scale is the Open Space Plan recently completed by Orange County (2004). For its biodiversity component, the plan uses a framework similar to that of the Conservancy's ecoregional planning and incorporates many of the ecoregional priorities (Fig. 7). These were used to provide a starting point for building a portfolio of priority conservation areas at the county level.

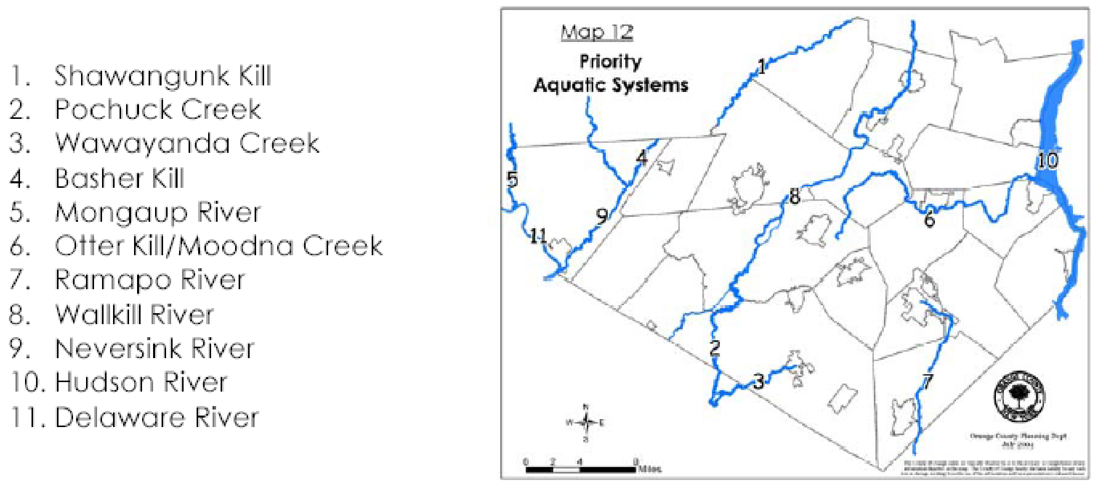

Figure 7. Priority Aquatic Systems for the Orange County Open Space Plan – an example of the application of ecoregional priorities to planning at smaller scales.

The priorities determined by the ecoregional assessments may or may not align with priorities set at smaller spatial scales, just as the conservation priorities identified at the scale of the Hudson River Estuary watershed may not be the same as those identified within a tributary watershed, county or town. In order to evaluate the degree to which ecoregional priorities overlap with those identified by other, intermediate-scale, assessments, a summary of alternative conservation priorities already identified for the Hudson River Estuary watershed is described and compared to ecoregional priorities in the following sections.

[11] Conservation Planning Resource: Example goal assessments for targets within the Hudson River watershed can be found in Project_Planning/Projects/Hudson_River_Estuary. Further details on goal setting in ecoregional plans can be found in Ecoregional_Planning/Methods/Goal_Setting

Synthesizing Alternative Conservation Priorities

How were these "alternative priorities" determined?

We gathered all of the available intermediate-scale assessments of biodiversity in the Hudson River Estuary. These included published reports and listings from government agencies, non-profit organizations, and academic sources, as well as some publicly-available GIS layers that mapped priority regions. We generally included those ecological assessments conducted throughout the watershed, although the scope of some included only a portion of the Estuary, while others covered the entire Hudson River watershed or the state of New York. We did not use studies conducted at the scale of single tributary watersheds or specific locations because they did not represent a relatively uniform evaluation of the entire watershed. This information was tabulated for moderate to large watersheds (31 total; 19 that were ecoregional priorities). Small watersheds (< 30 mi^2) were excluded at this stage because they were not included in the original ecoregional analysis. Work is currently in progress to conduct an assessment of these small tributary watersheds. Additionally, the Hudson River mainstem was not included in the assessment since it is implicitly considered to be a priority, and a separate analysis would be needed to evaluate priority areas within the mainstem.

How do these alternative priorities compare with the Conservancy's priorities?

A simple point system was established in which each watershed received a point if its area overlapped with or the stream drained into a designated priority area, or if the stream itself was designated as a priority in any of the nine assessments we reviewed. These scores were then summed to create a single value reflecting the number of times that the watershed captured a conservation priority. Since the geographic scope of the assessments we used varied, these raw scores were normalized by the potential number of hits for each watershed to create an adjusted score that removed the bias created by inconsistent scales of study. These adjusted scores reflect the relative degree to which each watershed captured the priority conservation areas and high quality habitats identified through the medium to large-scale assessments we surveyed. The tabulated results of this analysis are in Appendix 2.

Using watersheds as the foundation for our analysis, we compared the summary scores for the watersheds selected as ecoregional priorities to those for the watersheds that were not selected. In addition, we evaluated where priority areas or conservation target occurrences identified by other assessments did not fall within the ecoregional priority watersheds.

Comparing Conservation Priorities at Different Scales

Ecoregional priority watersheds – what do they capture?

We wanted to determine "How do the watersheds identified as a priority through the ecoregional planning process compare with those areas identified as important by other assessments?" A quick review revealed that all of the ecoregional priority watersheds contain documented habitats for migratory fish, all contain part of a Significant Biodiversity Area (SBA), and almost all drain into Significant Tidal Habitats with mapped submerged aquatic vegetation (SAV) beds where they enter the mainstem. To examine this question in more detail, we developed a statistical approach to provide an objective comparison. Using the adjusted scores from our synthesis of non-ecoregional assessments, the watersheds were ranked, with watersheds with equal scores receiving the same rank. Thus, the greater the number of times a watershed "captured" areas identified as important in one of the published studies, the higher the watershed rank (see Appendix 2). Our analysis revealed that overall, ecoregional priority watersheds captured significantly more of these alternative priorities than did watersheds not selected as ecoregional priorities.[12] When the analysis was restricted to just the large watersheds, there was no significant difference between the rank of the of the priority and non-priority watersheds. However, within the set of moderate-sized watersheds, the priority watersheds continued to rank significantly higher.

What do they miss?

Some ecoregional priority watersheds did not score highly. These included the Black Creek and Poesten Kill watersheds, which were the only ecoregional priority watersheds that did not have significant tidal habitats associated with them. In contrast, a few watersheds that were not selected as ecoregional priorities scored very highly. These include the Wappinger and Esopus Creek watersheds – large tributaries that were both identified in all of the nine other studies we reviewed. Additionally, the Fishkill and Peekskill Hollow watersheds ranked highly among the smaller size watersheds. Additional conservation "gaps" that can be seen from this analysis can be divided into two categories as follows:

1) Additional ecoregional priorities that occur outside ecoregional priority watersheds

Of the ecoregional portfolio occurrences of target species and communities selected by the LNE/NP and HAL ecoregional plans that fall within the Estuary watershed, just less than half (49%) occur within the priority watersheds. The majority of these "missed" target occurrences lie within the Albany Pine Bush and the Hudson Highlands. The occurrences in the Albany Pine Bush are mostly within the Normanskill watershed, which is not rated overall as a high-quality aquatic system. The Hudson Highlands occurrences largely fall outside of the large watersheds that were assessed. There are also a number of aquatic target occurrences that lie within the Hudson River itself, including the entire length of the mainstem which was identified as an ecoregional priority, but is not included in this tributary assessment. Priority forest blocks are generally well-captured by the priority watersheds with the notable exception of two - Waywayanda and Harriman - that are only partly within the Estuary watershed and do not overlap with any of the selected watersheds.

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[12] Wilcoxon Rank Sum Tests were performed on the "Rank" field in Appendix 2. Results are as follows for the tests summarized above: Watersheds selected as ecoregional priorities vs those not selected ($T = 2.53$, df = 19, $p = 0.020$); large vs medium size watersheds ($T = 3.60$, df = 27, $p = 0.001$); Selected vs non-selected watersheds, medium size only ($T = 2.88$, df = 17, $p = 0.010$)

2) Alternate conservation priorities that occur outside ecoregional priority watersheds

Several of the selected watersheds did not have diverse macroinvertebrate communities (good indicators of high water quality), while others did not contain any Important Bird Areas (IBAs) identified by Audubon New York (2003). Several of the areas identified as Significant Biodiversity Areas (SBAs) by the Hudson River Estuary Program (2005) are only partially included within any of the ecoregional priority watersheds, and some SBAs occur completely outside of them, including the Albany Pine Bush, the Dutchess County Wetlands, and the Palisades. In addition, the Helderberg Escarpment, which is identified as a significant habitat by the U.S. Fish and Wildlife Service and is part of the Hudson Valley Limestone and Shale Ridge SBA, is overlapped by only a very small part of the Hannacrois Creek watershed.

How can this information be used to help conservation efforts in the Hudson?

The Conservancy believes that by focusing on the highest-quality habitats for research, protection, and restoration, we can make the most efficient use of our conservation efforts. In this analysis, watersheds provided a useful unit of measure because they are natural ecological units, they connect aquatic and terrestrial systems, and they provided a direct link with the key target resource, the Hudson River itself. Ranking the watersheds by a set of conservation criteria helped to identify those systems that have the most potential to advance conservation goals. The discrepancies between the two priority systems (i.e., those selected though the ecoregional assessment, and those selected by the other intermediate-scale assessments) do not necessarily mean that one or the other of these priorities is wrong, but rather that each is emphasizing different criteria and each can be used to inform decision-making. Where the ecoregional priorities and other assessments overlap, we have additional confidence that we have identified an important natural resource clearly worthy of conservation effort. Where they do not, the ecoregional priorities may bring attention to resources that contribute to conservation on a larger scale, while the local priorities can help to fill in gaps that may be missed from the larger scale, ecoregional perspective.

Are these the "right" priorities?

The watershed selection process used in our ecoregional analysis is imperfect, and is based on limited information. One major shortcoming is the lack of information on small watersheds which may be extremely important habitats, such as those that drain into the National Estuarine Research Reserve sites. It is also based on a set of assumptions: that selecting high-quality large systems we will also capture a significant portion of the smaller scale targets, that including a diversity of physical environments will result in a diversity of biological components, and that limited human alteration is a good surrogate for high-quality habitats and populations. Ultimately there is no guarantee that any set of criteria will result in the "right" priorities. It is for this reason that it is crucial that these priorities be evaluated, discussed, and refined.

What if I don't agree with these priorities?

A crucial part of this preliminary assessment comparing conservation priorities established across the ecoregion with those identified at smaller spatial scales is the feedback we receive from those conducting research and conservation within the Hudson River Estuary. We ask you to share your comments and ideas on this process with us so that we can produce information that is mutually beneficial and useful in identifying our shared conservation needs in order to protect this valued resource.

Although far from comprehensive, this analysis provides a first pass at consolidating the large amount of information contained in the many reports and studies conducted in and around the Hudson River. We view this as a "first draft," and encourage comments on our approach, especially if you detect any errors or omissions, as it is very possible that we have missed some pertinent information. It is our intent to use later drafts of this assessment as a source of condensed information to help advance the more site-specific conservation planning necessary to identify appropriate conservation strategies for the Hudson River Estuary watershed in the coming months.

What's Next?

How do we figure out what conservation actions are most needed in the watershed?

The setting of conservation priorities through ecoregional planning is just the first step of the Conservancy's conservation approach – intended to answer the question of "where" to invest resource question in conservation. Yet knowing where conservation efforts are needed does not address what needs to be done, or how it should be carried out. In order to determine what conservation actions are most needed – that will determine "how" best to carry out conservation – the Conservancy has developed a second process that relies on much more site-specific knowledge and expertise.

This planning process will link terrestrial and aquatic biodiversity information across a variety of taxonomic levels (i.e., species, communities, and ecosystems) (Poiani et al. 2002). Priority conservation areas will be identified by amalgamating the conservation targets into logical, geographically and/or ecologically similar areas or groups. Once this information is in place, it will be used to structure a "threats assessment" of the conservation targets. The results of this work will be used to identify key threats in the watershed with a distinct "place-based" focus that will be used to identify appropriate conservation strategies to reduce these threats and improve the ecological "health" of the conservation targets. A foundation for measuring the effectiveness of these proposed actions will be developed according to the Conservancy's "measures of success" approach (Parrish et al. 2003)[13].

The Conservancy proposes to conduct a series of three workshops over the next several months that will work through this process. This will require, with the assistance of scientists and experts, condensing the long list of ecoregional targets in this document down to a smaller, manageable set (of approximately 8 or less) around which conservation strategies will be developed. For those targets, threats will be identified that, if reduced, will help achieve the ultimate goal of sustaining the long-term viability or ecological integrity of those targets.

Why is The Nature Conservancy so interested in conducting this assessment?

The recent completion of our own ecoregional planning processes has clearly shown us that the Hudson River Estuary ecosystem is a natural resource of such significant importance that the Conservancy is compelled to contribute to its conservation. In addition, the Hudson River is at the very center of the Eastern New York chapter of The Nature Conservancy, making the need and the desire infinitely compatible. The Nature Conservancy's ultimate goal is to discover how and where our organization's resources and experience can bring additional value to the ongoing

[13] Conservation Planning Resource: Project_Planning/Methods/Measures

conservation activities in the region. In order to achieve this we ask for your organization's assistance in working through our time-tested planning process. We look forward to working with you.

Conclusion

Ecological assessments at multiple spatial scales can be helpful in determining conservation priorities by focusing limited resources on conservation areas that provide multiple benefits. The identification of elements of biological diversity that are important at several spatial scales and by multiple assessment processes can provide a valuable tool. Large scale ecoregional assessments of terrestrial and aquatic species and ecosystems provide a new and alternative view of conservation priority setting in the Hudson River Estuary watershed. The 19 medium and large priority watersheds identified during the aquatic assessment of the ecoregional planning process capture significantly more of the ecological priorities identified by other assessment processes than do the 12 watersheds that were not selected as ecoregional priorities. Although these watersheds, by themselves, do not adequately represent the full array of ecological diversity within the estuarine watershed, they provide an alternative selection of priority areas for the conservation community to consider.

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Appendix 1.
LNE/NP Ecoregional targets within the Hudson River Estuary.

The following species and vegetation communities were identified as targets in the LNE/NP Ecoregional assessment and have Natural Heritage occurrences within the Hudson River Estuary watershed.

Species

Scientific Name	Common Name	Type
Acipenser brevirostrum	Shortnose Sturgeon	Vertebrate
Clemmys muhlenbergii	Bog Turtle	Vertebrate
Crotalus horridus	Timber Rattlesnake	Vertebrate
Myotis leibii	Eastern Small-footed Myotis	Vertebrate
Myotis sodalist	Indiana Bat	Vertebrate
Neotoma magister	Allegheny Woodrat	Vertebrate
Acronicta albarufa	Barrens Dagger Moth	Invertebrate
Alasmidonta varicosa	Brook Floater	Invertebrate
Callophrys irus	Frosted Elfin	Invertebrate
Chaetaglaea cerata	A Noctuid Moth	Invertebrate
Gomphus quadricolor	Rapids Clubtail	Invertebrate
Itame sp	Barrens Itame	Invertebrate
Lycaeides melissa samuelis	Karner Blue	Invertebrate
Ophiogomphus aspersus	Brook Snaketail	Invertebrate
Bidens bidentoides	Estuary Beggar-ticks	Plant
Cardamine longii	Long's Bittercress	Plant
Carex lupuliformis	False Hop Sedge	Plant
Malaxis bayardii	Bayard's Malaxis	Plant
Poa paludigena	Bog Bluegrass	Plant
Potamogeton hillii	Hill's Pondweed	Plant
Potamogeton ogdenii	Ogden's Pondweed	Plant
Pycnanthemum clinopodioides	Basil Mountain-Mint	Plant

Communities

Vegetation Type	Vegetation Community
Forests	Appalachian Oak-Hickory Forest; Black Spruce-Tamarack Bog; Chestnut Oak Forest; Floodplain Forest; Hemlock-Hardwood Swamp; Hemlock-Northern Hardwood Forest; Inland Atlantic White Cedar Swamp; Maple-Basswood Rich Mesic Forest; Oak-Tulip Tree Forest; Pine Barrens Vernal Pond; Pitch Pine-Oak-Heath Rocky Summit; Pitch Pine-Scrub Oak Barrens; Red Cedar Rocky Summit; Red Maple-Hardwood Swamp; Red Maple-Tamarack Peat Swamp; Silver Maple-Ash Swamp; Spruce Flats; Spruce-Fir Swamp
Woodlands	Acidic Talus Slope Woodland; Calcareous Talus Slope Woodland; Limestone Woodland; Shale Talus Slope Woodland
Shrublands	Dwarf Shrub Bog; Rich Shrub Fen
Herbaceous Vegetation	Brackish Intertidal Mudflats; Brackish Subtidal Aquatic Bed; Brackish Tidal Marsh; Calcareous Cliff Community; Calcareous Shoreline Outcrop; Cliff Community; Freshwater Intertidal Mudflats; Freshwater Intertidal Shore; Freshwater Tidal Marsh; Freshwater Tidal Swamp; Inland Poor Fen; Oligotrophic Dimictic Lake; Rich Graminoid Fen; Rich Sloping Fen; Rocky Summit Grassland; Sedge Meadow; Shale Cliff and Talus Community; Shallow Emergent Marsh

Appendix 2. Aquatic system rankings based on alternative ecological assessments.*

Watershed ID Code	Size Class	Name	Sign. Tidal Habitat	Coastal Fish and Wildlife Habitat	Submerged Aquatic Vegetation Beds	Migratory Fish Assess. Priority	Imp. Bird Area	Macro-invertebrate Survey	NY Bight Sign. Habitat	TNC Unique Area	Sign Biodiv. Area	Total # of Hits	Raw Score	Adjusted Score	Rank**
6369	**3**	**Roeliff-Jansen Kill**	1	1	1	1	1	1	1	1	1	9	9	1.00	1
6548	**3**	**Croton River**	1	1	1	1	1	1	1	1	1	9	9	1.00	1
6453	3	Wappinger Creek	1	1	1	1	1	1	1	1	1	9	9	1.00	1
6401	**3**	**Rondout Creek**	1	1	1	1	1	1	1		1	8	8	1.00	1
6365	**3**	**Catskill Creek**	1	1	1	1	1	1	1		1	8	8	1.00	1
6377	3	Esopus Creek	1	1	1	1	1	1	1		1	8	8	1.00	1
15067	**2**	**Croton River Upper**					1	1	1	1	1	5	5	1.00	1
14871	**2**	**Shawangunk Kill**					1	1	1	1	1	5	5	1.00	1
14738	**2**	**Roeliff-Jansen Kill Upper**					1	1	1	1	1	5	5	1.00	1
14888	**2**	**Rondout Creek Upper**					1	1	1		1	4	4	1.00	1
14760	**2**	**Esopus Creek Upper**					1	1	1		1	4	4	1.00	1
14702	**2**	**Catskill Creek Upper**					1	1	1		1	4	4	1.00	1
14730	**2**	**Kaaterskill Creek**					1		1		1	3	3	1.00	1
14984	2	Fishkill Creek	1	1	1	1	1	0	1	1	1	9	8	0.89	2
6352	**3**	**Stockport Creek**	1	1	1	1	1	0	1		1	8	7	0.88	3
14990	**2**	**Moodna Creek**	1	1	1	1	0	0	1	1	1	9	7	0.78	4
15045	2	Peekskill Hollow	1	0	1	1	1	0	1	1	1	9	7	0.78	4
14658	**2**	**Hannacroix Creek**	1	1	1	1	0	0	1		1	8	6	0.75	5
6400	3	Wallkill River	1	0	1		1	0	1	1	1	8	6	0.75	5
14641	2	Normanskill	1	1	1	0	1	0	1		1	8	6	0.75	5
14899	**2**	**Rochester Creek**					0	1	1		1	4	3	0.75	5
14674	**2**	**Kinderhook**					1	1	0		1	4	3	0.75	5
14815	**2**	**Wallkill River Upper**						0	1		1	3	2	0.67	6
14656	2	Coeyman's Creek	1	1	1	0	0	0	1		1	8	5	0.63	7
14661	2	Schodach Creek	1	1	1	1	1	0	0		0	8	5	0.63	7
14633	**2**	**Poesten Kill**	0	0	0	1	1	1	0		1	8	4	0.50	8
14946	**2**	**Black Creek**	0	0	1	1	0	0	0		1	8	3	0.38	9
14635	2	Wynants Kill	0	0	0	0	1	1	0		1	8	3	0.38	9
14649	2	Moordeneer Kill	1	0	1	0	0	1	0		0	8	3	0.38	9
14643	2	Vloman Kill	1	0	0	1	0	0	0		0	8	2	0.25	10
14980	2	Quassaick Creek	0	0	1	1	0	0	0	0	0	9	2	0.22	11

*Watersheds in bold indicate TNC ecoregional priority watersheds. For each criterion, 1 = meets criterion, 0 = does not meet, and blank = criterion does not apply.
**Watersheds are ranked by Adjusted Score which is the ratio of Raw Score (sum of 1s across row) to Number of Hits (count of entries across row).