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Conservation Status of Fish, Wildlife, and Natural Habitats in the Northeast Landscape

Implementation of the Northeast Monitoring Framework

The Nature Conservancy · Eastern Conservation Science

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Executive Summary April 2011

M. Anderson and A. Olivero Sheldon

The Northeast and Mid-Atlantic states have a long history of conservation and collaboration. Because the forests, rivers, and coastline of this region are extensive, but many of the individual states are small, the states have a tradition of working together to understand the broad ecological patterns that cross state lines. Toward this end, in 2008, the Northeast Association of Fish and Wildlife Agencies (NEAFWA) and its partners developed a multi-state monitoring framework to take stock of the condition and conservation of the species and habitats that characterize the region. The report, Monitoring the Conservation of Fish and Wildlife in the Northeast (Tomajer et al. 2008) was intended to inform decision makers and managers on how individual states are faring, as well as how the region as a whole is performing.

This report, also funded by NEAFWA, is the first attempt to implement the recommendations of the monitoring framework. Through compiling region-wide data, analyzing the underlying patterns, and assessing the many indicators suggested by the framework, it presents a comprehensive and three-dimensional picture of the state of the natural world in the northeast landscape. Full report at: http://conserveonline.org/workspaces/ecs/documents/northeast-conservation-status-report-april-2011/

The region studied includes: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia, Washington D.C., and West Virginia. In these states, Fish and Wildlife agency members are responsible for managing species and habitats in a diverse range of ecosystems that include terrestrial, freshwater, coastal, and marine systems, all set amongst one of the most densely populated regions of the country. All 13 states and D.C. have developed State Wildlife Action Plans (SWAPs) that together represent a vision for the future of conservation. These plans form the underlying basis of the monitoring framework and this report.

The monitoring framework intentionally focuses on the use of existing data to keep its recommendations simple and manageable. Nevertheless, implementing the recommendations required the compilation and management of over 50 data sets. Inevitably, some needed thorough revision, or had to be created anew from state sources for this report. Several federal agencies also provided datasets critical to this project, and we would like to thank their staff for sharing their expertise in using these.

The concept of a key indicator is important to an understanding of this report. The framework did not try to provide all-encompassing lists of every possible characteristic to monitor; rather, it recommended a few indicators for each target that were illustrative of overall progress and were meant to serve as a dashboard of information to guide decision makers. For our part, we focused strongly on compiling the information and displaying the patterns in as clear and transparent a way as possible. Usually, this meant keeping the analysis simple and direct. Still, there are many indicators, and as straightforward as any one indicator might be, together they interlink to form a complex, multi-dimensional picture of the target, and more than once revealed a striking and unexpected pattern.

Organization of the Report This report describes all secured lands in the region, and summarizes the status measures for seven thematic targets:

- Forests
- Wetlands
- Freshwater stream and river systems
- Lakes and ponds
- Unique habitats of the Northeast
- Species of greatest conservation need
- Grassland and shrubland (appendix only)

The chapters and sections are organized around the seven groups with a set of sub-targets, stressors, and indicators developed for each one. Each chapter begins by describing the target and its variations (for instance, forest types), and then discusses each key indicator, the method used to assess it, and the results of the analysis. The results include charts, tables, full page maps, and an appendix with detailed state-by-state information. Maps are also posted individually for anyone who may want to view or print them in high resolution. Additionally, there is an appendix of data sources that identifies the major sources used, and provides links to the original data. Lastly, there is an appendix with more specific explanations of our methods for those who may want to recreate the analyses.

Summary of Findings

Secured Lands

The eastern secured lands system represents a commitment to nature and to future generations, and an indication of what can be achieved through collective effort. These lands provide the core of efforts to protect the region's outstanding habitats and threatened species, and are increasingly understood as essential providers of ecosystem services and storehouses of the land's biological resources. Even as the region's ecology adjusts in response to a changing climate, the secured lands play a critical role in maintaining arenas for evolution and provide people with the opportunities and rewards stemming from direct contact with the land. Throughout this report, we use the term "**secured**" to refer to land that is permanently secured against conversion to development, and "**protected**" for the subset of those lands where the intent of the managing entity is the conservation of nature and biodiversity. The remaining subset of secured lands are managed for multiple uses, often including forest products and recreation

In total, 16 percent of the region is secured against conversion and is intended to permanently remain in natural cover, while 28 percent of the region has been converted to development or agriculture. Securement includes 5 percent protected for wild nature, and 11 percent for multiple uses, and thus, five acres have been converted for every one protected for nature. Conversion outweighs total securement 2:1.

The secured lands are held by over 6,000 fee owners and 2,000 easement holders. Private conservation easements account for 3 million acres and fee-owned conservation land for another 1.4 million acres, reflecting a huge increase in the reach and effectiveness of non-profit land trusts. State (12 million acres), federal (6 million acres) and municipal (900,000 acres) ownerships accounts for the rest of the conservation land.

In spite of great successes, the pattern of protection reveals widespread and fundamental biases in the network, with severe implications for biodiversity. Rocky granite habitats have protection equal to conversion, but diverse, productive, limestone habitats have 51 times more conversion than protection. Any way it is measured, protection is largely limited to slopes, granite and sedimentary bedrocks, and high elevations, while flats, floodplains, limestone, low elevations, sand and shale - the centers of diversity in the region - are largely converted and poorly protected.

Eastern Forests

Distribution, Loss, and Protection: The region was originally 91 percent forest supporting thousands of species; almost one-third of that, 39 million acres, has been converted. Forest conversion exceeds forest protection 6 to 1, and protection is not spread evenly across forest types. Upland boreal forests are 30 percent secured and 12 percent protected for nature. Northern hardwoods are 23 percent secured and 8 percent protected. Oak-pine forests are only 17 percent secured and 5 percent protected.

Fragmentation: Forests in the region are highly fragmented by 732,000 miles of permanent roads, enough to loop the equator 29 times. On average, 43 percent of the forest occurs in blocks less than 5,000 acres in size that are completely encircled by major roads, resulting in an almost 60 percent loss of local connectivity. Judging from current patterns, securement has been an effective strategy for preventing fragmentation as there are a large proportion of secured lands within most of the remaining big contiguous forest blocks.

Age and Size Structure: No matter what the forest type, this region's forests average only 60 years old and are overwhelmingly composed of small trees 6" to 7" in diameter. Upland boreal forests are the most heavily logged, and differ from the other forest types in having the majority of trees in the 2" to 3" diameter size class. Out of almost 7,000 stands sampled by the US Forest Inventory and Analysis program, none were dominated by old trees or had the majority of their canopy composed of trees over 20" in diameter.

Trends in Forest Birds: There have been substantial changes, both increases and declines, in forest bird abundances over the last 40 years. Species abundance changes were correlated with degree of fragmentation, with the road-riddled oak-pine forests showing declines in 11 species and increases in 10 species, the latter mostly being birds that tolerate edge habitat. Changes in bird abundances in the heavily logged boreal forests were less extensive.

Wetlands

Distribution, Loss, and Protection: Wetlands once covered 7 percent of the region, and swamps, peatlands, and marshes are some of the most diverse wildlife habitat in the region. At least 2.8 million acres of wetlands, one-quarter of the original extent, has been converted to development or drained for agriculture. Conservation efforts have secured 25 percent of the remaining acres including one-third of the largest tidal marshes. River-related wetlands, such as floodplain forests, have lost 27 percent of their historic extent and are only 6 percent protected for biodiversity, the greatest discrepancy of any wetland type.

Ecological Condition: The majority of individual wetlands have expanded slightly over the last 20 years, but 67 percent of them have paved roads so close to them, and in such high densities, that they have probably experienced a loss of species. Moreover, 66 percent have development or agriculture directly in their 100 meter buffer zones which can result in notable impacts on biodiversity.

Trends in Wetland Birds: There have been substantial changes, both increases and declines, in wetland bird populations over the last 40 years. Species change is correlated with the degree of conversion in the buffer zone and with the density of nearby roads. River-related wetlands have seen the most declines and tidal marshes the least. Some changes appear to be species specific and may not be tightly related to local wetland characteristics

Lakes and Ponds

Distribution, Loss, and Protection: Of the regions 34,000 waterbodies, 13 percent are fully secured against conversion to development. Very large lakes, over 10,000 acres in size, have the least securement (4 percent).

Shoreline Conversion: Forty percent of the region's waterbodies have severe disturbance impacts in their shoreline buffer zones, reflecting high levels of development, agriculture, and roads in this ecologically sensitive area. On the other hand, shoreline zones also have a high level of securement and in most lake types the amount of securement exceeds the amount of conversion.

Roads, Impervious Surfaces, and Dams: Lakes and ponds in this region are highly accessible; only seven percent are over one mile from a road and 69 percent are less than one tenth of a mile from a road, suggesting that most are likely to have non-native species. Dams are fairly ubiquitous; 70 percent of the very large lakes, 52 percent of the large lakes, and 35 percent of the medium size lakes, have dams associated with them and are likely to be somewhat altered in terms of temperature and water levels.

Biological Integrity: Over half of our small to large waterbodies have lost over 20 percent of their expected plankton and diatom taxa, and a third have lost over 40 percent. In small lakes this correlates roughly, but not significantly, with the amount of shoreline conversion. Recently, common loons, indicators of high quality lake habitats, have been producing slightly less chicks per breeding pair than the estimated 0.48 needed to maintain a stable population.

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Rivers and Streams

Biotic Integrity: The region contains over 200,000 miles of streams and rivers supporting over 1,000 aquatic species, including 300 types of fish. The majority of the region's watersheds still retain 95-100 of their native fish species, but are also home to up to 37 non-indigenous species. The range of native brook trout, a species that prefers cold high-quality streams, has been reduced by 60 percent. Direct indicators of biological integrity suggest that while 44 percent of the wadeable streams are undisturbed, another 30 percent are severely disturbed, and this correlates with impervious surfaces in the watershed.

Conversion and Securement in the Riparian Zone: Riparian areas, the narrow 100 m zone flanking all streams and rivers, are important for stream function and habitat. Currently, conversion of this natural habitat exceeds securement 2 to 1, as 27 percent of stream riparian area is converted and 14 percent is secured.

Dams and Connected Networks: Historically, 41 percent of the region's streams were linked into huge interconnected networks, each over 5,000 miles long. Today none of those large networks remain, and even the smaller ones over 1,000 miles long have been reduced by half. There has been a corresponding increase in short networks, less than 25 miles long, that now account for 23 percent of all stream miles - up from 3 percent historically. This highly fragmented pattern reflects the density of barriers, which currently averages 7 dams and 106 road-stream crossings per 100 miles of stream.

Flow: Water flow defines a stream; currently 61 percent of the region's streams have flow regimes that are altered enough to result in biotic impacts. One-third of all headwater streams have diminished minimum flows (they are subject to drying up) resulting in a reduction of habitat. Seventy percent of the large rivers have reduced maximum flows (smaller floods) that decreases the amount of nutrient laden water delivered to their floodplains.

Unique Habitats of the Northeast

Unique Habitats and Rare Species: Eleven unique habitats, from sandy pine barren to limestone glade, support over 2,700 restricted rare species. Three geologic habitats have very high densities of rare species: coarse-grained sands, limestone bedrock, and fine-grained silts. These three settings are also the most converted, the most fragmented, and in two cases, the least protected.

Distribution, Loss, and Protection: Remarkably, habitat protection was equal to, or greater than, conversion on granite settings, on summits and cliffs, and at high elevations. In stark contrast, habitat conversion exceeds habitat protection 51:1 on limestone settings, 29:1 on shale settings, 23:1 on dry flat settings, 19:1 on moderately calcareous settings and 18:1 on low elevations. These habitats need concerted conservation action if we are to maintain the full range of biodiversity in the region.

Fragmentation and Connectivity: Fragmentation and loss of connectivity is pervasive at lower elevations across all geology classes. Even the least fragmented setting in the region, granite, retains only 43 percent of its local connectivity. The highest level of fragmentation, with over an 80 percent loss of local connectivity, was found in calcareous settings, coarse-grained sands, fine-grained silts, and elevations under 800 feet.

Species of Greatest Conservation Need

Species of High Regional Responsibility: Out of all species-of-concern listed in the State Wildlife Action Plans, 112 have their distributions centered in this region, and occur across four or more states. This region bears the responsibility for their conservation, and examples include: Bicknell's thrush, blue spotted salamander, Atlantic sturgeon, dwarf wedgemussel, eastern small-footed bat, and wood turtle. Currently 25 percent of their known locations are on secured land, including 9 percent on land protected explicitly for biodiversity. Surprisingly, high responsibility species are secured at levels below those of low responsibility species: 25 percent versus 32 percent.

Species of Widespread or High Concern: For species found in four or more states, 246 were listed as species-of-concern in half of their State Wildlife Action Plans, even if this region is not the center of their distribution. Examples include: bald eagle, eastern spadefoot toad, American brook lamprey, cherrystone drop snail, Indiana bat, and Blanding's turtle. Currently 32 percent of the known locations of these species are on secured land, including 16 percent on land protected for biodiversity.

Conservation across Taxonomic Groups: Among all species-of-concern, mammals had the highest percent of highest percentage of secured locations (46 percent), followed by amphibians (40 percent) birds (36 percent) and reptiles (26 percent). Fish had the lowest level of inventory and securement (14 percent out of 575 locations)

Grassland and Shrubland

Trends in Grasslands Birds: Out of 22 species that preferentially breed in grasslands and fields, there have been persistent widespread declines in 17 of them: eastern meadowlark, field sparrow, northern bobwhite, ring-necked pheasant, brown thrasher, song sparrow, common yellowthroat, grasshopper sparrow, red-winged blackbird, killdeer, savannah sparrow, golden-winged warbler, vesper sparrow, yellow-breasted chat, blue-winged warbler, prairie warbler, and bobolink. This trend probably reflects the expansion of their habitat during the period of widespread farming and pasturing, followed by agricultural abandonment and a return of the land to forest.

For more information please see the full report at: http://conserveonline.org/workspaces/ecs/documents/northeast-conservation-status-report-april-2011/

Reference

Tomajer, T, Kart, J, Salafsky, N. Stem, C and V. Swaminathan. 2008. Monitoring the Conservation of Fish and Wildlife in the Northeast: A Report on the Monitoring and Performance Reporting Framework for the Northeast Association of Fish and Wildlife Agencies. 50 pp. http://rcngrants.org/regional_monitoring.shtml.

CHAPTER

Introduction

2

Understanding and Using this Report

April 2011

M. Anderson and A. Olivero Sheldon

The Northeast and Mid-Atlantic states have a long history of conservation and collaboration. Because the forests, rivers, and coastline of this region are extensive, but many of the individual states are small, the states have a tradition of working together to understand the broad ecological patterns that cross state lines. Toward this end, in 2008, the Northeast Association of Fish and Wildlife Agencies (NEAFWA) and its partners developed a new multi-state monitoring framework to take stock of the condition and conservation of the species and habitats that characterize the region. The report, Monitoring the Conservation of Fish and Wildlife in the Northeast: A Report on the Monitoring and Performance Reporting Framework for the Northeast Association of Fish and Wildlife Agencies. (Tomajer et al. 2008, posted at: http://rcngrants.org/regional_monitoring) was intended to be used to inform decision makers and managers on how individual states are faring, as well as how the region as a whole is performing. Although NEAFWA directors commissioned this process, each director will ultimately determine whether to implement the framework for reporting purposes.

The report you are reading now, also funded by NEAFWA, is the first attempt to implement the recommendations of the framework. Through compiling region-wide data, analyzing the underlying patterns, and assessing the many indicators suggested by the framework, this report presents a comprehensive and multidimensional picture of the state of the natural world in the Northeast landscape.

Background: The NEAFWA region includes: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia, Washington D.C. and West Virginia. In these states, Fish and Wildlife agency members are responsible for managing species and their habitats in a diverse range of ecosystems that include terrestrial, freshwater, coastal, and marine systems, all set amongst one of the most densely populated regions of the country.

All thirteen states and DC have developed State Wildlife Action Plans (SWAPs) that represent a collective vision for the future of conservation, and these plans form the underlying basis of the monitoring framework, and this report. The roots of this planning effort lie with the Teaming with Wildlife coalition – more than 3,500 agencies, conservation groups, and businesses - who came together to secure funding for work related to wildlife protection, and whose efforts led to the establishment of the Wildlife Conservation and Restoration Program and the State Wildlife Grants Program in 2000. SWAPS are proactive plans that assess the condition of each state's wildlife, identify the problems they face, and prescribe actions to conserve wildlife and vital wildlife habitats before they become more rare and costly to protect. These proactive plans outline steps that should be taken now and that ultimately will save states money over the long term.

Data, Approach, and Review: The monitoring framework intentionally focuses on using existing data and information, rather than requiring new sets of data, to keep its recommendations simple and manageable. Nevertheless, implementing the recommendations required the compilation and management of over 50 data sets. Inevitably, some needed thorough revision or had to be created anew from state sources for this report (e.g. secured lands, species locations). In most cases, compiling the existing data sets required us to learn the complexities of each integrated data base, decode its schema and field names, understand its strengths and limitations, and recognize how to correctly combine it with other datasets. Several federal agencies also provided datasets critical to this project, and we would like to particularly thank their staff for sharing their expertise; particularly: Pam Fuller of the USGS/BRD Nonindigenous Aquatic Species Program, John Sauer of the USGS Patuxent Wildlife Research Center Breeding Bird Survey, Jon D. Klimstra of the USFWS Division of Migratory Bird Management, Richard Mitchell PhD of the USEPA Office of Wetlands, Oceans, and Watersheds, Daren M. Carlisle of the USGS National Water-Quality Assessment Program and Mark Hatfield of USFS's Northern Research Station (FIA data). We would also like to thank Harry Vogel of the Northeast Loon Study Working Group; Patricia A. Soranno, Dana Infante, and Peter Esselman at Michigan State University; and Matthew Baker at the University of Maryland for their assistance with the lake and stream measures. Finally, we would like to thank Lynn Kutner and Margaret Ormes of NatureServe, for their advice on interpreting the data on rare species.

Whenever possible we worked directly with the people who created and managed the data, to ensure that we were using it correctly. A few of the data originators, such as Pam Fuller with the Nonindigenous Aquatic Species Program, were themselves willing to analyze data for us, and provide the needed tables, graphs and charts. We are grateful for all the help and goodwill we received; we learned a lot from assembling all the information, and any errors are solely our own.

As seen below, the framework report makes many specific recommendations about data and process. Our goal was to match the recommendations as closely as possible, but inevitably, because we were dealing with the intricacies of large region-wide datasets, we had to make adjustments. Sometimes, the proposed methods were not practical and we had to find alternatives, and sometimes the results were simply not as informative as originally hoped. In this, we were guided by a 13-state steering committee who endured six months of reviewing data summaries, viewing preliminary results, discussing alternatives, and joining in active discussions of patterns and issues. This committee, which met monthly for the first six months of the project, greatly improved this report and included the following people: Jenny Dickson and Rick Jacobson of CT DEP; Robert Coxe and Kevin Kalasz of DE DFW; John O'Leary and Thomas O'Shea of MA DFW; Glenn Therres, Lynn Davidson, Scott Stranko, and Dana L. Limpert of MD DNR; George Matula and Sandy Ritchie of ME DIFW; Jim Oehler, John Kanter, Matt Carpenter, Steve Fuller, and John Tash of NH DFG; Dave Jenkins, Kris Schantz, and Miriam Dunne of NJ DFW, Tracey Tomajer, Greg Edinger, Dan Rosenblatt, and Erin White of NY DEC; Dan Brauning and Lisa Williams of PA GC, Dave Day of PA FBC, Jeffrey Wagner of PA WPC/NHP; Jon Kart and Rod Wentworth of VT DFW; Gary Foster of WV CNR; Becky Gwynn of VA DGIF, Dave Tilton, Genevieve Pullis LaRouche, Ron Essig, and Ken Sprankle of USFWS; Don Faber-Langendoen of NatureServe, Dan Lambert of American Bird Conservancy, Dave Chadwick of the Association of Fish and Wildlife Agencies, Mary Anne Theising of USEPA, and James McKenna of USGS.

The Indicator Concept: The concept of a key indicator is important to an understanding of this report. The framework focused on the most important needs common to all states and across the region and did not try to provide all-encompassing list of every possible characteristic to monitor. Rather, the framework identified a few key indicators, for each target, that are illustrative of overall progress and that are meant to serve as a dashboard of information to guide decision makers. On our part, we focused strongly on compiling the information and displaying the patterns in as clear and transparent way as possible. Usually, this meant keeping the analysis simple and direct. Still, there are many indicators and, as straightforward as any one indicator might be, together they interlink to form a complex, multi-dimensional picture of the target, and more than once revealed a striking and unexpected pattern.

The monitoring framework provides background and justification for the various indicators, and we suggest that readers use the two reports together, as we do not repeat the information from the framework in this report. Moreover, there is extensive literature on each topic that we did not attempt to summarize. Rather, we focused directly on the data and the patterns revealed for the region. Citations are used sparingly and deliberately to refer directly to a data set or an information source, or to justify an analysis method or a key threshold. Although we introduce each chapter section with a sentence explaining why each indicator was chosen, we strove to let the data speak for themselves and to keep interpretation to a minimum. We do highlight places, throughout the report, where the patterns seemed obvious and important enough to merit special notice.

Organization of the Report: This report covers the proposed status measures for seven conservation targets:

- forests
- freshwater streams and river systems
- wetlands
- lakes and ponds
- managed grasslands and shrublands
- species of greatest conservation need
- unique habitats in the Northeast

The chapters and sections are organized around the thematic groups with a set of sub-targets, stressors, and indicators developed for each group. Each chapter begins by describing the target and its variations (for instance, forest types), and then discusses each key indicator, the method used to assess it, and the results of the analysis. The results include charts, tables and full page maps, and an appendix of tables with detailed state-by-state information. Maps are also posted individually in pdf form for anyone who may want to view or print it in high resolution. Lastly there is an appendix on data sources that identifies the major sources used and provides links to the original data, and an appendix with more specific explanations of our methods for those who may want to recreate the analyses.

An outline of the targets and their indicators was provided on page 17 in the Framework report (Table 1), and this table formed the basis of our table of contents. We made three important modifications to the overall structure. First, we added an entire chapter on the secured lands, to clarify the concepts of securement, protection, management and designation, and to highlight the overall patterns of securement for the region. This chapter is critical to an understanding of the rest of the chapters. Second, we completely omitted the highly migratory species target, because we were unable to compile credible data for this target within the time allotted. The decision to omit the target was approved by the steering committee after a discussion of the issues and a look at the available data. Third, the managed grassland and shrubland target was listed in the framework but measures were not developed for it; hence, we did

Table 1. Table of Targets, Stressors and Indicators from the monitoring framework (Tomajer et al. 2008).

Table 1. Targets, Stressors, and Proposed Indicators Fish, Wildlife, and Habitats (in alphabetical order)	**Proposed Indicators** (in order of importance for each species or habitat)	**Key Stressors** (in order of importance for each species or habitat)
1. Forests	1a. Forest area – by forest type 1b. Forest area – by reserve status Forest composition and structure – by seral stage Forest bird population trends	Forest fragmentation index Acid deposition index
2. Freshwater streams and river systems	Distribution and population status of native eastern brook trout Index of biotic integrity	% impervious surface Stream connectivity (length of open river) and number of blockages Distribution and population status of non-indigenous aquatic species
3. Freshwater wetlands	Size/area of freshwater wetlands Buffer area and condition (buffer index) 3a. Hydrology – upstream surface water retention 3b. Hydrology – high and low stream Wetland bird population trends	% impervious surface flow Road density
4. Highly migratory species	Migratory raptor population index Shorebird abundance Bat population trends Abundance of diadromous fish (indicator still under development) Presence of monarch butterfly	
5. Lakes and ponds	Overall Productivity of Common Loons	% impervious surface/landscape integrity % shoreline developed (shoreline integrity)
6. Managed grasslands and shrublands	To be developed	
7. Regionally Significant Species of Greatest Conservation Need	Population trends and reproductive productivity of federally listed species State-listing status and heritage rank of highly imperiled wildlife Population trends of endemic species	
8. Unique habitats in the Northeast.	Wildlife presence/absence Wildlife population trends	Proximity to human activity/roads Land use/land cover changes

not develop indicators or perform a complete assessment of this target. We did, however, make a preliminary attempt to map the target, overlay locations with secured lands, and compile information on breeding bird trends (Appendix C). Although it is not equivalent to a full chapter, we hope that some people find the information useful. We need better mapping capabilities for grasslands, and it would be useful to have an expert team develop a set of indicators comparable to those for other targets.

In most chapters, after discussions with the steering committee, we modified the recommended methods and data slightly from those in the original framework. Consider the four recommendations for the forest section (Table 2). While we summarize all four indicators in the forest chapter, two were summarized directly as suggested, two were improved slightly with new data, and two were added in order to address disturbance and forest loss. For example, for the forest distribution indicator we used the LANDFIRE dataset of 2009 to map the forest types and the newly revised TNC secured land dataset to assess how much of each forest type is in conservation. In both cases, these changes follow the recommendations of the steering committee and were an upgrade from the suggested methods. For the second indicator, we used the data sources recommended to summarize the age and size structure of the forests and the degree of harvesting. For the third indicator, fragmentation, we replaced and out-of-date connectivity analysis with a revised version based on forest blocks surrounded by major roads, and a new method of measuring local connectedness. Lastly, for the forest bird indicator we calculated the trends as recommended, the only difference being that we cast the net a little wider to look at cross-state and cross-decade trends.

Chapters can be read independently and in any order; however the chapter on Secured Lands contains material that will facilitate the reader's understanding of the others.

Table 2. Recommendation for forest indicators from the monitoring framework (Tomajer et al 2008).

Table 2. Summary Matrix of Forest Indicators Indicator	Description	Potential Data Sources	Potential Issues*
1a. Forest Area – by Forest Type 1b. Forest Area – by Reserve Status	Areal extent of forested lands How much forest in a land use category	Forest Inventory and Analysis (FIA) Program FIA Program	Margin of error in can be as high as 10% FIA categories for Reserve status need to be migrated to the Conservation Lands categories Margin of error in can be as high as 10% FIA categories for Reserve status need to be migrated to the Conservation Lands categories
2. Forest Composition & Structure by Seral Stage	% of forest lands with stands in several development stages	FIA	FIA data currently only available for timberlands – recent memorandum of understanding has given US Forest Service permission to establish plots in national parks FIA data based on saw-timber age but would be preferable to use ecologically based seral stage index. Methods available for converting but need more testing.
3. Forest Fragmentation Index	Relative level & causes of forest fragmentation Index based on forest connectivity, human caused fragmentation, & natural fragmentation	US EPA National Atlas Project	Fragmentation index data is out of date – need to run again with current data
4. Forest Bird Population Trends	Population trends of Woodland Breeding Birds, Successional or Scrub Breeding Birds, Cavity Nesting Birds, Mid-story or Canopy Nesting Birds	North American Breeding Bird Survey (BBS)	BBS data limited to roadside habitat, subject to multiple sources of bias and error, and do not include environmental or management covariates

References

Tomajer, T, Kart, J, Salafsky, N. Stem, C and V. Swaminathan. 2008. Monitoring the Conservation of Fish and Wildlife in the Northeast: A Report on the Monitoring and Performance Reporting Framework for the Northeast Association of Fish and Wildlife Agencies. 50 pp. http://rcngrants.org/regional_monitoring.shtml.

CHAPTER

3

Secured Lands

In the Northeast and Mid-Atlantic

April 2011

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Covering 16 percent of the region's land surface, the secured lands system represents a commitment to nature and to future generations; an indication of what can be achieved through collective effort. They provide the core of efforts to protect the region's outstanding habitats and threatened species, and are increasingly understood as essential providers of ecosystem services and storehouses of the lands biological resources. Even as the region's ecology adjusts in response to a changing climate, the secured lands play a critical role in maintaining arenas for evolution and provide people with the opportunity and spiritual rewards of direct contact with the land.

Eastern Secured Lands at a Glance	
Total Acres	24,429,606
Percent of the Region	16%
Number of Fee Owners	6,129
Average size of Ownership	10,025
Number of Easements	2,431
Average size of Easement	1,254
Number of Individual Tracts/Polygons	136,789

Definitions:

Secured: An area with permanent securement against conversion to development = **GAP status 1 - 3**

Protected: a Secured area intended for biodiversity or nature conservation = **GAP status 1 or 2**

Secured for multiple uses: A Secured area intended for multiple uses such as forest management and recreation = **GAP status 3**

Secured land: Sixteen percent of the region is currently secured against conversion to development and 5 percent of that land area is protected explicitly for nature. That land is held by over 6,000 fee owners and 2,000 easement holders. State government is the largest public conservation land owner, 12 million acres, followed by federal government, 6 million acres. Private lands held in easements account for 3 million acres and land owned by private non-profit land trusts account for another 1.4 million acres.

Conversion versus Securement: In total, 28 percent of the region is converted to development or agriculture, thus conversion exceeds securement 2:1. This ranges from a high of 4:1 in Delaware, to lows in New Hampshire and Maine where securement surpasses conversion. However, conversion outweighs protection by a larger amount, roughly 5 acres converted for every 1 protected; this ranges from a low of 1:1 to a high of 19:1 depending on the state.

Distribution across Natural Features: In spite of great successes, the pattern of securement, protection, and conversion, has widespread and fundamental biases with direct implications for biodiversity. For example, conversion in rocky granite areas is balanced with protection levels almost 1:1, but in productive, diverse, limestone areas, conversion exceeds protection 51:1. In forests, land securement accounts for most of the large contiguous blocks of habitat, but forest fragmentation in the rest of the landscape correlates with large changes in the bird communities. The chapters in this report aim to uncover and understand these biases to increase the effectiveness of conservation efforts.

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Background: Land and water permanently maintained in a natural state remains the most effective, long lasting, and essential tool for conserving species and habitats. Securement, in essence, aims to maintain the quality of land and water by regulating its use in specific places. Although secured lands share one attribute - they cannot be developed - they are far from uniform entities; instead, they have a wide range of management intents and are governed by a variety of public and private stakeholders. In fact, the tools for securing land have greatly expanded in scope and versatility as conservation has grown in sophistication. Strict reserves still exist, but they are only part of a whole variety of conservation lands representing a sometimes bewildering array of restrictions, intents, designations, tenures, easements, interest holders, and ownership types.

The evolution of land and water protection to encompass a much broader palette is one of the most exciting advances in conservation; it offers a realistic chance to create conservation infrastructure at a larger scale and with a more diverse set of players. Moreover, it is a necessary response to the increasingly complex nature of the environmental crisis and the challenge of sustaining the immeasurable benefits provided by nature. In this section, we define securement in a standardized way and then examine the patterns of conservation across the region. In later sections, the secured lands are examined in relations to particular natural features such as forests, wetlands or rivers. Thus, the terms and data described in this chapter form the basis of understanding the other chapters in this report.

Definition of Secured Land

Terminology: The term "**secured lands**" refers to the broad set of lands that are permanently secured against conversion to development. This language was adopted by an international group of scientists to differentiate them from the more restrictive "protected areas" which refers to land with a formal designation aimed at the conservation of nature. By this definition, secured lands may include land with no formal designation, if the intent of the owners is for permanent protection against development – for example, a "forever wild" easement. Conversely, they may exclude a formally designated protected area, such as a world biosphere preserve, if there is no conservation intent, or means for permanent conservation.

For any given parcel of land, the determination of the type and degree of securement is based on three factors relative to the owner or interest holder, summarized in these questions:

- What is the **intent** of the managing entity for the use of the land and water?
- What is the **duration** of ownership?
- Does the managing entity have the **potential for effective management?**

I**ntent** is the degree that owner or managing entity is focused on maintaining natural diversity. **Duration** is the owner or managing entity's temporal commitment to maintaining the land. **Effective management potential** is the apparent capability of a managing entity (e.g. agency, owner, manager) to implement the intent and duration, based on governance, planning, and resource levels. These factors can be applied to a wide range of conservation areas beyond formally designated protected areas, such as conservation easements, river flow management, or ecosystem-based fisheries.

The securement status of a tract of land is not the same as the conservation status of the feature that the tract is intended to conserve, a nuance that often confuses users. For example, a species breeding on secured land, may be only partially conserved if their conservation calls for the securement of multiple breeding areas, connecting land between breeding areas, and sufficient winter habitat. Meeting the species conservation goal requires a network of secured lands each with the appropriate type and quality level of securement. Only in the last decade have we been able to unravel the complicated question: how does this tract fit in with other tracts to accomplish the intended conservation?

The Nature Conservancy's Secured Land Dataset**:** In The Nature Conservancy's (TNC) Eastern Region secured lands dataset, every tracked parcel of land is assessed for the three factors of securement (intent, duration, and management potential) and assigned a categorical securement status. Importantly, only parcels where the ownership duration is permanent are included in the mapped dataset; so, by definition, this data set includes only *land that is permanently secured from conversion to development.* The requirement for permanent protection is not based on an ecological justification; it is simply beyond our capacity to track and maintain information on non-permanent ownerships. Certainly, important lands exist that contain temporary or volunteer conservation.

The TNC secured land data set is compiled annually from over sixty sources (TNC 2009, see list in appendix 3-2). For the most part, it is a combination of public land information maintained by each state, and private conservation land information compiled by the Nature Conservancy's state field offices. Nature Conservancy staff in each state office compile the dataset for their state, assign the securement status to each tract, and fill out the other standard fields (Table 1). The completed state dataset are then compiled by the regional science office and quality checked for consistency and discrepancies. Each year the data set is posted for public use and submitted to the Protected Areas Database US (PAD US) to become part of a national dataset of protected lands.

Secured Lands and GAP Status: The three factors of intent, duration and potential to manage effectively, form what the Nature Conservancy calls the tract's Conservation Management Status (CMS). In the United States, CMS has a one-to-one relationship to the US Forest Service's **GAP status** (Crist et al 1998). The relationship is straightforward in the United States because land-owning organizations all meet the standard for appropriate governance, and thus score high for effective management potential; therefore GAP status and CMS in this country is determined by intent and duration alone. Because GAP status is widely used in the U.S., we use is as our primary reporting standard in this document. The definitions of the GAP categories and their crosswalk to CMS are taken from Crist et al. (1998) and they crosswalk to CMS in the following way:

GAP Status 1: An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a natural state within which disturbance events (of natural type, frequency, intensity, and legacy) are allowed to proceed without interference or are mimicked through management. **Duration** = permanent, **Intent** = natural diversity, **CMS 1**

GAP Status 2: An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a primarily natural state, but which may receive uses or management practices that degrade the quality of existing natural communities, including suppression of natural disturbance. Recreation such as hiking is generally allowed on Gap 1 and 2 land, but extensive use of motorized vehicles usually fits better under GAP 3 for multiple uses. **Duration** = permanent, **Intent** = natural diversity, **CMS 1**

Table 1. Fields and field definition in The Nature Conservancy's secured land data set.

Secured Area attribute fields	
Field	**Description**
Area_Name	Common name of secured area
Fee_Owner	Name of fee owner if known
Fee_Orgtyp	Organization type of the Fee Owner: FED= federal, STP=state/province, LOC=local, PNP=Private Non-Profit, PFP=Private For-Profit, TRB=tribal, UNK=unknown, PLO=Private Land Owner (mainly for easements))
Int_Holder	Name of Entity holding additional interest in property
Int_Orgtyp	Organization type of the Interest Owner: FED= federal, STP=state/province, LOC=local, PNP=Private Non-Profit, PFP=Private For-Profit, TRB=tribal, UNK=unknown, OTH=Other
Int_Type	Type of Interest held by Int_Holder: F=Fee, E=Easement, R=Restriction
GAP_ORIG	GAP Status as assigned by the GAP Program: 1, 2, 3, 4, 9
GAP_TNC	GAP status codes compiled and assigned by TNC following GAP protocol of Crist et al. 1998 http://www.gap.uidaho.edu/handbook/Stewardship/default.htm
GAP_STATUS	The Final GAP code to use. TNC GAP overrides original GAP when present.
IUCN_Cat	IUCN management objective category: I, II, III, IV, V, VI Used outside US. See http://www.unep-wcmc.org/protected_areas/categories/
Cons_Intnt	Conservation Intent - An indicator of the degree to which a conservation situation is intended to secure biodiversity. Used with pot_Ef_Mgt and Cons_Tenur to measure Conservation Management Status.
Cons_Tenur	Conservation Tenue - An indicator of the legnth of commitmnet to the conservation situation. This indicator is used to distinguish variations in the permanence of the conservation work. Used with Cons_Intnt and Pot_Ef_Mgt to measure Conservation Management Status.
Pot_Ef_Mgt	Potential for Effective Management - an indicator of the ability for an entity (e.g. agency, owner, manager) to impliment the intended focus of a conservation situation, based on governance planning and resource levels. Uses with Cons_Intnt and Cons_tenur to measure Conservation Management Status.
Cons_Mg_St	Conservation Management Status - A measure of the likelihood that an existing conservation situation is sufficient to secure biodiversity and allow for its persistance. This measure is based on Cons_Intnt, Cons_Tenur, Pot_Ef_Mgt.
State_Prov	two-letter Postal abbreviation
Designatn	Designation for management unit: NP=National Park, NF=National Forest, NWR=Wildlife Refuge, NRA=Recreation Area, NS=Seashore, NWA=Wilderness Area, RNA=Research Natural Area, FO=Federal Other (including Military), SP=State Park, SF=Forest, SL=Other State Land, TL=Tribal Land, MP=Municipal Park, MF= Municipal Forest, NAT=Nature Reserve/ Preserve/ Sanctuary, PCL = Private Conserved Land, AGE = Agricultural Easement, CE=Conservation Easement, EDU=Educational Lands (Schools, University), WSL=Water Supply Lands, WAT=Water, OTH=Other, UNK=unknown
Statedes	The original designation as populated by the states - should be from designation field list, but often is not
GIS_Acres	Polygon's area * 0.0002471
Source	Official citation or internet address of agency responsible for maintaining this polygon

GAP Status 3: An area having permanent protection from conversion of natural land cover for the majority of the area, but subject to extractive uses of either a broad, low-intensity type (e.g., logging) or localized intense type (e.g., mining), or motorized recreation. It also confers protection to federally listed endangered and threatened species throughout the area. Note, we are using a new category "3x" for land that is permanently protected from development, but the intent is for permanent non-natural land cover such as an agricultural easement or a park. **Duration** = permanent, **Intent** = multiple uses, **CMS 3**

GAP Status 4: There are no known public or private institutional mandates or legally recognized easements or deed restrictions held by the managing entity to prevent conversion of natural habitat types to anthropogenic habitat types. The area generally allows conversion to unnatural land cover throughout. **No duration or intent**, not secured, not in data set.

Distribution of Secured Lands in the Northeast and Mid-Atlantic

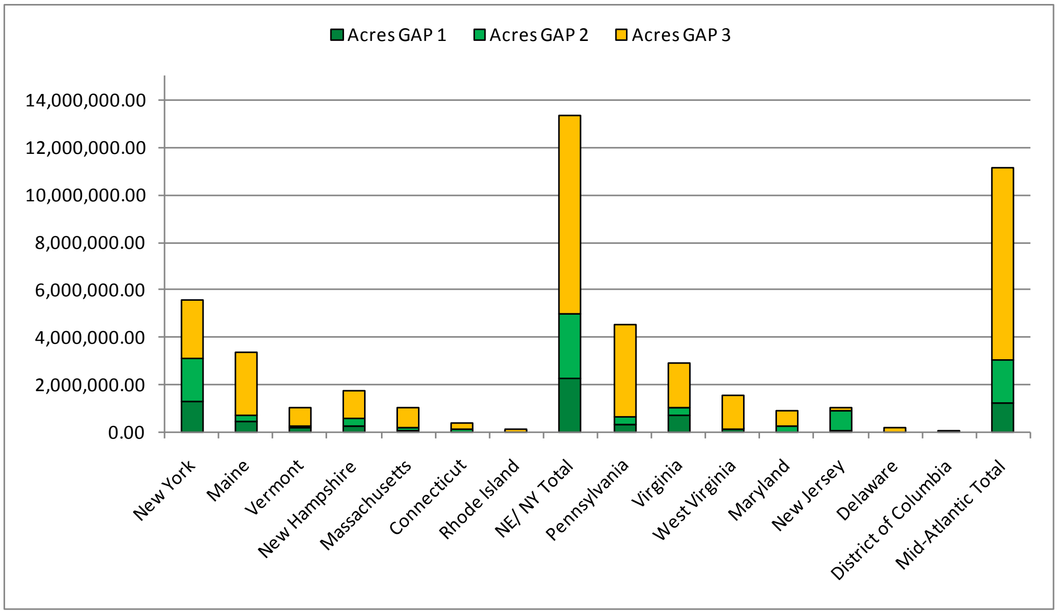
Conservationists have fought hard to secure important places, but do all those places add up to a larger conservation picture? In this report, we try to fit together the pieces of the securement puzzle, in order to take stock of our collective accomplishments, and identify where we need to put more effort. We begin by examining the overall patterns of securement across the region, by acres, by status, and by ownership type, to understand the overall quality and quantity of the secured land network. In later chapters we re-examine the secured lands with respect to the species, habitats, and natural features that we are interested in conserving.

Patterns of Securement: The newly compiled secured land data set, current through December 2009, revealed that the secured land network covered 16 percent of the region's lands (TNC 2009, Map 1-3). Five percent of the land was protected explicitly for nature (GAP 1 or 2) and 11 percent was secured for multiple uses (GAP 3). New England and New York had about twice the acreage of GAP 1 land as the Mid-Atlantic (Table 3). Secured land in the individual states also averaged 16 percent and the total amount of secured land was highly correlated with the size of the state (r = 0.91). New Hampshire, Rhode Island, Massachusetts and New Jersey had more secured land than expected for their size (21 to 30 percent of the state), and West Virginia and Virginia had somewhat less than expected (10 to 11 percent of the state). The amount of GAP 1and 2 land, protected explicitly for nature, however, was far less correlated with a state's size, averaging only 5 percent. New York, with 10 percent of the state in GAP 1-2 (5.5 million acres), was considerably above the average. In contrast, Pennsylvania with 2 percent, and Maine with 3 percent, were both below the average, relative to their size (Figure 1).

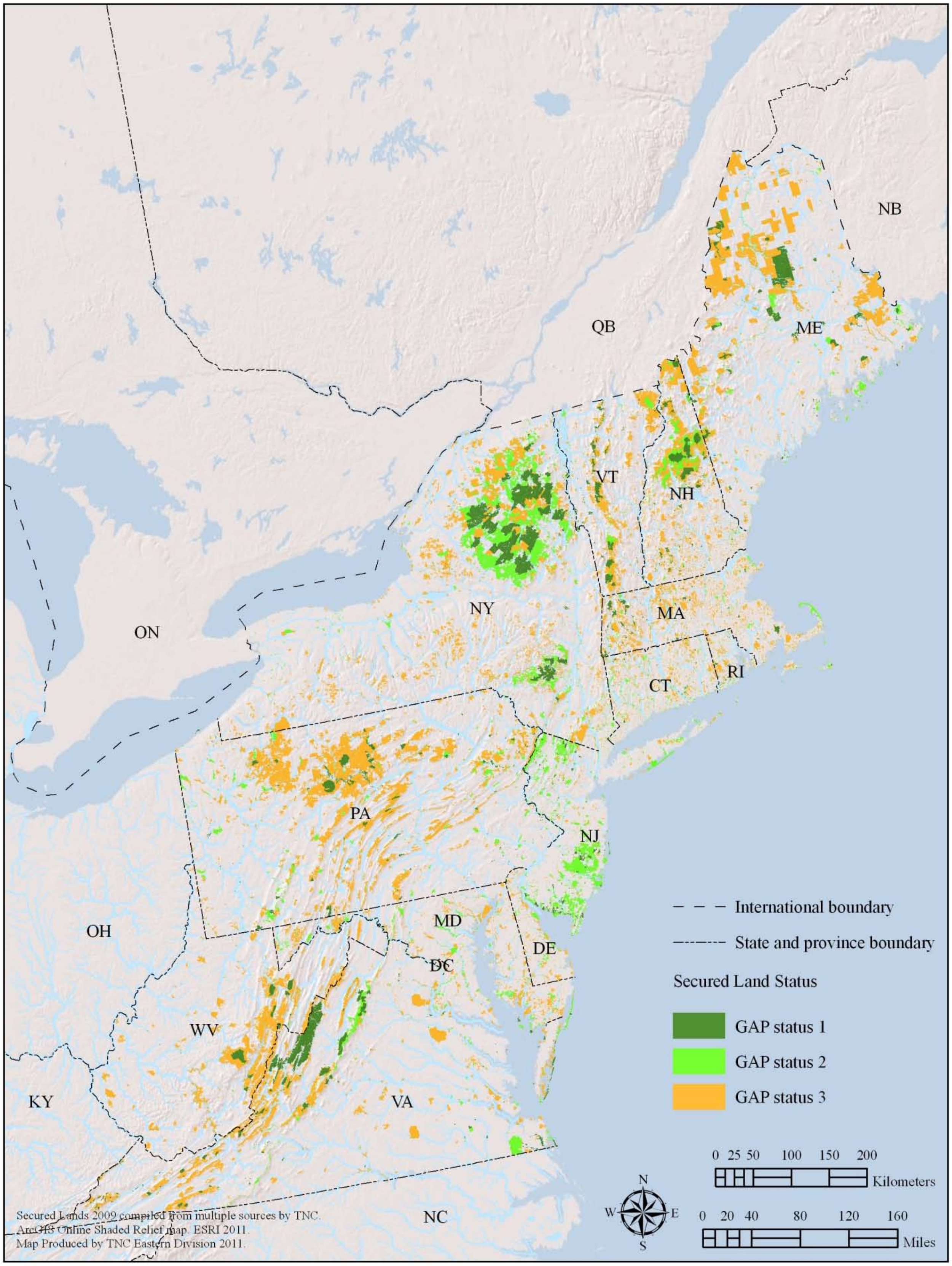
Table 3. Acres and percentages of secured lands by GAP status.

Geographic Area	Acres GAP 1	%	Acres GAP 2	%	Acres GAP 3	%	Acres: Unprotected	%	Total acres
New England & New York	2,291,698	3%	2,711,844	4%	8,319,072	11%	59,756,859	82%	73,079,473
Mid-Atlantic	1,227,124	1%	1,849,366	2%	8,097,145	10%	71,463,322	86%	82,636,957
Region Total	3,518,822	2%	4,561,210	3%	16,416,217	11%	131,220,181	84%	155,716,430

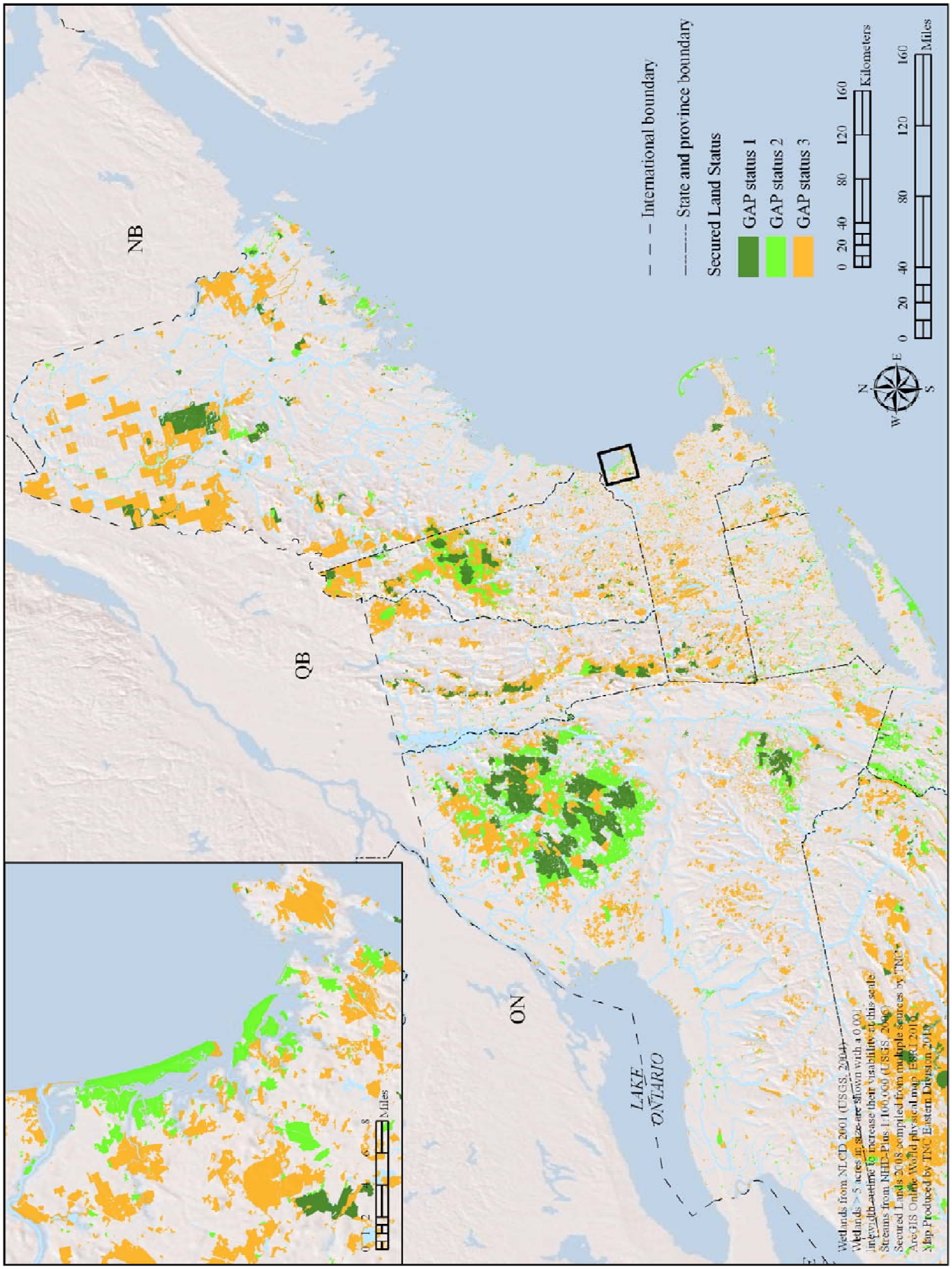
Figure 1. The total amount of secured land by state and sub-region. The overall acreage wass closely correlated with the size of the state (r=0.91).



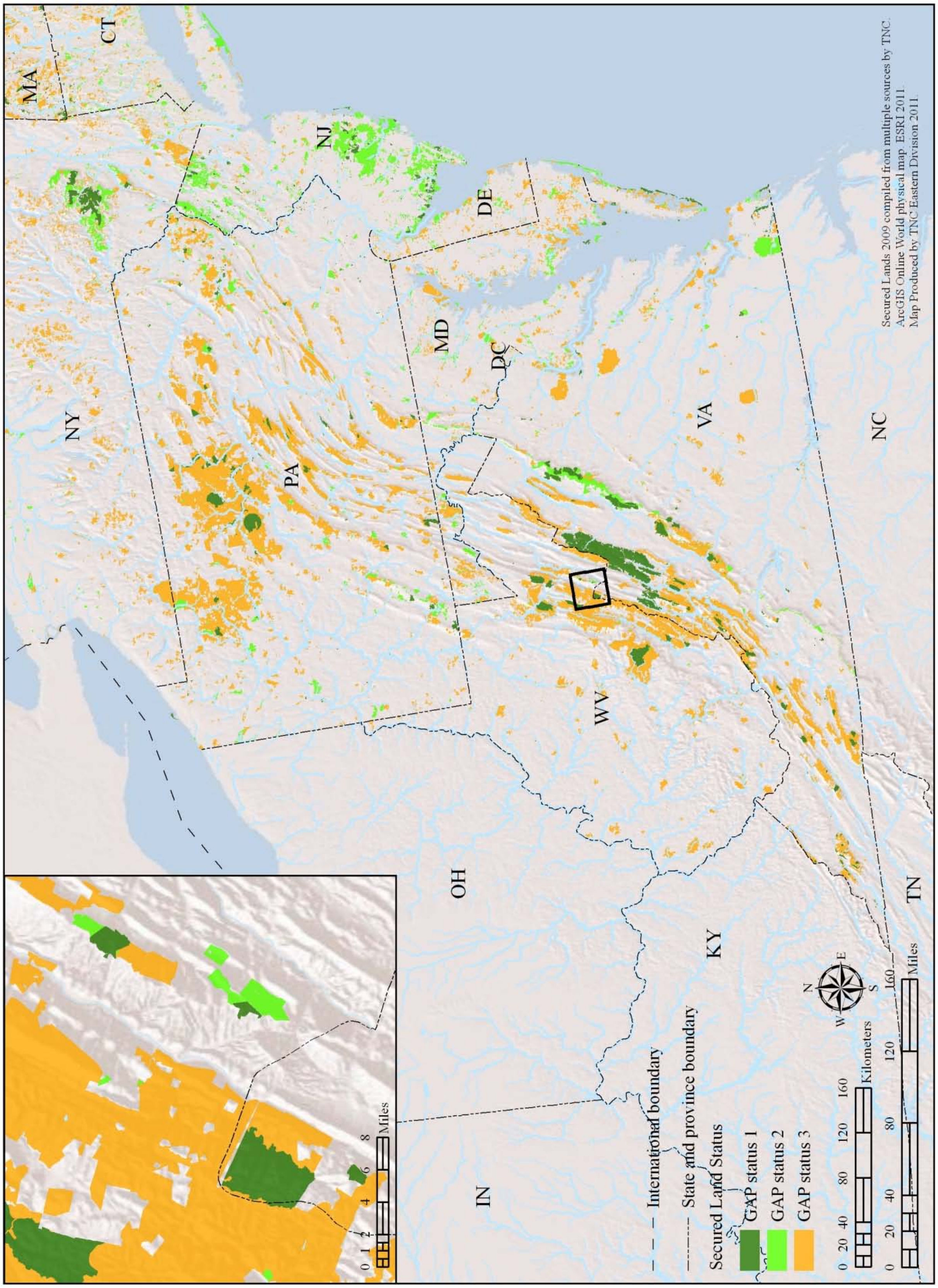
Map 1. Secured land by GAP status.



Map 2. Secured land by GAP status, New England and New York.



Map 3. Secured land by GAP status, Mid-Atlantic.



Conversion versus Securement: How much conservation do we need? One approach to this question is to compare the degree of securement with the degree of conversion. Hoekstra and others (2005) introduced a conservation risk index (CRI) as the ratio of conversion to protection within large ecological regions. We use this index extensively in this report, but expand on it in two ways. First, we examine the ratio with respect to ecological features at a variety of scales: from individual cliffs to entire regions. Second, we look both at the ratio of conversion to protection (GAP 1-2) and the ratio of conversion to securement (GAP 1-3), as the latter allows for a much broader assessment of efforts to prevent conversion. To keep this straight, in the accompanying tables we labeled the ratio of conversion to protection as CRI-P and conversion to securement at CRI-S.

We calculated the amount of agricultural and developed land in the region by overlaying the National Land Cover dataset (Homer et al. 2004) on maps of the region and tabulating the acreage of each land use by states and sub-regions (Map 4). We used land cover data to understand patterns of conversion in the region because, in general, natural vegetation provides a suite of benefits to many natural communities and processes while conversion to development and agriculture is associated with loss of habitat, fragmentation of connected areas, and elevated levels of nitrogen, phosphorus, and pesticides.

Results show that in this region, habitat conversion exceeds habitat protection by a ratio of 5:1. Nine percent of the landscape was developed and 18 percent was farmed, resulting in 28 percent converted as compared to 5 percent protected (Figure 2, Table 4). However, conversion exceeds securement only by a ratio of only 2:1. This accounts for all the private land easements and state forests being managed for multiple uses even if their value to biodiversity is not explicitly a goal of their management. One third of the Mid-Atlantic has been converted and slightly over one fifth of New England and New York. Maine was the least converted state, and together with New Hampshire, were the only states where the percent of secured land was greater than the percent of converted land (Table 4). Delaware was the most converted state and also has the highest ratio of conversion to securement, in spite of successfully conserving 14 percent of the state.

Map 4. Regional land cover.

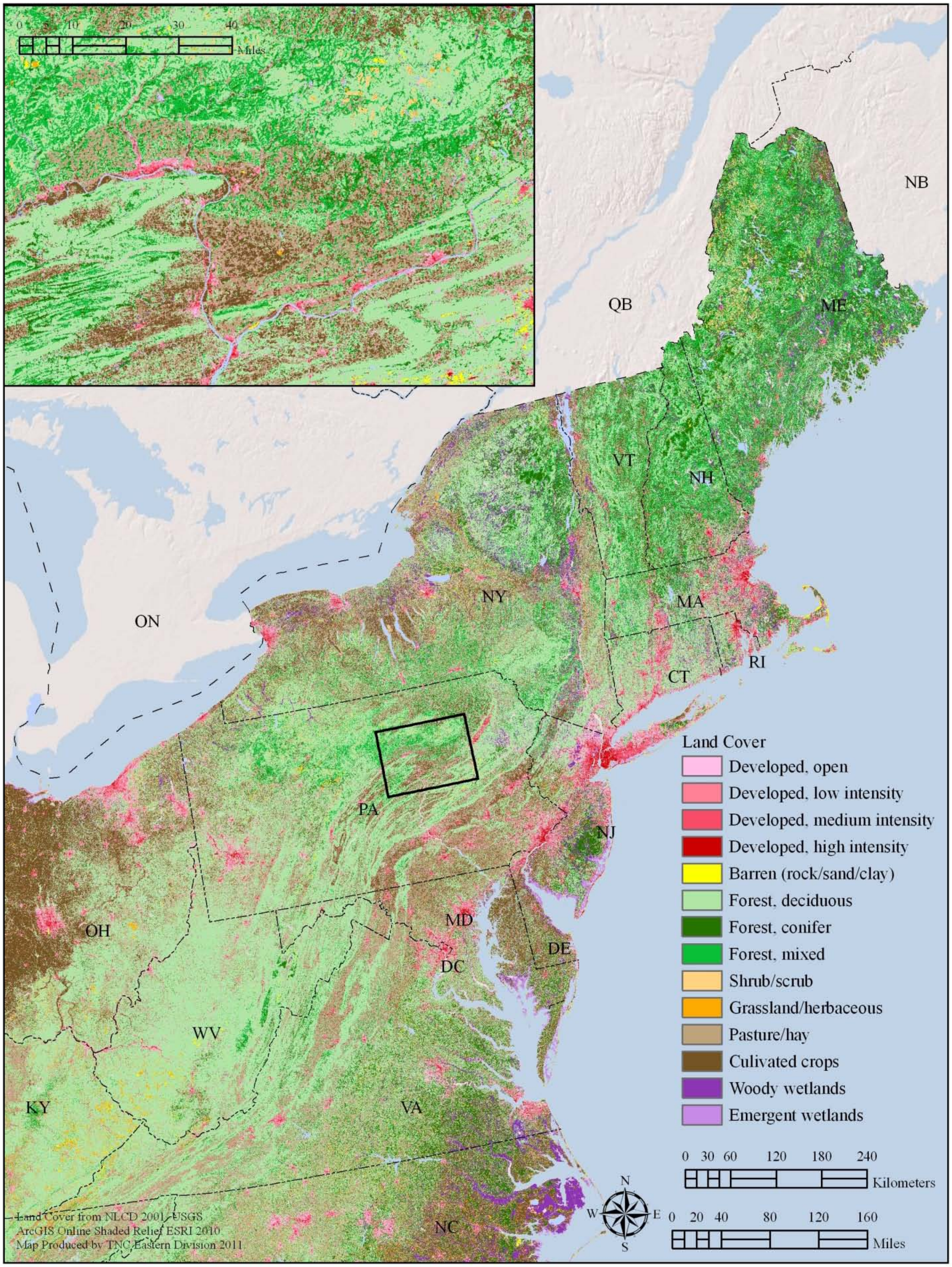


Figure 2. The distribution of land conversion and land securement by state, sub-region, and region. In this chart, each bar represents the total area of land in the geographic area. Land to the left of the center bar has been converted to development or agriculture; land to right of the center bar remains unconverted. Unconverted land is apportioned by securement status and the percent unsecured.

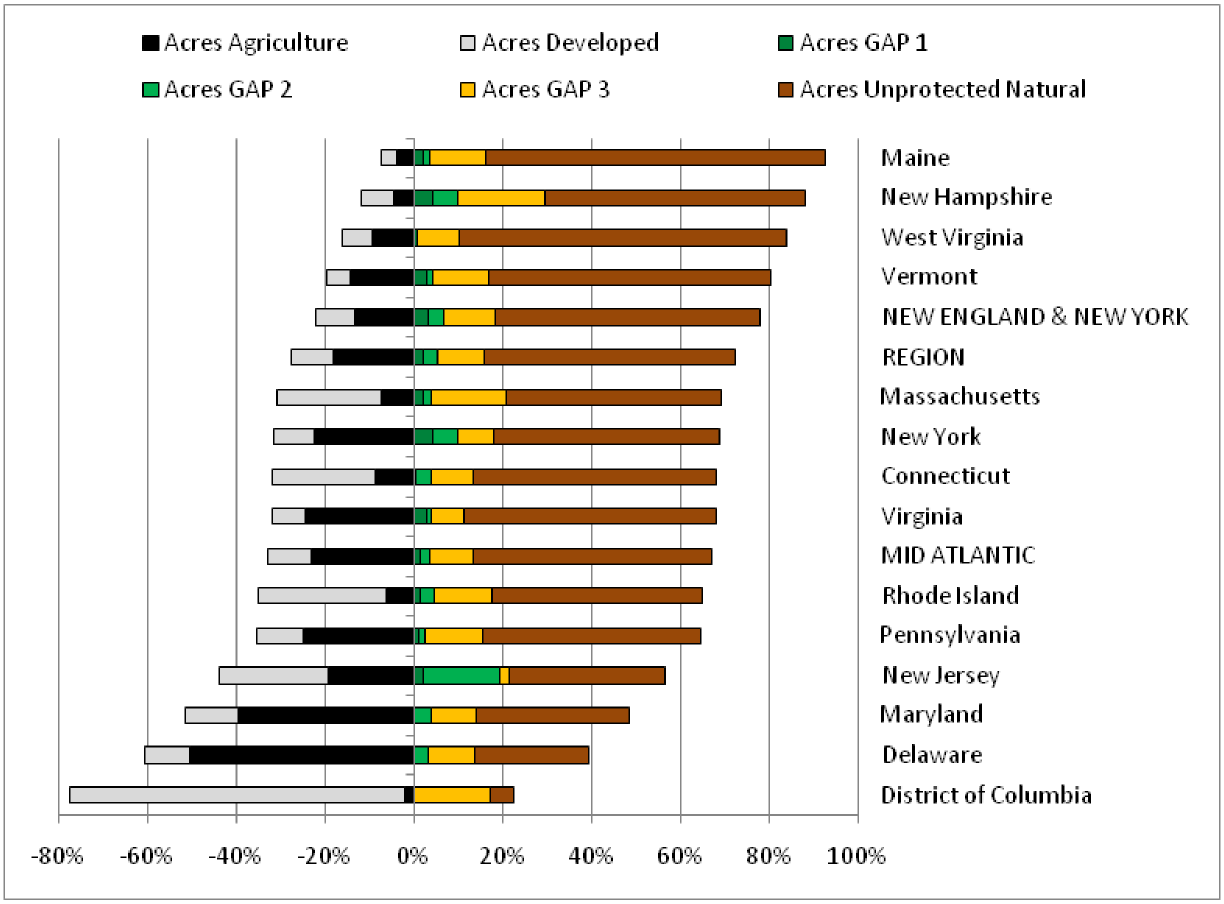


Table 4. Converted and secured land by state and region.

STATE	Acres Developed	%	Acres Agriculture	%	Acres Gap 1-2	%	Acres Gap 3	%	Acres Unsecured Natural	%	Total Acres	Total Secured	%	Total Converted	%	CRI-S	CRI-P
New York	2,794,293	9%	6,960,684	22%	3,089,050	10%	2,466,297.4	8%	15,804,457	51%	31,114,781	5,555,347	18%	9,754,977	31%	1.8	3.2
Maine	722,111	3%	822,410	4%	705,996	3%	2,650,619.4	13%	15,905,973	76%	20,807,110	3,356,616	16%	1,544,521	7%	0.5	2.2
Vermont	325,660	5%	872,547	14%	268,632	4%	761,062.8	12%	3,925,023	64%	6,152,926	1,029,695	17%	1,198,207	19%	1.2	4.5
New Hampshire	445,903	8%	265,355	4%	590,605	10%	1,159,610.9	20%	3,468,873	58%	5,930,347	1,750,216	30%	711,258	12%	0.4	1.2
Massachusetts	1,226,212	24%	376,532	7%	198,763	4%	877,940.3	17%	2,515,144	48%	5,194,591	1,076,704	21%	1,602,743	31%	1.5	8.1
Connecticut	735,005	23%	278,500	9%	119,428	4%	311,681.7	10%	1,739,256	55%	3,183,870	431,109	14%	1,013,505	32%	2.4	8.5
Rhode Island	199,456	29%	43,593	6%	31,067	4%	91,859.8	13%	329,873	47%	695,850	122,927	18%	243,049	35%	2.0	7.8
NE/ NY Total	6,448,640	9%	9,619,620	13%	5,003,542	7%	8,319,072.3	11%	43,688,599	60%	73,079,473	13,322,614	18%	16,068,260	22%	1.2	3.2
Pennsylvania	3,125,101	11%	7,158,129	25%	689,830	2%	3,842,409.8	13%	14,176,189	49%	28,991,659	4,532,240	16%	10,283,230	35%	2.3	14.9
Virginia	1,946,536	8%	6,223,031	24%	1,016,992	4%	1,910,905.9	7%	14,487,343	57%	25,584,807	2,927,898	11%	8,169,566	32%	2.8	8.0
West Virginia	1,059,156	7%	1,441,744	9%	130,715	1%	1,454,873.3	9%	11,420,281	74%	15,506,769	1,585,588	10%	2,500,900	16%	1.6	19.1
Maryland	758,932	12%	2,541,953	40%	261,391	4%	643,947.8	10%	2,189,125	34%	6,395,350	905,339	14%	3,300,885	52%	3.6	12.6
New Jersey	1,171,074	24%	934,592	19%	936,079	19%	101,864.3	2%	1,683,933	35%	4,827,542	1,037,943	22%	2,105,666	44%	2.0	2.2
Delaware	126,843	10%	651,590	51%	41,483	3%	135,595.0	11%	331,633	26%	1,287,144	177,078	14%	778,433	60%	4.4	18.8
District of Columbia	32,964	75%	952	2%	0	0%	7,548.6	17%	2,221	5%	43,686	7,549	17%	33,916	78%	4.5	0.0
Mid-Atlantic Total	8,220,606	10%	18,951,991	23%	3,076,490	4%	8,097,144.7	10%	44,290,726	54%	82,636,957	11,173,635	14%	27,172,596	33%	2.4	8.8
Region Total	14,669,246	9%	28,571,611	18%	8,080,032	5%	16,416,217.1	11%	87,979,325	56%	155,716,430	24,496,249	16%	43,240,856	28%	1.8	5.4

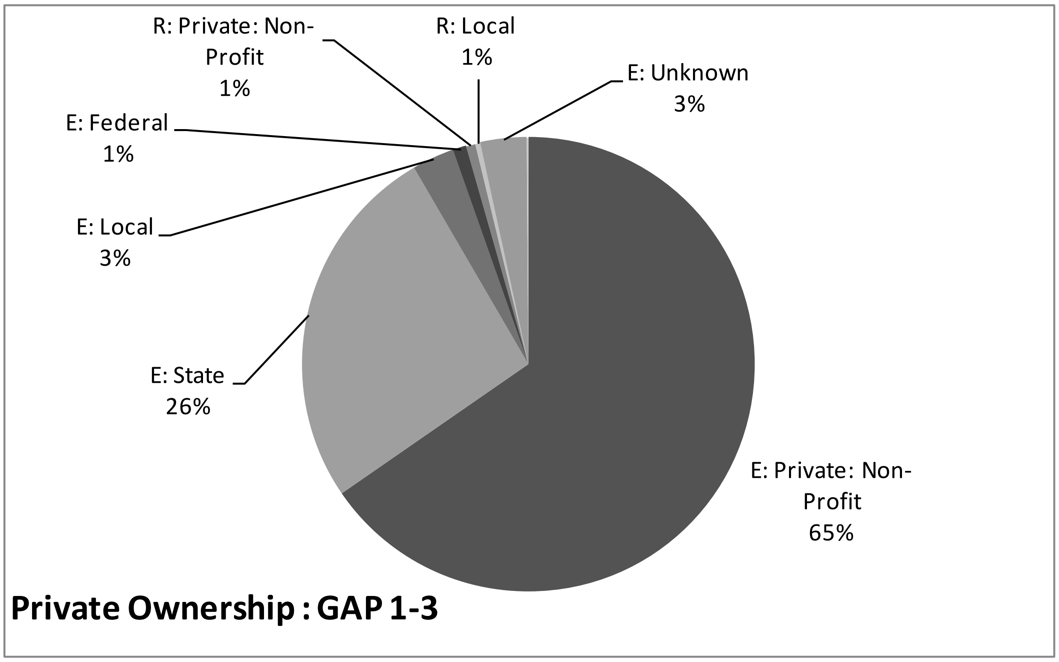
Ownership and Designation

Ownership: According to our data, the 2009 secured land network was owned by 6,129 different entities. The majority of fee-owned acres were held by state agencies (50 percent), followed by almost equal amounts of federal (25 percent) and private ownerships (21 percent). Private ownership was the fastest growing sector, and private individuals have now placed permanent conservation easements on over 3 million acres (Map 5, Table 5), most of that in the last twenty years. Land trusts, and other non-profit organizations, held the interest on a majority of the private easements, representing over 2,400 individuals and reflecting a growing involvement of private land owners in the long term conservation of their lands (Figure 3).

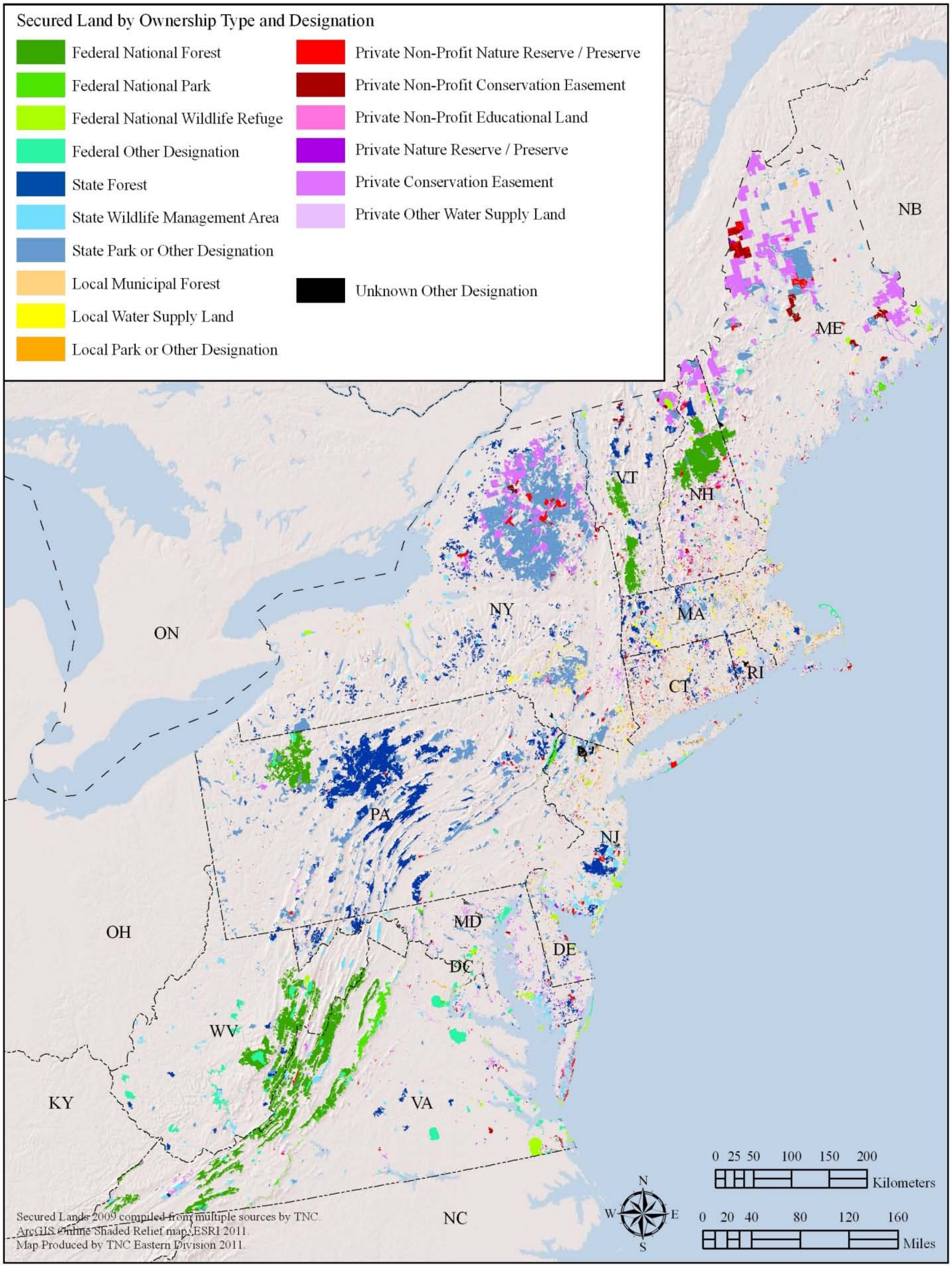
Table 5. Secured land ownerships. This table is organized by fee ownership types and shows both the average size of the ownership as well as the average tract or parcel size. Ownership by private individuals must have a conservation easement or restriction to qualify as permanent securement.

FEE OWNER	OWNERSHIP					TRACTS	
ORGANIZATION TYPE	Total Acres	Number of Owners	Average Acres per Owner	Maximum Acres per Owner	Owner of maximum	Average Tract size (acres)	Max Tract Size
State	12,227,956	126	97,047	3,795,834	NY-DEC	369	5,997
Federal	5,980,524	24	249,188	3,896,790	USFS	735	4,006
Local	943,674	1,125	839	108,097	NYC-DEP	52	1,985
Private: For Profit	795,859	361	2,205	413,675	Lyme Timber	79	4,474
Private: Ind. w Easement	3,048,651	2,431	1,254	21,979	Long Pond/NYS	47	21,979
Private: Non Profit	1,366,285	1,641	833	643,299	TNC	122	15,951
Unknown	66,657	421	158	61,916		126	1,364
Grand Total	24,429,606	6,129	10,025			234	9,065

Figure 3. The distribution of private conservation. This chart shows the distribution of easements (E) and restrictions (R) among types of interest holders of all secured land. The vast majority are easements held by private non-profit entities.



Map 5. Secured land by ownership type and designation.



Designation: How land is formally designated in the United States is variable, and most designations do not have consistent definitions with respect to management. States have substantial leeway in determining the specifics of each designation, and thus, what a particular designation means with respect to allowable uses, management practices, owner intent, or even tenure of the holding, varies greatly from state to state. In our data set, land in each designation often reflected the full range of GAP status classes (Table 6). The most restrictive designations (nature reserve or wilderness area) were generally synonymous with GAP 1, but almost three million acres of state lands were protected explicitly for nature without any formal designation, mostly ensured by conservation easements.

Including the GAP 3 lands in the secured land data tripled the area of the secured land network. If well managed, these lands offer implicit conservation values and may maintain connectivity and water quality at scales beyond what is possible for the protected GAP 1 or 2 lands. While protected lands are still the fundamental building blocks of most national and international conservation strategies, evidence of the past two decades suggests that they are necessary, but not sufficient, for solving many conservation problems or reversing the disturbing trends of fragmentation.

Table 6. Secured lands by designation. GAP 1 and 2 land was mostly designated as state land or nature reserve. GAP 3 lands have more land designated state forest, or conservation easements on private land.

Desgnation Name	GAP 1 & 2	%G1-2	GAP 3	%G3	GAP 1-3	%G1-3
State Land	2,816,320	35%	2,260,004	14%	5,076,324	21%
National Forest	1,040,537	13%	3,151,063	19%	4,191,601	17%
State Forest	577,390	7%	3,538,986	22%	4,116,376	17%
Private Conserved Land	261,838	3%	3,186,361	19%	3,448,199	14%
Wildlife Management Area	383,015	5%	971,898	6%	1,354,913	6%
State Park	682,363	8%	650,671	4%	1,333,034	5%
Nature Reserve	880,091	11%	271,524	2%	1,151,614	5%
Other: Tribal / Federal	68,427	1%	631,325	4%	699,753	3%
Conservation Easement	101,690	1%	481,840	3%	583,529	2%
Municiple Park /Land	115,260	1%	389,701	2%	504,961	2%
National Wildlife Regfuge	438,015	5%	22,692	0%	460,707	2%
Water Supply Land	16,648	0%	426,934	3%	443,582	2%
National Park	371,348	5%	31,009	0%	402,358	2%
Wilderness Area	185,899	2%	0	0%	185,899	1%
Municiple Forest	3,746	0%	130,046	1%	133,792	1%
National Rec. Area	76,425	1%	46,313	0%	122,738	1%
Agricultural Easement	5,564	0%	94,414	1%	99,979	0%
Unknown	4,394	0%	80,989	0%	85,383	0%
Educational Lands	1,507	0%	50,448	0%	51,955	0%
National Seashore	49,551	1%	1	0%	49,552	0%
Grand Total	8,080,032	100%	16,416,217	100%	24,496,249	100%

Designation, GAP Status, and IUCN Management Categories

GAP status has an indirect relationship with World Conservation Union (IUCN) protected areas management categories. The difference hinges on the fact that IUCN scheme relies on the land's formal designation as the basis of its status assignments as opposed to intent and duration. Confusion may arise when land with the same designation. For example, "State Forest" (IUCN VI) actually encompasses a wide range of management intents, and ownership durations. Moreover, many conservationists are uncomfortable calling a state-owned forest that is managed for timber, a managed resource protected area. However, if the land is permanently secured against conversion it may offer many implicit biodiversity values such as connectivity, that are important to the conservation of natural diversity, and thus it fits within the broader secured land definition. Because the IUCN and GAP/CMS systems share a common commitment to understanding, tracking and promoting land and water conservation, TNC is trying to maintain both systems, although only GAP status is used in this report. The IUCN protection categories can be loosely cross-walked to GAP status (Table 2).

Securement of Natural Features

A big question for biodiversity conservation is not only how much secured land exists but whether it is in the right places; this question is explored in detail in this report. Here we summarize (Table 3a and b) major patterns of securement and conversion for forests, wetlands, lakes and ponds, streams, unique habitats, open habitats, and species as explained in each individual chapter

Table 2. Crosswalk between IUCN and GAP status. IUCN descriptions are intentionally vague to allow flexibility for global application, therefore the crosswalk to the four GAP categories is ambiguous. The name of those categories and the approximate GAP equivalents are shown here

IUCN Category	Description	GAP status
I	Strict nature reserve/Wilderness area: protected area managed mainly for science or wilderness protection	1
Ia	Strict nature reserve: protected area managed mainly for science	1
Ib.	Wilderness Area: protected area managed mainly for wilderness protection	1
II.	National Park: protected area managed mainly for ecosystem protection and recreation	1 or 2
III.	Natural Monument: protected area managed mainly for conservation of specific natural features	1,2, or 3
IV.	Habitat/Species Management Area: protected area managed mainly for conservation through management intervention	1,2, or 3
V.	Protected Landscape/Seascape: protected area managed mainly for landscape/seascape conservation and recreation	3 or 4
VI.	Managed Resource Protected Area: protected area managed mainly for the sustainable use of natural ecosystems	1,2, or 3
VII.	Natural biotic area/anthropological reserve	2 or 3
VIII.	Multiple-use management area/managed resource area	3 or 4

Table 3a. Summary of conversion and securement across a variety of natural features. The table shows the percent of historic and current acres converted, the percent secured as GAP 1-3 or protected as GAP 1-2, and the ration of conversion to securement (CRI-S) or conversion to protection (CRI-P).

Forests	% Ag.	% Dev.	% GAP1-2	% GAP3	% Unsecured	Remaining Natural (acres)	Historic Total (acres)	% Converted	% Secured	CRI-S (%C/%S)	CRI-P (%C/%G1-2)
All Forests	19%	10%	5%	10%	56%	96,046,777	**134,656,652**	29%	15%	1.89	5.94
Mid-Atlantic	23%	11%	3%	9%	54%	49,300,927	**73,885,248**	33%	12%	2.67	11.13
NE and NY	15%	8%	7%	11%	59%	46,750,852	**60,771,405**	23%	18%	1.26	3.27
Forest Types											
Boreal Upland Forest	-	-	12%	18%	70%	**9,646,490**					
Northern Hardwood & Conifer	-	-	8%	16%	77%	**48,931,275**					
Central Oak-Pine	-	-	5%	12%	83%	**30,906,495**					
Plantation and Ruderal Forest	-	-	2%	9%	89%	**6,562,516**					
All remaining forest			7%	14%	79%	**96,046,777**					

Wetlands	% Ag.	% Dev.	% GAP1-2	% GAP3	% Unsecured	Remaining Natural (acres)	Historic Total (acres)	% Converted	% Secured	CRI-S (%C/%S)	CRI-P (%C/%G1-2)
All Wetlands	14%	11%	9%	10%	56%	8,422,366	**11,208,132**	25%	19%	1.32	2.74
Tidal	7%	13%	20%	13%	48%	1,429,638	**1,771,285**	19%	33%	0.58	0.95
Alluvial	16%	12%	6%	9%	58%	1,564,214	**2,154,107**	27%	15%	1.86	4.84
Basin	15%	10%	7%	9%	58%	5,428,514	**7,249,215**	25%	17%	1.51	3.40
Wetland Types											
Basin Swamp			10%	12%	78%	**4,967,799**					
Alluvial Swamp			7%	12%	80%	**1,358,464**					
Tidal Marsh			26%	18%	56%	**878,840**					
Tidal Swamp			24%	13%	63%	**550,800**					
Basin Marsh			8%	12%	80%	**460,715**					
Alluvial Marsh			10%	15%	75%	**205,750**					
All remaining wetland			12%	13%	75%	**8,422,368**					

Riparian Buffer zone	% Ag.	% Dev.	% GAP1-2	% GAP3	% Unsecured	Remaining Natural (acres)	Historic Total (acres)	% Converted	% Secured	CRI-S (%C/%S)	CRI-P (%C/%G1-2)
All riparian	17%	10%	5%	10%	58%	12,955,428	**17,747,162**	27%	14%	1.90	5.40
MA-Riparian	19%	12%	3%	9%	57%	7,006,550	**10,154,421**	31%	12%	2.50	10.33
NE-NY Riparian	14%	9%	6%	11%	60%	5,846,411	**7,592,741**	23%	17%	1.30	3.83
Stream Types											
Headwater	18%	9%	4%	10%	59%	6,019,311	**8,245,632**	26%	15%	1.80	6.50
Creek	16%	11%	5%	10%	58%	4,661,032	**6,384,975**	27%	15%	1.90	5.40
Small River	17%	14%	5%	8%	56%	1,189,542	**1,723,974**	31%	13%	2.40	6.20
Medium Tributary River	16%	14%	5%	8%	57%	568,891	**812,701**	30%	13%	2.40	6.00
Medium Mainstem River	15%	15%	4%	8%	58%	226,410	**323,443**	30%	12%	2.60	7.50
Large River	12%	20%	5%	8%	55%	110,039	**161,822**	32%	13%	2.40	6.40
Great River	12%	24%	7%	11%	46%	60,554	**94,616**	37%	18%	2.00	5.29

Lake & Pond Shorelines	% Ag.	% Dev.	% GAP1-2	% GAP3	% Unsecured	Remaining Natural (acres)	Historic Total (acres)	% Converted	% Secured	CRI-S (%C/%S)	CRI-P (%C/%G1-2)
Region Shoreline	11%	8%	10%	14%	57%	1,563,689	**1,933,985**	19%	24%	0.81	1.99
MA-shoreline	12%	15%	9%	9%	54%	448,991	**620,415**	28%	18%	1.50	2.95
NE-NY Shoreline	11%	4%	10%	16%	59%	1,114,698	**1,313,570**	15%	26%	0.58	1.55
Waterbody Types											
Ponds	15%	16%	7%	9%	54%	295,222	**424,531**	30%	16%	1.93	4.54
Small Lakes	12%	7%	10%	14%	56%	530,459	**658,977**	20%	24%	0.80	1.87
Medium Lakes	11%	4%	9%	16%	61%	353,300	**412,692**	14%	25%	0.58	1.60
Large Lakes	7%	2%	15%	17%	58%	251,695	**277,592**	9%	32%	0.29	0.60
Very Large Lakes	9%	8%	6%	16%	61%	133,013	**160,194**	17%	22%	0.78	3.04

Table 3b. Summary of conversion and securement across a variety of natural features. The table shows the percent of historic and current acres converted, the percent secured as GAP 1-3 or protected as GAP 1-2, and the ration of conversion to securement (CRI-S) or conversion to protection (CRI-P).

Geologic settings	% Ag.	% Dev.	% GAP1-2	% GAP3	% Unsecured	Remaining Natural (acres)	Historic Total (acres)	% Converted	% Secured	CRI-S (%C/%S)	CRI-P (%C/%G1-2)
Calcareous	39%	13%	1%	2%	45%	4,814,659	**10,081,655**	52%	3%	16.73	51.18
Coarse sediments	26%	17%	6%	5%	46%	10,019,798	**17,667,196**	43%	11%	3.98	7.63
Fine sediments	25%	13%	3%	4%	55%	5,756,230	**9,228,436**	38%	8%	4.91	11.36
Acidic shale	25%	9%	1%	7%	57%	12,072,928	**18,390,526**	34%	9%	3.98	29.29
Mod calcareous	21%	9%	2%	8%	61%	11,053,136	**15,640,399**	29%	10%	3.05	19.22
Ultramafic	18%	10%	5%	5%	62%	84,596	**118,028**	28%	10%	2.94	6.00
Mafic/intermediate	11%	8%	12%	11%	57%	5,806,669	**7,212,394**	19%	24%	0.82	1.58
Acidic sedimentary	12%	7%	4%	14%	63%	45,293,472	**55,967,531**	19%	18%	1.05	4.72
Acidic granitic	11%	7%	13%	12%	58%	17,826,146	**21,622,929**	18%	25%	0.71	1.40
All geology classes	18%	9%	5%	10%	58%	115,600,054	**158,805,382**	27%	15%	1.86	5.59

Elevation Zones	% Ag.	% Dev.	% GAP1-2	% GAP3	% Unsecured	Remaining Natural (acres)	Historic Total (acres)	% Converted	% Secured	CRI-S (%C/%S)	CRI-P (%C/%G1-2)
< 20'	12%	10%	6%	5%	66%	6,040,181	**7,759,868**	22%	11%	1.93	3.44
20-800'	24%	14%	2%	4%	55%	39,987,413	**64,881,968**	38%	7%	5.85	18.60
800-1700'	16%	6%	4%	11%	64%	44,174,524	**56,816,806**	22%	14%	1.56	6.06
1700-2500'	11%	3%	11%	21%	54%	19,205,744	**22,395,143**	14%	32%	0.45	1.25
2500-3600'	9%	3%	17%	22%	49%	5,502,051	**6,241,805**	12%	39%	0.31	0.68
> 3600'	1%	2%	24%	44%	29%	690,140	**709,792**	3%	68%	0.04	0.11
All elevation zones	18%	9%	5%	10%	58%	115,600,054	**158,805,382**	27%	15%	1.86	5.59

Landforms	% Ag.	% Dev.	% GAP1-2	% GAP3	% Unsecured	Remaining Natural (acres)	Historic Total (acres)	% Converted	% Secured	CRI-S (%C/%S)	CRI-P (%C/%G1-2)
Dry flats	35%	15%	2%	6%	42%	7,367,501	**14,575,877**	49%	8%	6.14	22.87
Gentle hill/valley	26%	13%	3%	8%	50%	35,396,616	**57,916,255**	39%	11%	3.62	13.70
Wet flats	15%	11%	7%	9%	58%	16,538,627	**22,282,244**	26%	16%	1.58	3.69
Sideslope	10%	5%	6%	13%	66%	38,899,790	**45,715,537**	15%	19%	0.77	2.35
Cove/footslope	6%	7%	8%	16%	63%	3,782,415	**4,327,911**	13%	25%	0.51	1.51
Summit/ridgetop	4%	1%	11%	17%	66%	2,898,911	**3,068,775**	6%	28%	0.20	0.52
Cliff/steep slope	0%	2%	12%	18%	67%	3,951,897	**4,048,329**	2%	30%	0.08	0.19
Open water* (omitted)	1%	1%	2%	2%	94%	6,764,299	**6,870,454**	2%	4%	0.36	0.85
All landforms	18%	9%	5%	10%	58%	115,600,054	**158,805,382**	27%	15%	1.86	5.59

Open Habitats	% Ag.	% Dev.	% GAP1-2	% GAP3	% Unsecured	Remaining Natural (acres)	Historic Total (acres)				
All open habitats			3%	9%	88%	6,695,840					
Mid-Atlantic			2%	9%	89%	2,761,492					
NE and NY			4%	10%	87%	3,934,348					

Species	Number of Species		% GAP1-2	% GAP3	% Unsecured	Number of secured occurrences	Number of total occurrences				
Mammals	9		12%	31%	58%	381	**899**				
Amphibians	15		24%	16%	60%	842	**2,099**				
Birds	74		21%	15%	64%	4,248	**11,849**				
Reptiles	9		9%	17%	74%	1,502	**5,825**				
Invertebrates	31		4%	12%	84%	275	**1,725**				
Fish	39		3%	11%	86%	80	**575**				

References

Please see the data sources (appendix A) and detailed methods(appendix B) sections of the main report for more information on the data sources and analysis methods used in this chapter.

Crist, P. J., B. Thompson, T. C. Edwards, C. J. Homer, and S. D. Bassett. 1998. Mapping and Categorizing Land Stewardship. A Handbook for Conducting Gap Analysis.

Hoekstra, J. M., Boucher, T.M., Ricketts, T.H., and C. Roberts. 2005. LETTERS: Confronting a biome crisis: Global disparities of habitat loss and protection. Ecology Letters **8**(1)**:**23-29.

Homer, C., C. Huang, L. Yang, B. Wylie and M. Coan. 2004. Development of a 2001 national land cover database for the United States. Photogrammetric Engineering and Remote Sensing.

The Nature Conservancy. 2009. Eastern U.S. Secured Lands. Various scales. Compiled from multiple sources.

Appendix 3-1

Shortened wording for definitions of GAP status

GAP 1: Permanent protection for biodiversity. Examples: Nature reserves; research natural areas; wilderness areas, Forever Wild easements.

GAP 2: Permanent protection to maintain a primarily natural state. Examples: National Wildlife Refuges; many state parks; high use National Parks.

GAP 3 Permanent protection for multiple uses, typically retaining natural cover but often subject to extractive uses such as logging. Examples: State or Town forest or Crown lands in Canada managed for timber; land protected from development by forest easements. GAP 3x referes to permanent protection where natural cover is removed (permanent farm easements, city parks).

GAP 4 Temporarily protected lands, or lands with no securement

If there is no practical way to contact each manager of every protected area to determine management practices, these assignments based on the designation can be used as a starting point, after first determining if the area has permanent protection or is not already developed. :

Status 1: National Park, National Monument, Wilderness Area, Nature Reserve/Preserve, Research Natural Area, Heritage areas

Status 2: State Parks, State Recreation Areas, National Wildlife Refuge, National Recreation Area, Area of Critical Environmental Concern, Wilderness Study Area, Forever Wild Conservation Easement, , National Seashore

Status 3: BLM Holdings, Military Reservations, National Forests, State Forest, Wildlife Management Areas, Game and Fish Preserves, , State Commemorative Area, Access Area, National Grassland, ACOE Holding. Private Land with Conservation Easement

Status 4: Private Land with no easements, Tribal Land, City Park, Undesignated State Land, County Land, City Land, Fish Hatcheries

Dichotomous key for assigning GAP protection status codes

A-1:
If the management intent can be determined through agency or institutional documentation GO TO A-2, if not, GO TO A-5

A-2:
If the land unit is subject to statutory or legally enforceable protection from conversion to anthropogenic use of all or selected biological features by state or federal legislation, regulation, private deed restriction, or conservation easement intended for permanent status, GO TO B-1; if not, GO TO A-3

A-3:
If ecological protection is not legally enforceable, temporary, or lacking but managed by a plan intended for permanent status, GO TO A-4; if not, GO TO A-5

A-4:

Management to benefit biological diversity is provided by a written plan in place or in process under an institutional policy requiring such management - Status 3

A-5:

Not subject to an adopted management plan or regulation that promotes biological diversity, or management intent is unknown - Status 4

B-1:

If the total system in the land unit is conserved for natural ecological function with no more than 5% of the land unit in anthropogenic use, GO TO B-4; if conservation provisions apply only to selected features or species, GO TO B-2

B-2:

If management emphasizes natural processes including allowing or mimicking natural ecological disturbance events, but also allows low anthropogenic disturbance, renewable resource use, or high levels of human visitation on more than 5% of the land unit - Status 2; if not, GO TO B-3

B-3:

Management allows intensive, anthropogenic disturbance such as resource extraction, military exercises, or developed or motorized recreation on more than 5% of the land unit, but includes ecological management for select features - Status 3

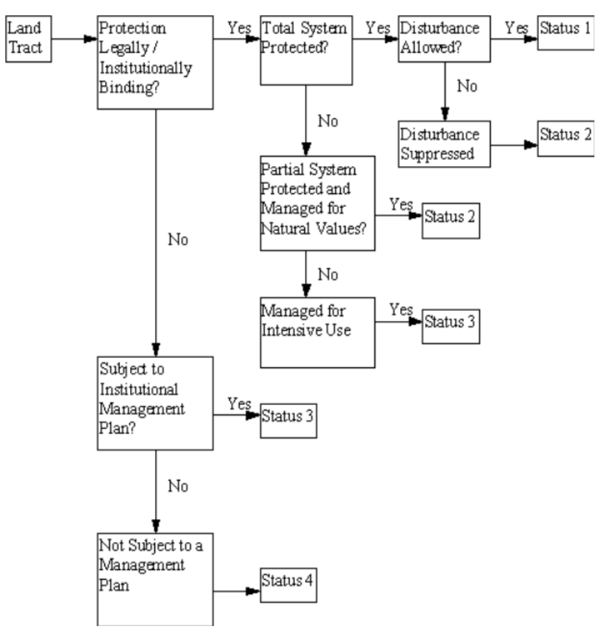
B-4:

If management strives for natural processes including allowing or mimicking natural ecological disturbance events - Status 1; if not, GO TO B-5

B-5:

Managed for natural processes, but some or all disturbance events are suppressed or modified - Status 2

Dichotomous key for assigning GAP protection status codes



Appendix 3-2. The Nature Conservancy's Secured Lands Data Sources:

MAINE

Overview: The Maine Conservation Lands Geodatabase is maintained and updated by the Maine Chapter of The Nature Conservancy. It includes most of the state, federal, and larger private conservation lands with legal protection in the state of Maine. It is however, not a complete picture of conservation in the state. Maine is home to many small land trusts, and much of their protection work is not captured in this dataset. TNC in Maine is working with both state agencies and land trusts to improve comprehensive updating and the overall content of this dataset. The spatial data is compiled from over 300 different data sources and are from a variety of scales, ranging from 1:100,000 scale to high-accuracy digital surveys. In general the polygons representing TNC-owned or managed lands are most accurate.
Download: None
Contact Information: Dan Cooker (dcooker@tnc.org), The Nature Conservancy of Maine.
Lead Agency: The Nature Conservancy of Maine
Last Updated: Major updates in 2003, Continuous updates since.

NEW HAMPSHIRE

Overview: In 2009 NH GRANIT and the New Hampshire Chapter of The Nature Conservancy completed a substantive update to New Hampshire's Conservation/Public Lands Data Layer. The update was completed through extensive outreach to federal and state agencies, municipalities, and state and regional land trusts. This data layer includes public lands, protected lands, and institutional lands that are undeveloped and are likely to stay that way, but that have no legal form of protection. Land owners of properties within the data layer includes federal, state, county, and municipal governments; land trusts and private land owners.
Download: http://www.granit.unh.edu/data/downloadfreedata/category/databycategory.html
Lead Agency: New Hampshire Geographically Referenced Analysis and Information Transfer System (NH GRANIT)
Last Updated: April 2010

Overview: The NH GRANIT data is missing protection level (GAP Status) for the US Forest Service land in the White Mountains of New Hampshire. This information is added to the regional secured lands layer from a 2009 US Forest Service Management Areas shapefile.
Download: www.fs.fed.us/r9/white/
Lead Agency: US Forest Service
Last Updated: 2009

VERMONT

Overview: The Vermont Conservation Lands Database is a project of the Spatial Analysis Laboratory (SAL) at the University of Vermont working in cooperation with the Vermont Agency of Natural Resources, the Vermont Housing and Conservation Board, the Vermont Land Trust, The Nature Conservancy, the Green Mountain National Forest, regional planning commissions, and community land trusts throughout the state. This year the dataset includes a specially funded update of Town Lands. There are many secured areas that continue to go unmapped or mapped incorrectly in this dataset. Apparently state lands are in great need of update. Many state lands have not been updated since 2004.
Download: http://www.uvm.edu/~envnr/sal/vtcons.html
Lead Agency: Spatial Analysis Laboratory (SAL) at the University of Vermont
Last Updated: 2010 for town lands, for most other lands 2004

Overview: The Vermont Land Trust (VLT) has helped landowners in communities throughout Vermont, to permanently protect more than 483,000 acres -- 8 percent of Vermont's privately-owned land. They keep their own GIS record of their lands as well as many other privately protected lands in Vermont and update it continuously. This is the most up-to-date source of conservation land in Vermont.
Download: Not Available
Lead Agency: Vermont Land Trust
Last Updated: 2010

Overview: The Nature Conservancy of Vermont keeps their own database of properties that they have an interest in (fee, easement, or assist).
Download: Not Available
Lead Agency: The Nature Conservancy of Vermont
Last Updated: 2010

MASSACHUSETTS

Overview: Executive Office of Energy and Environmental Affairs, Office of Geographic and Environmental Information (MassGIS) Protected and Recreational Open Space datalayer. This layer contains the boundaries of conservation lands *and* outdoor recreational facilities in Massachusetts. The associated database contains relevant information about each parcel, including ownership, level of protection, public accessibility, assessor's map and lot numbers, and related legal interests held on the land, including conservation restrictions. Conservation and outdoor recreational facilities owned by federal, state, county, municipal, and nonprofit enterprises are included in this datalayer. Not all lands in this layer are protected in perpetuity, though nearly all have at least some level of protection.
Download: http://www.mass.gov/mgis/osp.htm
Lead Agency: MassGIS
Last Updated: Updated Continuously – Accessed 2/2010

RHODE ISLAND

Overview: Local & NGO Conservation and Park Lands layer contains Non-State Conservation lands are real property permanently protected from future development by recognized land protection organizations other than the State of Rhode Island.
Download: http://www.edc.uri.edu/RIGIS/spfdata/environment/LocCons10.zip
Lead Agency: The State of Rhode Island Department of Environmental Management.
Last Updated: April 2010

Overview: State Conservation and Park Lands layer contains approximate edges of Conservation Lands protected by the State of Rhode Island through Fee Title Ownership, Conservation Easement, or Deed Restriction.
Download: http://www.edc.uri.edu/RIGIS/spfdata/environment/LocCons10.zip
Lead Agency: The State of Rhode Island Department of Environmental Management.
Last Updated: April 2010

CONNECTICUT

Overview: Protected Open Space Phase 1 is a 1:12,000-scale layer that depicts parcels designated as permanently protected open space by the Connecticut Department of Environmental Protection (CTDEP) in the area of Connecticut (CT) that comprises Phase 1 of the CTDEP Protected Open Space Map (CT POSM) Project. The CTDEP defines permanently protected open space as "(1) Land or interest in land acquired for the permanent protection of natural features of the state's landscape or essential habitat for endangered or threatened species; or (2) Land or an interest in land acquired to permanently support and sustain non facility-based outdoor recreations, forestry and fishery activities, or other wildlife or natural resource conservation or preservation activities." Phase 1 is comprised of CT towns bordering the coast and the Thames River. After joining to the Protected Open Space Phase 1 Data table using the parcel ID, use this layer to, for example, display open space parcels by open space type or official name, compare current open space (as of the date of town hall data collection) to older open space data sources, or analyze the ratio of open space to developed or developable land in a particular Phase 1 town or region.
Download: http://www.ct.gov/dep/cwp/view.asp?a=2698&q=322898&depNav_GID=1707
Lead Agency: State of Connecticut Department of Environmental Protection
Last Updated: 2005

Overview: This layer includes polygon features that depict protected open space for towns included in Phase 2 (non-coastal towns) of the Protected Open Space Mapping (POSM) project. Only parcels that meet the criteria of protected open space as defined in the POSM project are in this layer. Protected open space is defined as:
(1) Land or interest in land acquired for the permanent protection of natural features of the state's landscape or essential habitat for endangered or threatened species; or

(2) Land or an interest in land acquired to permanently support and sustain non-facility-based outdoor recreation, forestry and fishery activities, or other wildlife or natural resource conservation or preservation activities.
The most non-coastal towns were involved in Phase 2 of the POSM project.
This information is based on data from various sources collected and compiled during the period from March 2005 through the present. These sources include municipal Assessor's records (the Assessor's database, hard copy maps and deeds) and existing digital parcel data. The layer represents conditions on the date of research at each city or town hall. The Protected Open Space layer includes the parcel shape (geometry), a project-specific parcel ID based on the Town and Town Assessor's lot numbering system, and system-defined (automatically generated) fields.
Download: http://www.ct.gov/dep/cwp/view.asp?a=2698&q=322898&depNav_GID=1707
Lead Agency: State of Connecticut Department of Environmental Protection
Last Updated: 2005 – Present

Overview: The Nature Conservancy of Connecticut keeps their own database of properties that they have an interest in (fee, easement, or assist).
Download: Not Available
Lead Agency: The Nature Conservancy of Connecticut
Last Updated: 2008

Several Towns were not included in the POSM project due to a lack of data. For these towns we used Secured Lands information from 2008. These data sources were:
Overview: Municipal and Private Open Space - This is a 1:24,000-scale datalayer of property owned by Connecticut municipalities and private organizations for the purpose of preserving open space. It is a polygon Shapefile that primarily includes land conservation trust property, town open space, parks, school playgrounds, campgrounds, golf courses, club and association recreational property, and cemeteries.
Download: http://www.ct.gov/dep/cwp/view.asp?a=2698&q=323108&depNav_GID=1707
Lead Agency: Connecticut Office of Policy and Management
Connecticut DEP, Office of Information Management
Last Updated: This information is not complete and is out of date. The property boundaries have not been field checked or verified with surveys. This information has not been updated or corrected by DEP or OPM since about 1997.

Overview: DEP Property - This is polygon Shapefile that includes state owned fish hatcheries, flood control areas, historic preserves, natural area preserves, state forests, state parks, state park scenic reserves, state park trails, state owned waterbody access, wildlife areas, and wildlife sanctuaries.
Download: http://www.ct.gov/dep/cwp/view.asp?a=2698&q=323104&depNav_GID=1707
Lead Agency: Connecticut Department of Environmental Protection.
Last Updated: The data was originally published in 2002 and is updated monthly or as new properties are acquired.

NEW YORK

Overview: This data layer combines the most current known parcels of land in New York state that have some level of protection and/or management taking place. Data was compiled from several data sources which include New York DEC, New York DEP, New York OPRHP, New York State Civil and Public Boundaries, TNC survey information, and local land trusts. An effort was made to delete overlapping polygons where more than one dataset contained the same data. Data that was deemed the most accurate and representative of the fee owner was chosen during this selection/deletion process. Overlapping polygons due to disparate data sources were reconciled where there was major overlap. Smaller overlaps including sliver polygons were not edited.
Sources:
NYS Parks and Historic Sites Boundaries, NY OPRHP, 2008
NYSDEC Division of Lands & Forests, 2008
NYC DEP Property - Division of Lands & Forests, GIS 2008, Polygon coverage locating the boundaries of state lands under the jurisdiction of DEC throughout the state
NYC DEP, 2008, NYC DEP property
Land Trust data
Open Space Institute
Albany County Land Conservancy
Agricultural Stewardship Association

Finger Lakes Land Trust
Lake George Land Conservancy
Hudson Highlands Land Trust
Rondout Esopus Land Conservancy
Wallkill Valley Land Trust, Inc.
Shawangunk Conservancy
Genesee Land Trust
Scenic Hudson, Inc.
Tug Hill Tomorrow Land Trust
Mohonk Preserve
Saratoga PLAN

PENNSYLVANIA

Overview: To our knowledge, The Nature Conservancy is the only entity in Pennsylvania that is currently maintaining a database of managed lands in the state. The Pennsylvania office of The Nature Conservancy compiled the base of the current dataset in 2006 from the following sources:
(1) 2004 Protected Lands Inventory produced by The Conservation Fund (TCF) – TCF was awarded a grant by the Pennsylvania Department of Conservation and Natural Resources to create a spatial database of managed lands for Pennsylvania. However, the resulting inventory was incomplete, and data were collected inconsistently across the state. As of September 2008, no updates to this database are planned either by state agencies or by TCF.
(2) 1998 GAP Managed Lands dataset from the statewide GAP analysis,
(3) data from federal, state, and local governments, and
(4) data from regional and local land trusts.
For the original base dataset, the Pennsylvania Chapter of TNC cleaned up and added information to the original compilation. In each year since this original compilation, the database is maintained and updated, using information collected from federal and state agencies, local governments, regional and local land trusts, etc.

Source A: Protected Lands Inventory: Federal Lands; Nonprofit and Private Lands - These data layers depict a subset of protected lands information for the Commonwealth of Pennsylvania. Data were collected from the 1998 PA GAP Analysis Program's Managed Lands data layer as well as from hard copy and digital data provided by land trusts and local governments.
Download: PASDA website www.pasda.psu.edu
Lead Organization: The Conservation Fund
Last Updated: November 2004

Source B: Pennsylvania State Game Lands
Download: PASDA website www.pasda.psu.edu
Lead Agency: Pennsylvania Game Commission
Last Updated: July 2009

Source C: Pennsylvania Department of Conservation and Natural Resources – State Forest, and State Parks –
Lead Agency: Pennsylvania Department of Conservation and Natural Resources, Bureau of Forestry
Contact: Bureau of Forestry, Greg McPherson
Date Acquired: 2006
Last Updated: September 2009

Source D: Boundaries of State Parks in Pennsylvania 2008
Lead Agency: Pennsylvania Department of Conservation and Natural Resources, Bureau of State Parks
Download: PASDA website (www.pasda.psu.edu)
Publication Date: 2008

Source E: County Parcel Data (basis for TNC fee and eased lands polygons)
Date Acquired: Chester County (2001), Clinton County (2003), Elk County (2005), Juniata County (2007), Lancaster County (2001), Monroe County (2009), Northampton County (2007), Pike County (2005), Venango County (2004), Wayne County (2003)

Source F: Lands owned and eased by the Western Pennsylvania Conservancy
Lead Organization: Western Pennsylvania Conservancy
Date Acquired: October 2009
Last Updated: October 2009

Source G: Northeast Pennsylvania Protected Lands Inventory – A number of local NGOs in that area of the state submit biyearly updated protected lands datasets to the Natural Lands Trust, which in turn shares a compiled dataset with all participating NGOs.
Lead Organization: Natural Lands Trust
Participating Organizations: Countryside Conservancy, Delaware Highlands Conservancy, Lackawanna Valley Conservancy, North Branch Land Trust, Pocono Heritage Land Trust, Wildlands Conservancy
Date Acquired: July 2009
Last Updated: July 2009
Contact: Natural Lands Trust, Megan Boatright (mboatright@natlands.org)

Source F: Lands owned by Pennsylvania Fish and Boat Commission
Lead Organization: Pennsylvania Fish and Boat Commission
Date Acquired: July 2009
Last Updated: July 2009

NEW JERSEY

Overview: Power Company properties that TNC manages
Download or contact: Not Available
Lead Agency: PSEG
Last update: Last edit date 05/17/2007.

Overview: Green Acres Program - this was the source of three shapefiles, one of all of the state-owned conservation easements, one of all state-owned lands, and one that Green Acres tracks of all local (county/mun) and non-profit lands they know of in NJ.
Download: Not Available - These are obtained these by e-mail request from Sharon Cost and John Thomas annually
Lead Agency: NJDEP
Last Updated: Current through January 2010

Overview: Farmland Preservation File
Download: http://www.state.nj.us/agriculture/sadc/farmprogress.htm
Lead Agency: New Jersey Department of Agriculture (NJDA) and State Agriculture Development Committee (SADC),
Last updated: published 07/02/2007

DELWARE

Overview: Conservation Easements (2008): This polygon coverage geographically indicates those lands that are preserved under the designation of Conservation Easement. These lands may be protected under other designations as well. For more information on Conservation Easements, contact the Lands Preservation Office at 302-739-9235
Download: none available. Contact: Krumrine Michael L. (DNREC) [Michael.Krumrine@state.de.us]
Lead Agency: DNREC Division of Parks and Recreation
Last Updated: 2008

Overview: Nature Preserves (2008): This polygon coverage geographically indicates those lands that are preserved under the designation of Nature Preserve. These lands may be part of other protected lands under other designation. The key characteristic is that these lands are dedicated Nature Preserves
Download: none available. Contact: Krumrine Michael L. (DNREC) [Michael.Krumrine@state.de.us]
Lead Agency: DNREC Division of Parks and Recreation
Last Updated: 2008

Overview: ORI (2008): The Outdoor Recreation Inventory (ORI) was originally created to track publicly owned lands within Delaware that are open for public recreation. The database has since been expanded to include all publicly owned lands (Federal, State, County, Municipal, and private conservation lands) regardless of whether or not they are open to the public.
Download: none available. Contact: Krumrine Michael L. (DNREC) [Michael.Krumrine@state.de.us]
Lead Agency: DNREC Division of Parks and Recreation
Last Updated: 2008

Overview: Forestry Easements
Download: None Available Contact: Glenn.Gladders@state.de.us
Lead Agency: Delaware Forest Service

Overview: Delaware Department of Agriculture – State Agriculture easements
http://66.173.241.168/dda/downloads.html

MARYLAND

Overview: Agricultural Land Preservation Foundation Easements/Districts (MALPF) -
The Maryland Agricultural Land Preservation Foundation (MALPF), housed within the Maryland Department of Agriculture (MDA), protects agricultural lands through the use of perpetual easements. This program was created by the Maryland General Assembly in 1977, is governed by the Agricultural Article, Sections 2-515 through 2-516 of the Annotated Code of Maryland. Described briefly, the process begins with an interested, qualified landowner voluntarily creating a district, containing one or more tracts of land. Easements may then be donated or purchased, protecting in perpetuity the land for agricultural purposes. There is a formal process for obtaining these designations, including the Maryland Board of Public Works approval. These data are intended for general guidance and use only.
Download: http://dnrweb.dnr.state.md.us/gis/data/data.asp
Lead Agency: Maryland Department of Agriculture
Last Updated: 10/4/2006

Overview: County Parks - The County Owned Properties data consists of land areas that are run and maintained by county and municipal authorities.
Download: http://dnrweb.dnr.state.md.us/gis/data/data.asp
Lead Agency: MD DNR
Last Updated: 9/26/2007

Overview: DNR Lands - The Maryland Department of Natural Resources (DNR) manages over 446,000 acres of public lands and protected open space in the state. The DNR Lands data consists of mapped information that represent those lands that are owned by the Maryland Department of Natural Resources.
Download: http://dnrweb.dnr.state.md.us/gis/data/data.asp
Lead Agency: MD DNR
Last Updated: 10/5/2009

Overview: Environmental Trust Easements (MET) - The Maryland Environmental Trust (MET) is a statewide local land trust governed by a citizen Board of Trustees. Since its creation by the General Assembly in 1967, MET's main goal is the preservation of open land, such as farmland, forest land, and significant natural resources. The primary tool for doing this is the conservation easement, a voluntary agreement between a landowner and the MET Board of Trustees.
Download: http://dnrweb.dnr.state.md.us/gis/data/data.asp
Lend Agency: Maryland Environmental Trust
Last Updated: 11/30/2009

Overview: Federal Lands - The Federal Lands data consists of land areas that are run and maintained by U.S. Governmental authorities.
Download: http://dnrweb.dnr.state.md.us/gis/data/data.asp
Lead Agency: MD DNR
Last Updated: 10/4/2006

Overview: Forest Legacy Easements - The program is designed to identify and protect environmentally important forest lands through the use of perpetual conservation easements between willing sellers and willing buyers. Only private forest land in a Forest Legacy Area is eligible for the program. Landowners who are willing to sell their development rights are encouraged to apply during a sign-up period. At the end of a sign-up period, all applications will be evaluated and ranked. The highest ranked applications will enter the acquisition process. If negotiations produce acceptable easement terms, the easement will be acquired and recorded in the land records. If they do not produce acceptable terms, eminent domain will NOT be used. The number of parcels accepted for acquisition will depend on the funding available and the estimated value of the parcels selected.
Download: http://dnrweb.dnr.state.md.us/gis/data/data.asp
Lead Agency: MD DNR
Last Updated: 10/1/2009

Overview: Private Conservation Properties - The Private Conservation data layer is a collection of properties that are protected from development by ownership of a Private Conservation group or Society.
Download: http://dnrweb.dnr.state.md.us/gis/data/data.asp
Lead Agency: MD DNR
Last Updated: 2/25/2009

Overview: Rural Legacy Properties - In 1997, the Maryland General Assembly approved the Rural Legacy Program as a major component of Governor Glendening's Smart Growth and Neighborhood Conservation Initiative. The purpose of the Rural Legacy Program is to protect Maryland's best remaining rural landscapes and natural areas through the purchase of land or conservation easements. Funds are awarded by grants to sponsors to purchase fee simple interests or easements on property within a Rural Legacy Area. This file consists of properties that have been protected using Rural Legacy funds.
Download: http://dnrweb.dnr.state.md.us/gis/data/data.asp
Lead Agency: MD DNR
Last Updated: 10/1/2009

Other MD Data: Charles County govt (TDR easements), Conservancy for Charles County (CCC easements), the MD Dept of Planning.

WEST VIRGINIA

WMA_Property_Boundaries_DNRSDE_101013
Overview: In West Virginia the WV DNR has a public lands database that is continually maintained and updated. It includes all Wildlife Management Areas, some federal lands, and known private inholdings.
Lead Agency: West Virginia Department of Natural Resources
Date Accessed for our dataset: 10/13/2010
Last Updated: updated continuously
Contact: Michael Dougherty (michaeldougherty@wvdnr.gov)

WVPublicLands_DNRSDE_101013
Overview: In West Virginia the WV DNR has a public lands database that is continually maintained and updated. It includes all state-owned land, some federal lands, and known private inholdings.
Lead Agency: West Virginia Department of Natural Resources
Date Accessed for our dataset: 10/13/2010
Last Updated: not available
Contact and Download: Michael Dougherty (michaeldougherty@wvdnr.gov)

WVFO GIS layer
Overview: The Nature Conservancy of West Virginia keeps their own database of properties that they have an interest in (fee, easement, management agreement, transfer, or assist).
Download: Not Available
Lead Agency: The Nature Conservancy of West Virginia
Contact Person: Ruth Thornton (rthornton@tnc.org)
Last Updated: 2010

VIRGINIA

Overview: In Virginia there is a conservation lands database that is continually maintained and updated by the state Department of Conservation & Recreation. It includes all state and federal lands and many local and private conservation lands. Local and regional parks are included where digital data exist for these features but such data is not comprehensive statewide. Similarly, many non-profit and land trust holdings and easements are included where they are available digitally but comprehensive statewide data for these features is not available. Local and private conservation lands are added as they become available.
Lead Agency: Virginia Department of Conservation & Recreation
Date Accessed for our dataset: 3/18/10
Last Updated: updated continuously
Contact and Download: David Boyd (David.Boyd@dcr.virginia.gov)
http://www.dcr.virginia.gov/natural_heritage/cldownload.shtml

CHAPTER

4

Eastern Forests

Condition and Conservation Status

April 2011

M. Anderson & A. Olivero Sheldon

From the sturdy oak and hickory slopes of the Central Appalachians to the pungent spruce flats of northern New England, forests define the eastern landscape. Although trees give a feel of permanence to the land, the forests of the east have been in continual change for centuries. In this chapter we look at the state of our forests, their age, condition, fragmentation, conservation, and at the abundance trends of forest dwelling birds.

Summary of Findings

Distribution, Loss, and Protection: Ninety-one percent of the region was once covered by forests; almost one-third of that, 39 million acres, has been converted to agriculture or development. Of the remaining 96 million acres, conservation efforts have secured 28 percent. Conservation has not been spread evenly across forest types; upland boreal forests are 30 percent secured, while oak-pine forests are only 17 percent secured. A smaller percentage of land is protected explicitly for nature conservation: upland boreal forest 12 percent, northern hardwood forest 8 percent, and oak-pine forest 5 percent. Across the entire region, conversion exceeds protection 6:1

Fragmentation: Forests in the region are highly fragmented by 732,000 miles of permanent roads, enough to loop the equator 29 times. On average, 43 percent of the forest occurs in blocks less than 5,000 acres in size that are encircled by major roads, resulting in an almost 60 percent loss of connectivity. Oak-pine forests are the most fragmented type. Judging from current patterns, securement has been an effective strategy for preventing fragmentation, as there is a high proportion of secured land within most of the remaining large contiguous blocks.

Age and Size Structure: No matter what the forest type, forests in the region average only 60 years old and are overwhelmingly composed of small trees 6” to 7” in diameter. Upland boreal forests are the most heavily logged, and they differ from the other types in having the majority of trees in the 2” to 3” diameter size class. Out of 6,952 forest samples collected in this region by the US Forest Inventory and Analysis program, no forest stands were dominated by old trees or had the majority of their canopy composed of trees over 20” in diameter.

Trends in Forest Birds: There have been substantial changes in forest bird abundances over the last 40 years including both increases and declines. Species abundance changes were correlated with degree of fragmentation, with the road heavy oak-pine forests showing declines in 11 species and increases in 10 species, the latter mostly being birds that tolerate edge habitat. Changes in boreal birds were less extensive suggesting that logging has not had as obvious an effect on bird abundance as fragmentation, but this pattern needs more research to confirm.

Forest Types

Ecologists recognize four major forest types in this region and 30-40 variations related to latitude and setting. We used the LANDFIRE (2009) map of existing vegetation to quantify the abundance of each type.

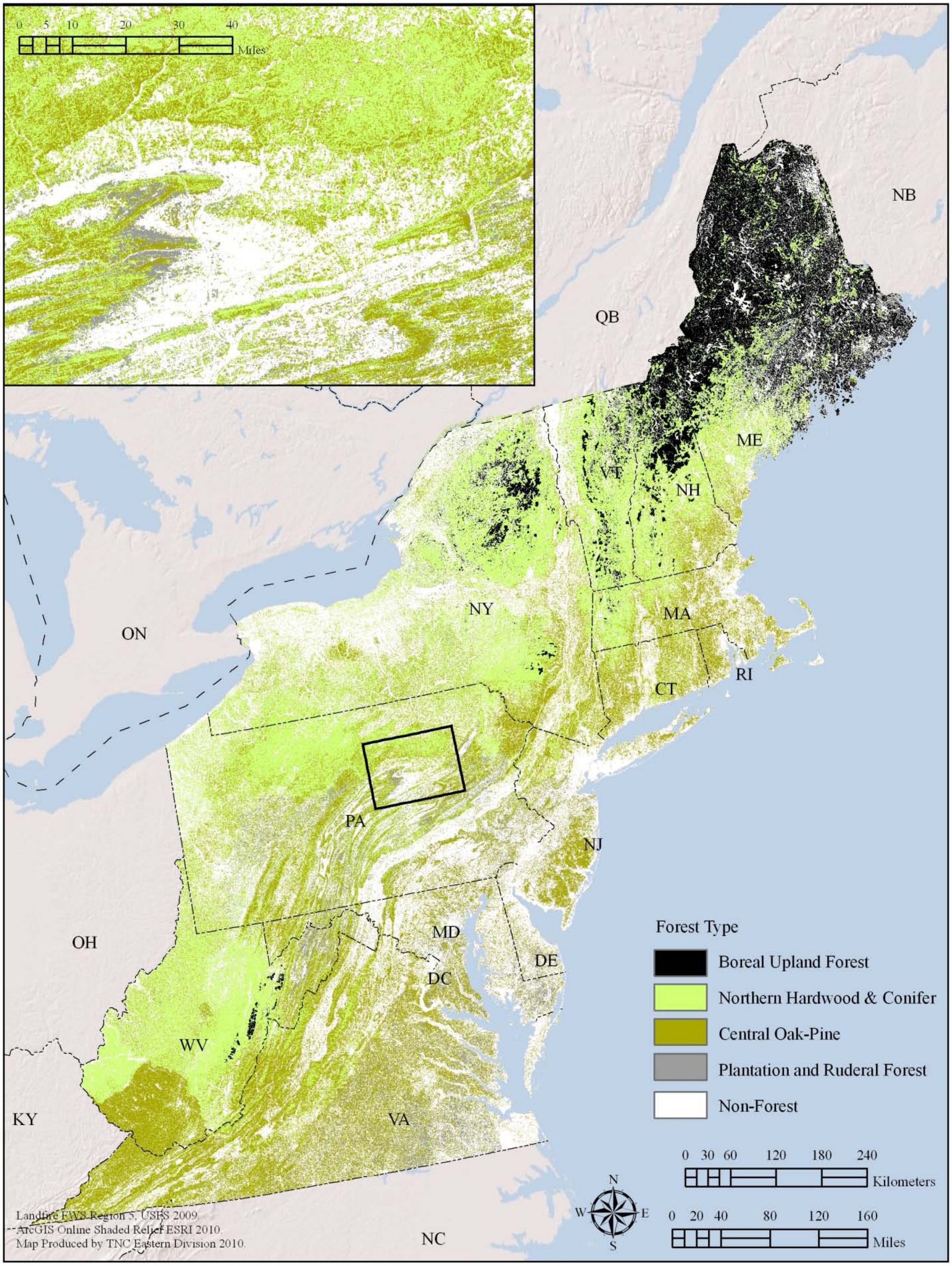
Northern Hardwood and Conifer Forest: This heterogeneous forest type is typical of mesic settings and was the most common forest of the region, covering 51 percent of the region (48.9 million acres) and occurring throughout (Map 1). It is a deciduous or mixed forest dominated by sugar maple, American beech, and yellow birch (i.e. hardwoods other than oaks and hickories). Conifers, when present, include white pine, eastern hemlock, or red spruce. Other deciduous associates include: red maple, white ash, paper birch, red oak, American basswood, and tuliptree. Mixed forests are often dominated by some combination of hemlock with sugar maple, and tend to occur in moist ravines or north slopes. In the southern portion of the region, examples in coves or protected settings may include the characteristic trees: cucumber-tree, mountain magnolia, umbrella-tree, yellow buckeye, and mountain silverbell, and a diverse herb layer with blue cohosh, black bugbane, American ginseng, and northern maidenhair.

Central Oak-Pine Forest: This forest type was most common in the southern portion of the region, covering 32 percent of the region (30.9 million acres, Map 1). Oaks and pines are the characteristic species of these dry forests that typically have a well developed understory and a full or discontinuous canopy. Dominant trees include eastern white pine, pitch pine, or red pine with chestnut oak, northern red oak, and/or bear oak. Early-successional examples are often more strongly pine-dominated with oaks and hickories increasing over time or sometimes the pines are absent and oaks, hop hornbeam, or sugar maple dominate. Dry acidic places, such as exposed ridges and plateaus, often have heath shrub layers and abundant chestnut oak. On more mesic sites, chestnut oak is less important than northern red oak, white oak, black oak, and/or scarlet oak; mockernut hickory, shagbark hickory, and/or red hickory may be common associates.

Boreal Upland Forest: This forest type covered 10 percent of the region (9.6 million acres) and was largely restricted to the northern states or high elevation settings (Map 1). The characteristic trees of this forest type are spruce and fir, with conifer cover generally exceeding that of deciduous trees. In mountain settings, yellow birch often shares the canopy over an understory of mountain-ash, woodfern, and other montane species. Red spruce and balsam fir and occasionally jack pine are the dominant conifers in valley settings with hardwoods associates such as yellow birch, paper birch, or American beech. Black spruce is often characteristic on imperfectly drained flat soils.

Ruderal and Plantation Forest: This is a forest type dominated by early-successional trees such as red maple, paper birch, loblolly pine, Virginia pine, bigtooth, or quaking aspen, etc., without a strong component of oak, hickory, or other hardwoods. Essentially this forest is comprised of combinations of short-lived, light-requiring trees, and it develops on land reverting from being cleared, plowed, or grazed. Plantations are identified by trees apparently in rows, or having other evidence of intentional planting by humans. Ruderal forest comprised 7 percent of the region (6.5 million acres, Map 1).

Map 1. Region forest types.



Distribution, Loss, and Protection Status

Forest currently covers 62 percent of the region's land area: 96 million acres. Northern hardwood is the most common forest type, followed by central oak-pine, boreal upland, and ruderal (Map 1, LANDFIRE 2009). The northern region differs substantially in composition from the south; New England and New York forests are 61 percent northern hardwoods, 20 percent boreal forest, and 16 percent central oak-pine, the latter largely restricted to lowlands. In contrast, Mid-Atlantic forests are 48 percent central oak pine, 42 percent northern hardwoods and 10 percent ruderal forest, with a tiny amount of boreal forest occurring in the extreme mountainous areas.

Forest clearing and conversion in this region undoubtedly dates back to the earliest human inhabitants. To quantify forest conversion, we overlaid the National Land Cover Data (Homer et al. 2004) on a regional map of landforms and tabulated the amount of conversion on all topographic settings where forest naturally occur (e.g. all landforms except open water, cliff, ridge and a portion of wet flats –see data sources). The results of this analysis suggest that 38.6 million acres, or 29 percent of all historic forest, have been transformed. Mostly, this land is now used for agriculture (19 percent), however, 13 million acres (10 percent of the region) has been permanently converted to development (Figure 1). A larger percentage of forest in the Mid-Atlantic has been converted than in New England/New York, again mostly to agriculture (Figure 1).

The region also has a long history of public and private conservation. To measure the amount of forest securement in the region, we overlaid the TNC secured lands dataset on the map of existing forest types. The results show that 20 million acres of forest were secured against conversion, including 6.5 million acres of forest protected primarily for nature conservation and 13.9 million acres secured for multiple uses, such as forest management (Figure 2, Map 2). Most of the secured forest was the northern hardwood type, amounting to 11.4 million acres (Figure 2). Boreal forests had the highest proportion of conservation land with 30 percent of the forest type secured, but the lowest actual acres: 2.8 million. Central oak-pine, at 17 percent secured, had proportionally the least conservation, although the land amounted to 5.3 million acres. Central oak-pine forest also had the lowest percentage of land protected explicitly for biodiversity, while upland boreal forest had the most (5 and 12 percent respectively). Northern Hardwood forests were 23 percent secured and 8 percent protected.

Conservation Land Terminology

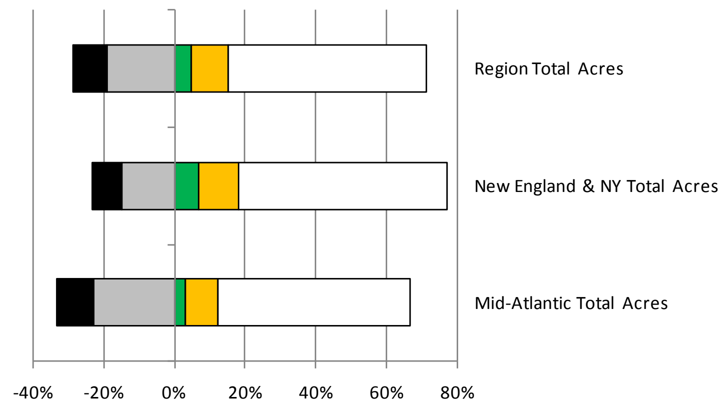
Secured (GAP 1-3): The land is permanently secured against conversion to development.

Protected (GAP 1 or 2): The land is secured AND the intent of the management is primarily for nature conservation or natural processes

Secured for Multiple Uses (GAP 3): The land is secured AND the intent of the management is for multiple uses, including forest management. This land may provide implicit conservation value such as connectivity or providing stream buffers.

Contrasting the 20 million acres of secured land with amount of converted land showed that conversion exceeds securement roughly 2:1, ranging from 1:1 in New England and New York, to 3:1 in the Mid–Atlantic states (Table 1). The discrepancy between conservation and conversion, and the gap between the two sub-regions, was much greater when applied solely to lands protected explicitly for nature: conversion exceeds protection 11:1 in the Mid-Atlantic, 3:1 in New England and New York, and 6:1 across the whole region.

Figure 1. Estimates of forest conversion to agriculture or development compared with the current status of forest securement. Securement is defined as forest land permanently secured against conversion to development and either protected for nature conservation (GAP 1 or 2) or intended for multiple uses (GAP 3). Each bar represents 100% of the historic forest area. Area to the left of the "0" axis indicates acreage lost to development or agriculture. Area to the right of the "0" axis indicates the conservation status of the land remaining as forest.



	Mid-Atlantic Total Acres	New England & NY Total Acres	Region Total Acres
Agriculture	-16,713,502	-8,943,989	-25,657,490
Developed	-7,870,818	-5,076,564	-12,947,383
GAP 1 or 2	2,208,800	4,291,556	6,500,356
GAP 3	7,009,064	6,864,801	13,873,865
Unprotected	40,083,064	35,594,494	75,677,558

Figure 2. Percent of forest acres secured by forest type. Securement is defined as forest land permanently secured against conversion to development and either intended for nature conservation (GAP 1 or 2) or intended for multiple uses such as forest management (GAP 3).

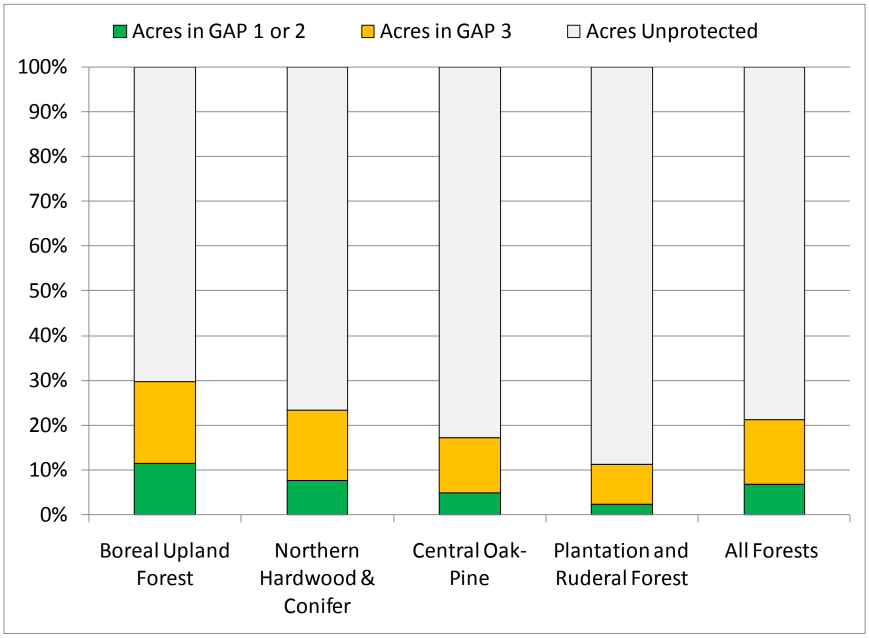
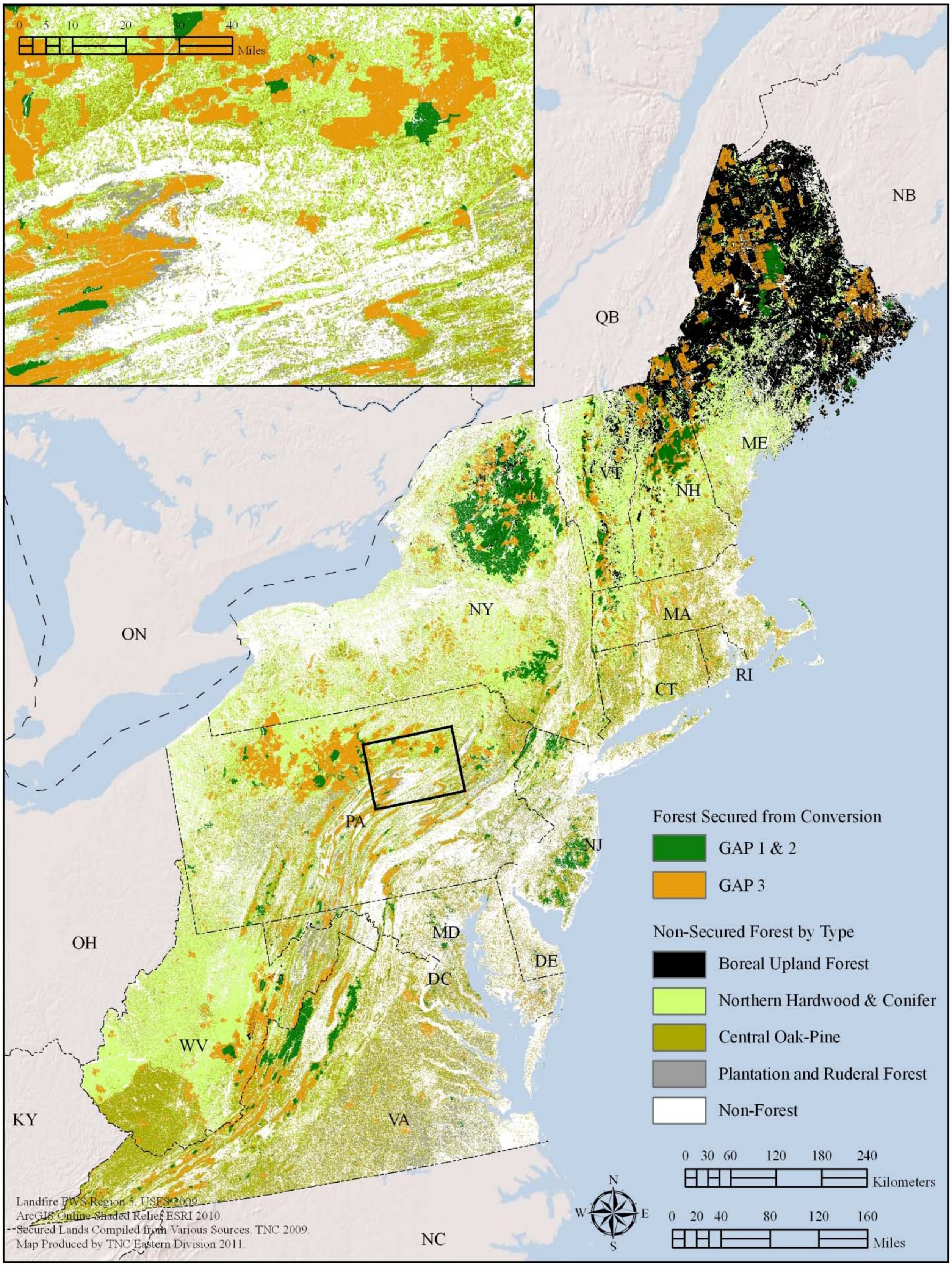


Table 1. Acres of forest by secured land status, forest type and sub-region. % C is the percent converted and % S is the percent secured. CRI-S is the ratio of conversion to securement and CRI-P is the ratio of conversion to protection. The percent conversion was not available by forest type.

Geography	Forest Type	Acres in GAP 1 or 2	Acres in GAP 3	Acres Un-protected	Total Acres	% C	% S	CRI-S	CRI-P
Region	Boreal Upland Forest	1,111,849	1,763,714	6,770,927	9,646,490				
	Northern Hardwood & Conifer	3,749,378	7,665,244	37,516,653	48,931,275				
	Central Oak-Pine	1,479,577	3,861,594	25,565,324	30,906,495				
	Plantation and Ruderal Forest	159,303	582,198	5,821,016	6,562,516				
	All Forests	6,500,356	13,873,865	75,677,558	96,051,779				
	Longleaf Pine	249	1,114	3,639	5,002				
Region Total		13,000,712	13,873,865	75,677,558	96,051,779	29%	15%	1.9	5.9
Mid-Atlantic	Boreal Upland Forest	16,635	48,806	10,190	75,631				
	Central Oak-Pine	1,227,698	2,977,493	19,413,322	23,618,513				
	Longleaf Pine	249	1,114	3,639	5,002				
	Northern Hardwood & Conifer	852,003	3,557,810	16,058,847	20,468,660				
	Plantation and Ruderal Forest	112,214	423,840	4,597,067	5,133,121				
Mid-Atlantic Total		2,208,800	7,009,064	40,083,064	49,300,927	33%	12%	2.7	11.1
New England & New York	Boreal Upland Forest	1,095,214	1,714,908	6,760,737	9,570,860				
	Central Oak-Pine	251,879	884,100	6,152,002	7,287,982				
	Northern Hardwood & Conifer	2,897,374	4,107,435	21,457,806	28,462,615				
	Plantation and Ruderal Forest	47,088	158,358	1,223,949	1,429,395				
New England & New York Total		4,291,556	6,864,801	35,594,494	46,750,852	23%	18%	1.3	3.3

Map 2. Forest land by securement level and type.

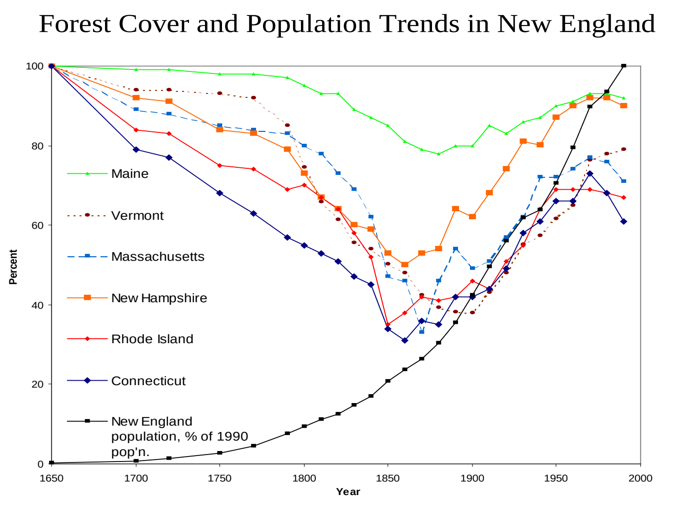


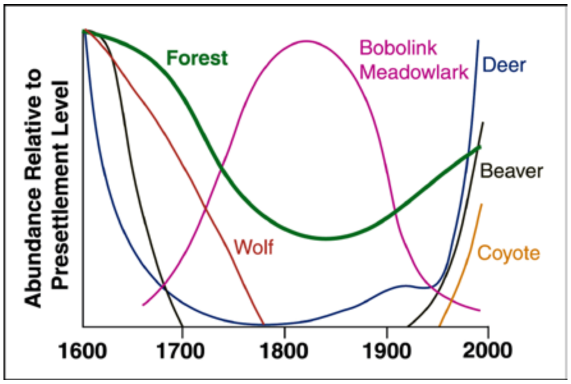
Forest Condition: Fragmentation, Structure, Disturbances

Forests in the east have a long history of human use, from widespread local-scale burning by Native Americans, to extensive clearing for agriculture and pasture by settlers in the 1800s, to the current logging of hardwoods and conifers for materials. Moreover, as eastern forests recovered from turn-of-the-century clearing, other changes transformed the land. These include an increase of the human population from a few hundred thousand to 71 million, and the development of a road network that now includes over 732,000 miles of permanent roads (enough to circle the equator 29 times; Map 3). One effect of these changes has been dramatic shifts in the type and abundance of wildlife; most dramatically, a decrease in forest interior species, a spike in the abundance of open habitat species, and a recent increase in forest generalists and game species (Figure 3). While it is difficult to comprehend the scope of these changes, the aim of this section is to objectively assess the current age and size structure of the forest, the degree of forest fragmentation, and trends in the breeding populations of forest dwelling birds.

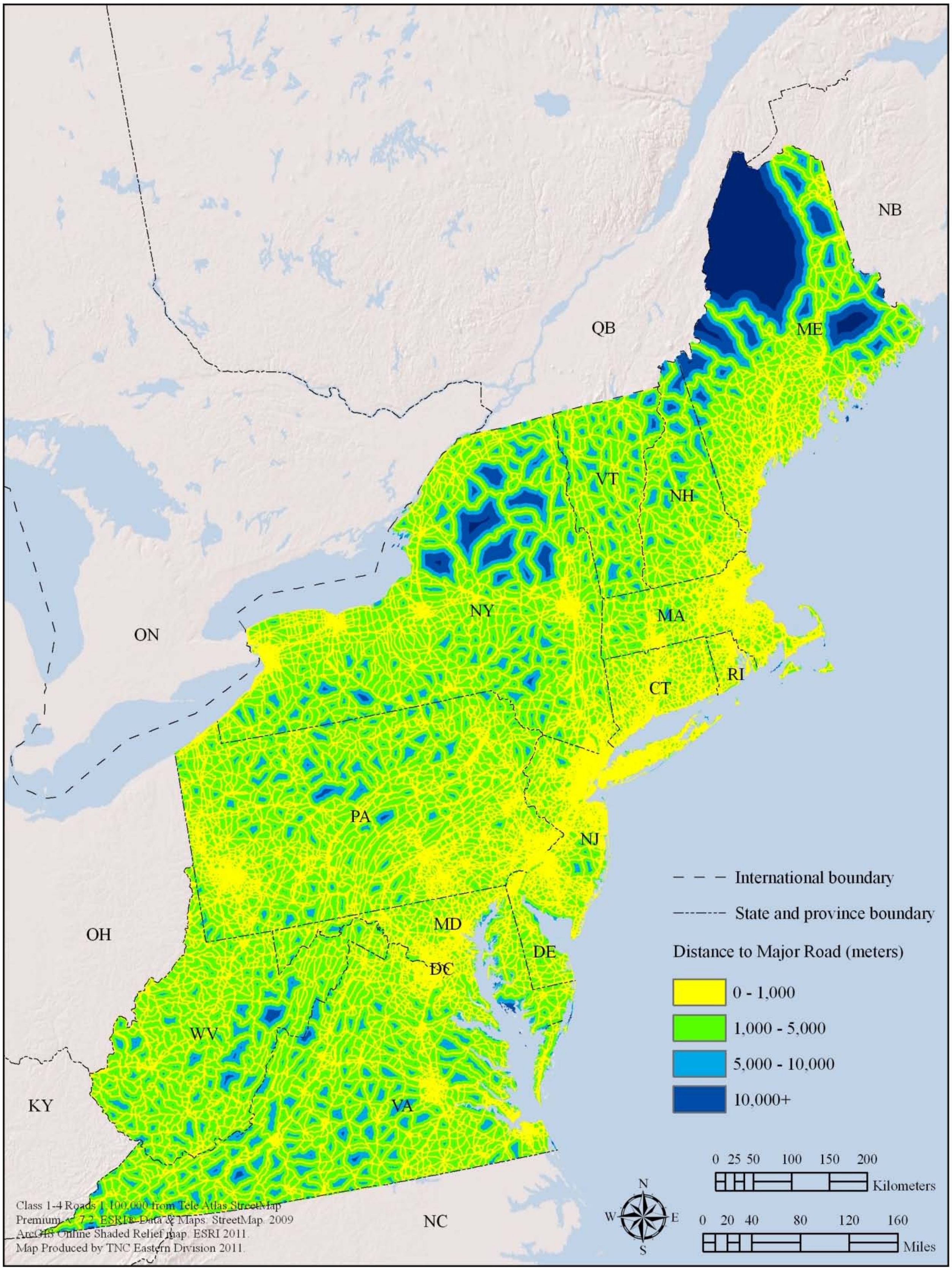
Fragmentation: Fragmentation occurs when a contiguous area of forest is subdivided into smaller patches, resulting in each patch having more edge and less interior. Because edge habitat contrasts strongly with interior - drier and more exposed, higher predator densities, greater susceptibility to blowdowns - the surrounding edge habitat tends to isolate the interior region and contribute to its degradation. Thus, the divide-and-conquer effect of fragmentation can lead to an overall deterioration of forest quality and a shift in associated species from interior specialists to edge generalists. A simple guide to understanding forest interior is available from the Ontario Extension Office here:
http://www.lrconline.com/Extension_Notes_English/pdf/forInterior.pdf

Figure 3. Changes in forest cover, population, and wildlife composition over the last three centuries. The left figure shows the extent of clearing over the last two centuries juxtaposed against human population growth. The right figure illustrates changes in the abundance of common species and habitats. Source: David Foster, used with permission.





Map 3. Distance to major roads.



Roads affect forest systems primarily by providing access into forest interior regions, thus decreasing the amount of sheltered secluded habitat preferred by many species for breeding. Additionally, heavily-used paved roads create noisy edge habitat that many species avoid, and the roads themselves may form movement barriers to small mammals, reptiles, and amphibians. To evaluate the extent and potential impact, of roads on forests in the region, we examined the patterns created when major roads connect to encircle contiguous blocks of forest (Map 3). To this end, we defined a forest block as a distinct area of forest surrounded on all sides by major roads (e.g. wide paved roads with significant traffic volume, Tele Atlas North America, Inc. 2009), and we mapped the major-road bounded blocks comprehensively across the region (Map 4). The area of each block was calculated, assigned to a block size class, and the amount of each forest type within each block was summarized to determine the size class distribution of different forest types (Figure 4, Table 2). Our assumption was that the highest quality interior habitat would be found in the central core of each block, essentially the region greater than 100 meters from any major road, field or developed area, and that the effects of the fragmenting feature would decrease with the size of the blocks (Map 3).

Across the entire region, block size distribution patterns showed a relatively even distribution of forest block sizes; small blocks less than 10,000 acres accounted for 20 percent of the acreage, and huge blocks over 250,000 acres accounted for 15 percent of the acreage (Figure 4, third column from the right). The forest types differed in their degree of fragmentation with boreal upland forest being the least fragmented forest type with 74 percent of its area in blocks over 250,000 acres. Central oak-pine forest, in contrast, had less than 1 percent of its distribution in blocks over 250,000 acres, and almost 19 percent of its distribution in blocks less than 5,000 acres (Figure 4). Overlaying the secured lands on the forest blocks revealed that conservation lands were correlated with the larger blocks, suggesting that the larger blocks may be a result of conservation efforts (Figure 5).

The two sub-regions differed in their degree of fragmentation. The New England and New York region had 20 percent more large blocks than the Mid-Atlantic, although both shared roughly the same amount of smaller blocks (Figure 4). Blocks of central oak-pine forest were actually larger in the Mid- Atlantic, where this forest type dominates, than in New England and New York, where it is restricted to low elevations and coastal areas which are highly developed (Table 2).

Connectivity: One solution to the pervasive problem of fragmentation is to preserve connectivity, which helps maintain the quality of the whole ecosystem. The metric we used to measure connectivity - local connectedness - is related to, but more sensitive than, the forest block analysis of the previous section. Using more than just major roads, this metric takes into account the impacts of local roads, as well as the density of all nearby roads and the degree of nearby conversion. The assessment method treats the landscape as having a gradient of permeability where highly contrasting land cover types have reduced permeability between them, and highly similar ones have enhanced permeability. In applying the metric, we differentiated between developed lands, agricultural lands, and natural cover, but all forms of natural land cover were combined into one class for the analysis. The assessment of local connectivity was developed and run by Brad Compton at the University of Massachusetts (Compton 2010), based on the 30 m National Land Cover dataset (Homer et al. 2004) land cover map supplemented with major and minor road information (Tele Atlas North America, Inc. 2009 –see data sources Appendix A).

Map 4. Major road bounded block size.

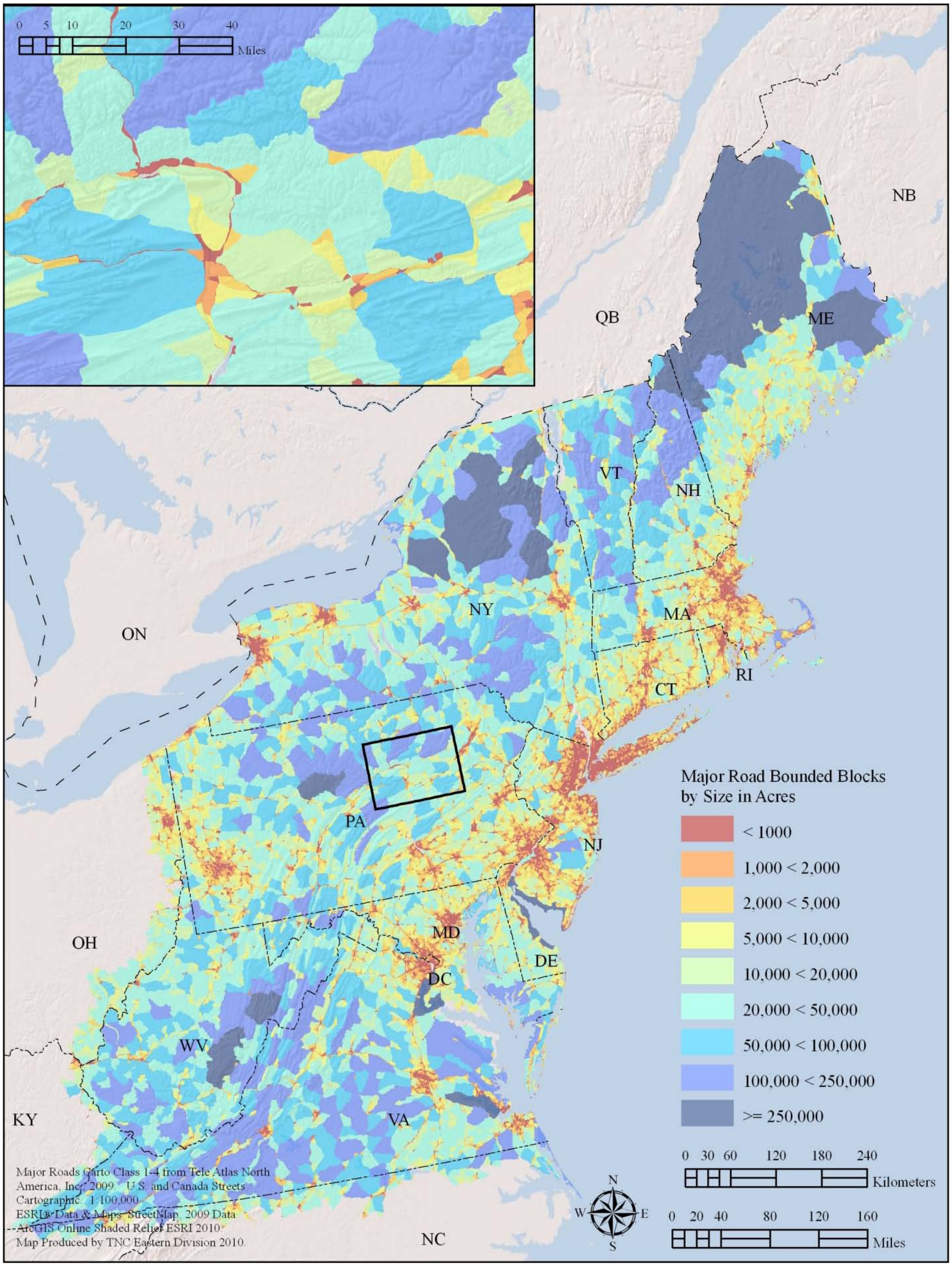


Figure 4. Percent of forest acres within major road bounded blocks. Size classes are in acres (*note figures do not include all local paved roads or any unpaved roads).

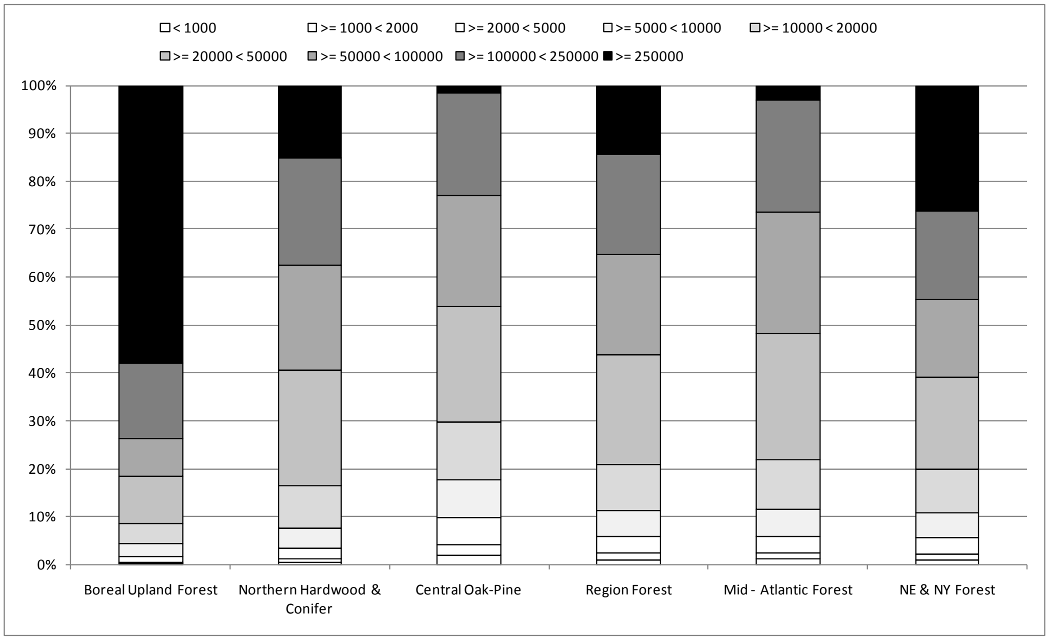


Figure 5. Secured status by block size. Securement is defined as forest land permanently secured against conversion to development and either protected for nature conservation (GAP 1 or 2) or intended for multiple uses such as forest management (GAP 3).

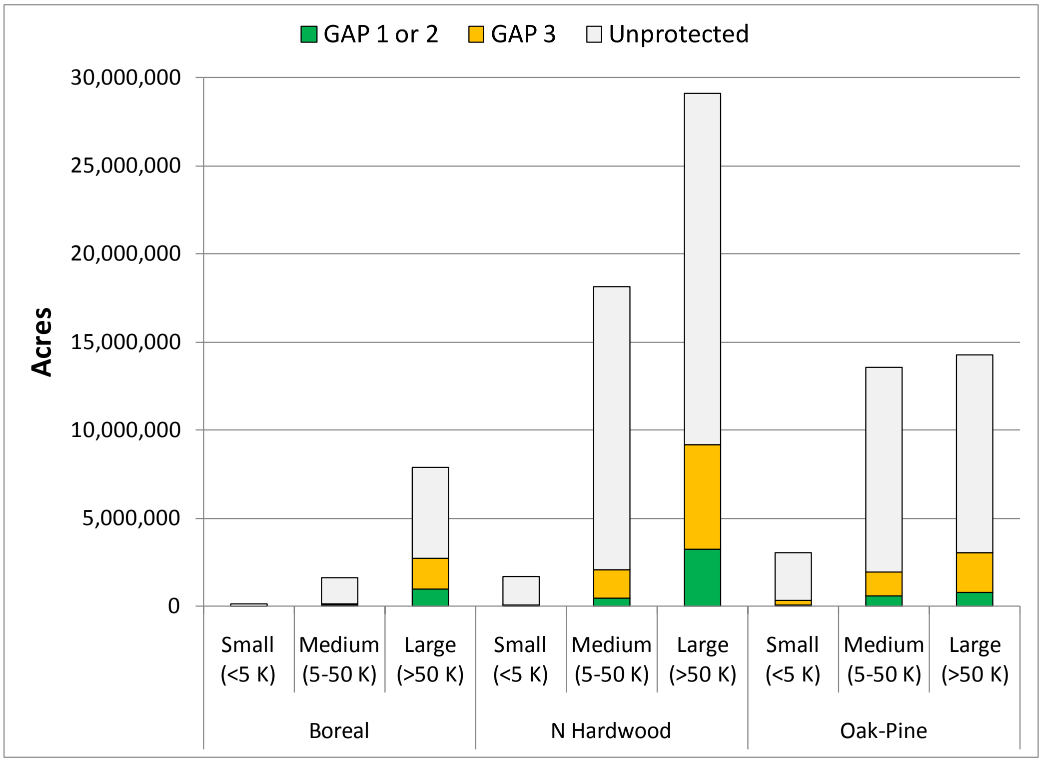


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Table 2. Acres of forest type within each size class of the major road bounded blocks. The forest types are Boreal Upland (BU), Northern Hardwood and Conifer (NH), Central Oak-Pine (OP), and Ruderal and Plantation (PR).

Region	Block Size in Acres	BU	NH	OP	PR	Total	Total Acres
	< 1000	0%	1%	2%	2%	1%	1,035,054
	1000 < 2000	0%	1%	2%	2%	1%	1,228,634
	2000 < 5000	1%	2%	6%	5%	3%	3,285,943
	5000 < 10000	3%	4%	8%	8%	5%	5,221,306
	10000 < 20000	4%	9%	12%	14%	10%	9,386,511
	20000 < 50000	10%	24%	24%	28%	23%	21,950,231
	50000 < 100000	8%	22%	23%	19%	21%	20,019,168
	100000 < 250000	16%	22%	21%	17%	21%	20,201,795
	>250000	58%	15%	2%	5%	14%	13,723,138
Region Total						100%	96,051,779
Mid-Atlantic	< 1000	0%	1%	1%	3%	1%	545,838
	1000 < 2000	0%	1%	2%	3%	1%	649,371
	2000 < 5000	0%	2%	4%	6%	3%	1,717,816
	5000 < 10000	0%	5%	6%	8%	6%	2,783,843
	10000 < 20000	0%	10%	10%	15%	10%	5,101,972
	20000 < 50000	2%	28%	24%	29%	26%	12,970,786
	50000 < 100000	8%	26%	26%	20%	25%	12,502,358
	100000 < 250000	50%	22%	26%	16%	23%	11,521,231
	>250000	40%	5%	2%	2%	3%	1,507,711
Mid-Atlantic Total						100%	49,300,927
NE & NY	< 1000	0%	1%	4%	1%	1%	489,215
	1000 < 2000	0%	1%	5%	1%	1%	579,263
	2000 < 5000	1%	2%	11%	3%	3%	1,568,127
	5000 < 10000	3%	4%	13%	6%	5%	2,437,462
	10000 < 20000	4%	8%	20%	11%	9%	4,284,540
	20000 < 50000	10%	21%	24%	24%	19%	8,979,445
	50000 < 100000	8%	19%	15%	18%	16%	7,516,810
	100000 < 250000	15%	22%	8%	20%	19%	8,680,564
	>250000	58%	22%	1%	14%	26%	12,215,427
NE & NY Total						100%	46,750,852

For every 30 m grid cell in the region, a circular area with a 3 km radius around the cell was evaluated and the amount of resistance /permeability was calculated to create a wall-to-wall grid with cell values ranging from 0 to 100; "0" indicating complete impermeability (e.g. developed) and "100" indicating complete permeability (e.g. natural cover with no barriers, Figure 6). See Appendix B for detail.

We measured the connectedness of the four forest types by overlaying the local connectedness grid on all cells of forest cover and tabulating the mean and variance for all cells of each forest type. Results indicated that across all areas of forest, the mean connectedness score was "41" suggesting a loss of over half of their natural connectivity (Map 5). Visually, areas with this score appear to have fairly contiguous cover, broken by small patches of field, power-lines or minor roads (Figure 6).

The three natural forest types differed markedly in their connectedness scores. Boreal upland forest scored the highest with a mean score of "66," and the central oak-pine forest scored the lowest with a mean score of "31," the latter score being similar to ruderal forest (Figure 7).

Figure 6. Aerial photo image of areas with different connectedness scores. The image on the left has a mean score of "23" for the area under the circle; the one on the right has a mean score of "43" for the area under the circle. A pristine area with no roads, power-lines, development or farms would score "100".

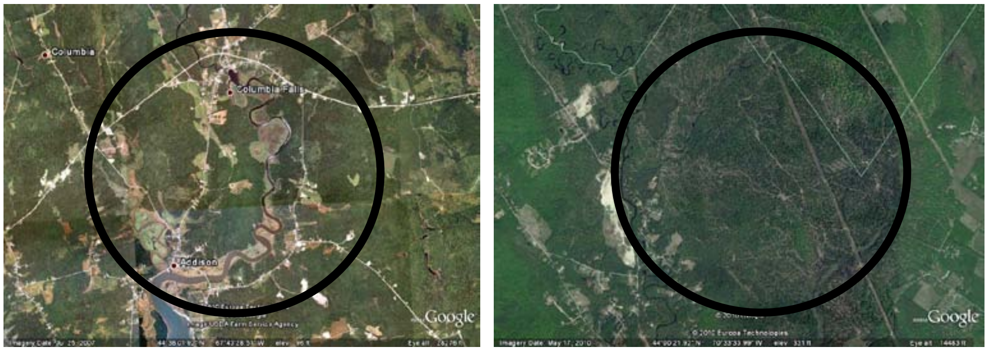
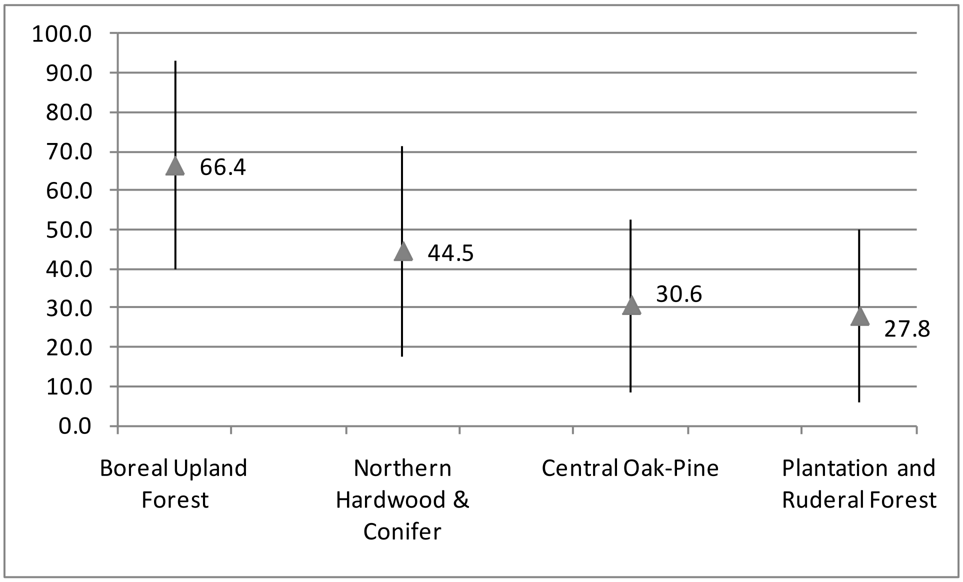
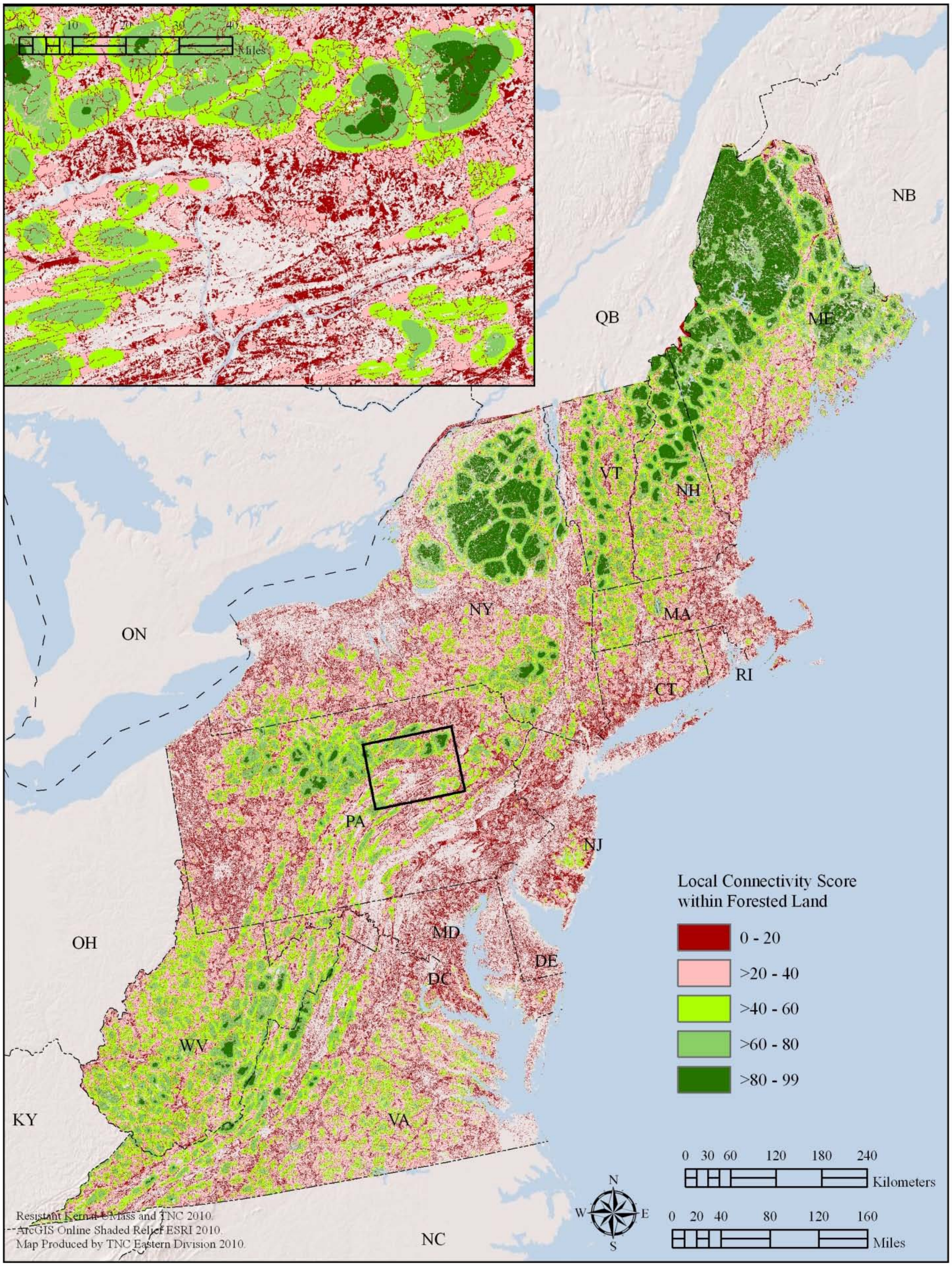


Figure 7. Average connectedness scores for the four forest types. Error bars show one standard deviation above and below the mean.



Map 5. Local Connectedness.



We found that the local connectedness scores were directly related to the forest block size such that connectedness increased at a faster rate as the blocks got larger (Figure 8).

Age and Size Structure: The age and size structure of a forest provides a picture of ecosystem development. Over centuries, an unmanaged forest will develop a complex structural heterogeneity characteristic of the classic self regenerating uneven-aged old growth stand (Figure 9). In contrast, a young or heavily managed forest is more likely to have an even age structure with most trees being close in age, and the spread of ages approximating a normal distribution with spikes of recruitment to the left of the mean.

Figure 8. Average connectedness scores of forest cells in different major road block size classes. The relationship is described by the equation: *Average connectedness = 1.995 * block size class*$^{1.7662}$

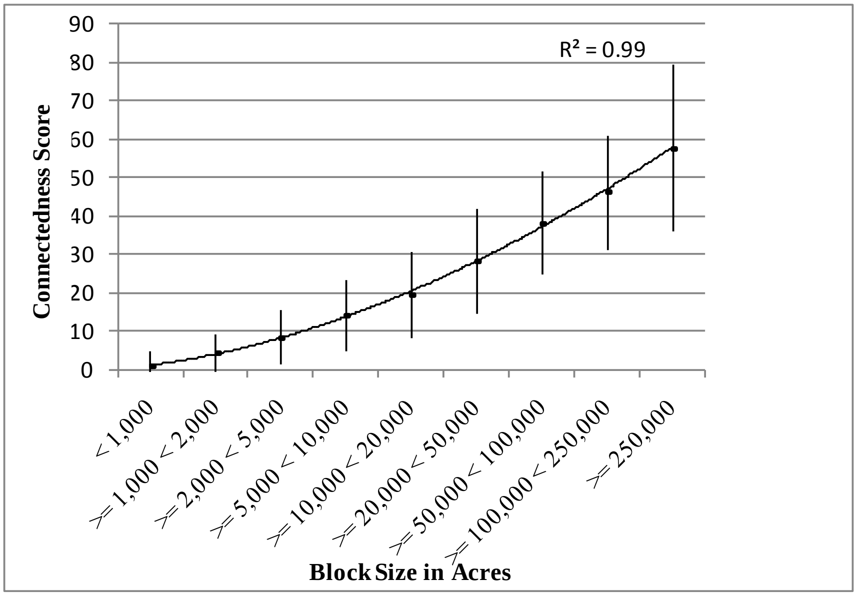
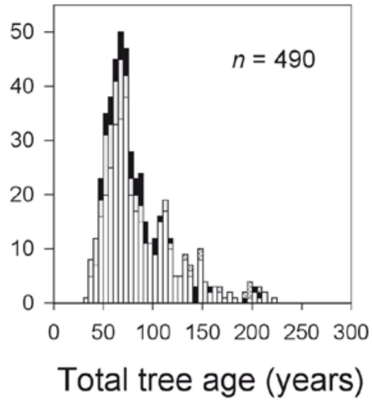


Figure 9. Characteristic old growth plots of a boreal forest stand. The chart shows the uneven age size classes as spikes in older age classes (adopted from McCarthy and Weetman 2006).



Note the low amount of regeneration and the high frequencies of trees over 100 years of age.

We used USDA Forest Service's Forest Inventory and Analysis (FIA) data to assess the age and size structure of forests in the region. FIA is an annual and continuous forest census, designed to collect the information needed to evaluate whether current forest management practices are sustainable in the long run. The survey collects data on tree species composition, size, and health of trees; tree growth, mortality, and removals by harvest. More information on the program is available here: http://fia.fs.fed.us/

We obtained all 6,952 FIA samples points available for this region from USFS, with each point containing information on its tree composition, age, and size structure. To connect the FIA data with the maps of forest types, we overlaid the points on the forest type data layer and assigned each point to one of the four major forest types. Note that the FIA point locations we received were slightly generalized to protect the actual location of the plot, so there may be some error associated with these assignments; presumably the error was distributed evenly across the forest types so as not to skew the results.

We assessed forest age and size structure at two scales: across-stands and within stands. To examine the across-stand structure we tabulated the average stand age for each forest type using the FIA field "stand age," and examined the stand age distributions across all stands in the region using histograms to show the frequency of age classes (Figure 10). Across all stands, we expected a wide range of stand ages indicating forests with different cutting histories and intensities, but the results showed that our forests are overwhelmingly similar in age with the average age being 60 years and most stands (68 percent) averaging between 50 and 90 years old (Figure 10). There was little difference in average stand age between forest types, although the upland boreal forest had a substantially larger component of young, 20-30 year old, stands, perhaps reflecting more active logging (Figure 10 and 11).

The size structure of forests is easier to measure in the field than the age structure, as the latter requires coring individual trees. Thus, the FIA data had more comprehensive information on size structure, and, because size is recorded along with each individual tree species, we could summarize the internal size structure for each sample. The results of summarizing the size structure across all plots indicated that the forest stands were almost entirely composed of small trees: 6" to 7" in diameter (Figure 12). In the upland boreal forest the most frequent size class was even smaller, 3" in diameter, consistent with intensive logging. For the other two forest types, the most frequent size class was 6" to 7" in diameter, with the profiles of both types showing small spikes in the 2" to 3" diameter class. Although size is not necessarily related to age, the size structure patterns corresponded strongly with the patterns of age structure.

Figure 10. Frequency distributions showing the average stand age by forest type. Charts are based on all FIA sample points that contained information on stand age: Upland Boreal (966), Northern Hardwood (4283), Central Oak-Pine (1501).

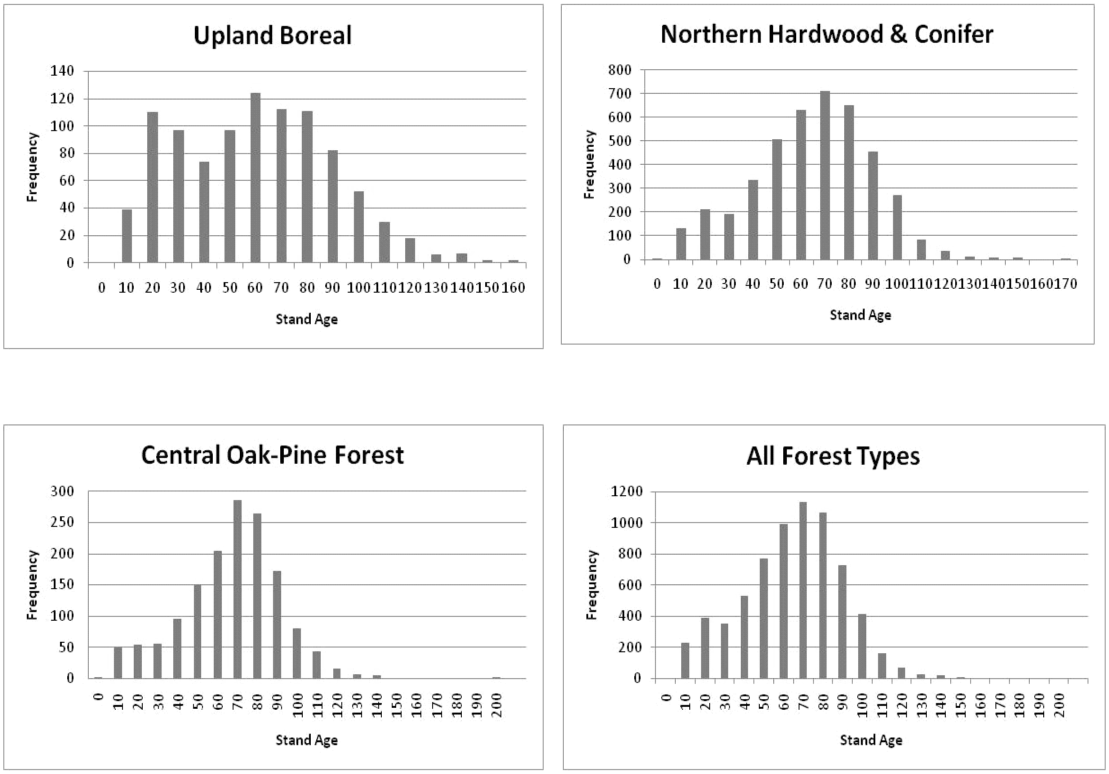
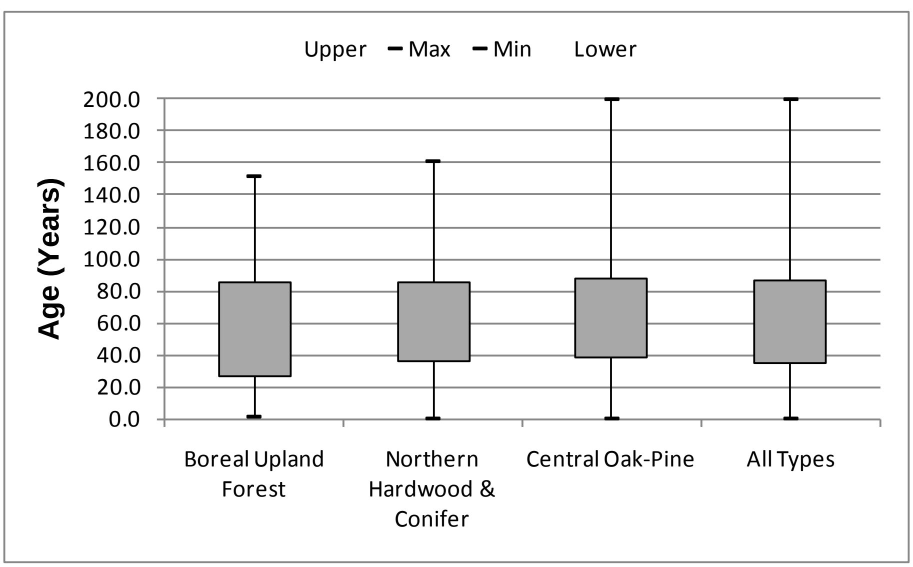


Figure 11. Average stand age: Standard deviation and range of each forest types. Mean ages are: Upland Boreal = 56.1, Central Oak-Pine = 62.9, Northern Hardwood = 60.6, All Forests = 60.4.



In addition to individual tree size measurements, FIA crews make their own plot-based field assessment of size class distributions using four simple categories, recorded in the data as the "field-stand size class code." We summarized this information by forest type and found that it strongly reinforced the patterns described above (Figure 13). The upland boreal forest was composed of 30 percent seedlings and saplings under 5" in diameter, while the northern hardwood and central oak-pine had had only 10 percent of their trees this small size class; both of the latter types having the majority of their trees in size class 3 (9-20" in diameter). No significant component of any forest types was in the larger size classes 4 or 5, indicating that in none of the almost 7,000 samples was the plurality of the canopy cover made up of trees over 20" in diameter. The results suggest that the forests in this region are not simply growing back after 19th century clearing but are actively being maintained in a young state with small diameter trees.

Figure 12. Stand level size structure of forests in the Northeast and Mid-Atlantic. The figures are based on all FIA samples that contained diameter at breast height (DBH) information for all trees. For each forest type, this amounts to the following: Upland Boreal (40,266 trees), Northern Hardwood and Conifer (145,832 trees), Central Oak-Pine (47,309 trees), Plantation and Ruderal (not shown 5664 trees).

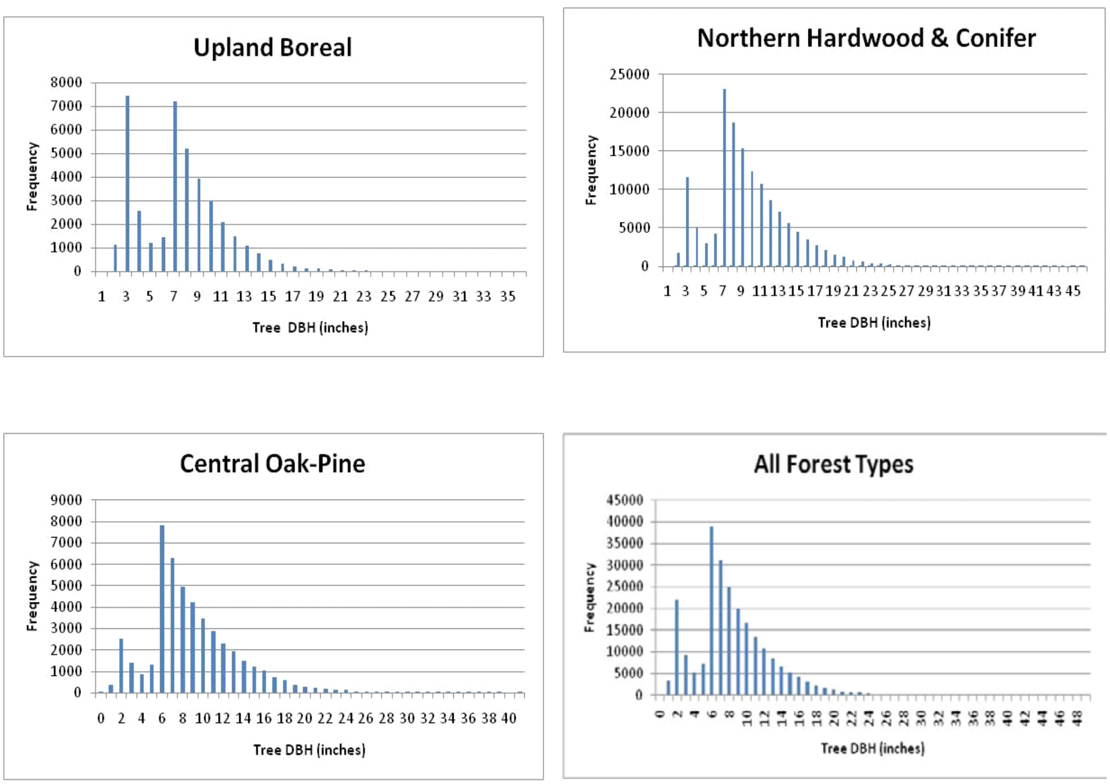
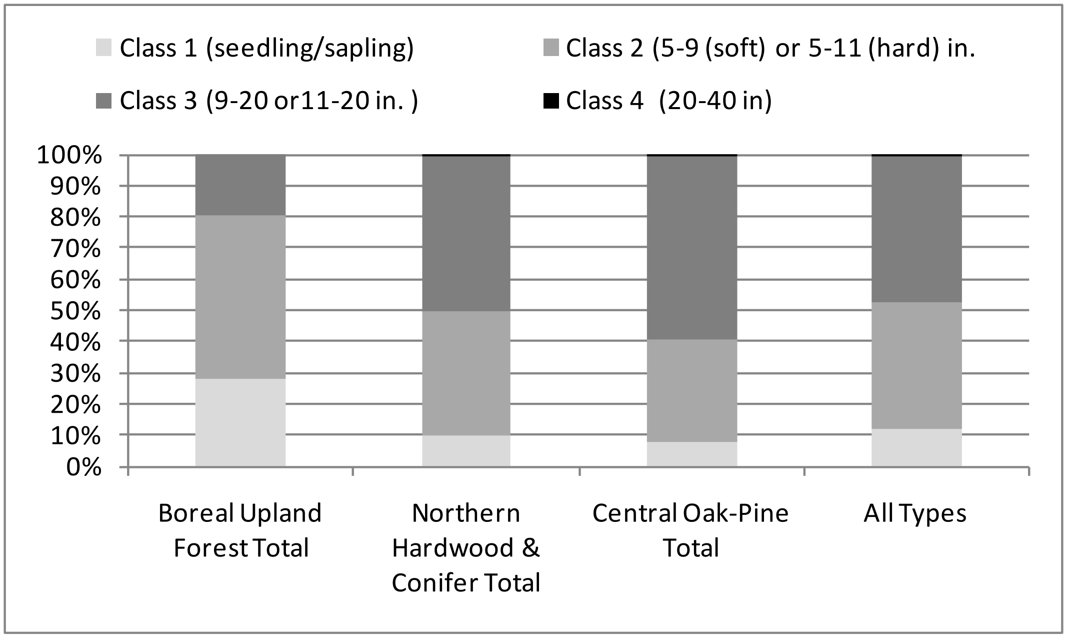


Figure 13. Size structure classes for the forest types based on the field stand-size code. This is a field assigned classification where Class 1 = Seedlings, saplings, two-thirds of stand less than 5 inches, Class 2 = one-third of crown cover is in trees greater than 5 inches and the plurality of cover is softwoods 5-9 inches or softwoods 5-11 inches in diameter, Class 3 = plurality of cover is softwoods 9-20 inches or softwoods 11-20 inches in diameter, and Class 4 = plurality of crown cover is 20-40 inches in diameter.



<u>Forest Disturbance:</u> Eastern forests are subject to an array of natural disturbances and over time these structure the ecosystem. Disturbances have several benefits, as patches of tree damage free up resources such as light and water, and contribute nutrients and woody debris to the soil. Periodic insect outbreaks may be accompanied by irruptions of specialist bird species, and fires may stimulate the regenerations of particular species. This constant adjusting to the perpetual cycles of disturbances creates a shifting mosaic of ages and composition in an old forest.

Natural Disturbance Types in FIA

Ice: snapping of branches or crown by ice load

Wind: blowdowns and breakage from downburst and hurricanes

Fire: mortality or scarring from crown and understory fires

Flood: mortality or stress from flooding

Drought: mortality due to insufficient water availability

Animal: damage by deer, porcupine, beaver

Insect: leaf and bark damage by insects

Vegetation: competition or suppression by vines etc.

To understand the extent of various forest disturbances we again used the FIA data, in which primary disturbances were noted by field crews when the data is collected. From this information it was possible to create a disturbance profile for each forest types (Figure 14). Importantly, 96 percent of the forest stands showed no effects from natural disturbance; the pie-charts and damage percentages shown in Figure 14 reflect only the 4 percent of the samples that had evidence of disturbance. Harvesting is treated as a special case of disturbance by FIA and is tracked separately; we also examined it separately.

Among all forests, ice was the predominant natural disturbance accounting for 24 percent of all observed tree damage (Figure 14). The next three most common disturbances were all biotic: animals, vegetation, and insects. Upland boreal forests had simpler disturbance regimes, ice and wind were the prevalent disturbances and five types accounted for all the observed damage. Northern hardwood forests had more complex disturbance profiles with evidence of nine disturbance types, and dominated by ice and animal damage. Oak-pine forests were similar to northern hardwoods but differed in having a larger component of fire and vegetation impacts, and less ice damage.

We examined forest harvesting patterns separately from disturbance using the treatment information recorded for each stand that indicated whether the stand was recently cut, or if it showed signs of harvest preparation. Over all forests types, 10 percent showed some evidence of harvest (Figure 15). More than twice as much harvesting was found in the upland boreal forest stands than in the oak pine forests, the former having evidence of cutting in 14 percent of the stands, and the latter in 6 percent.

Figure 14. Disturbances and forest types: The relative amounts of disturbances affecting forest.

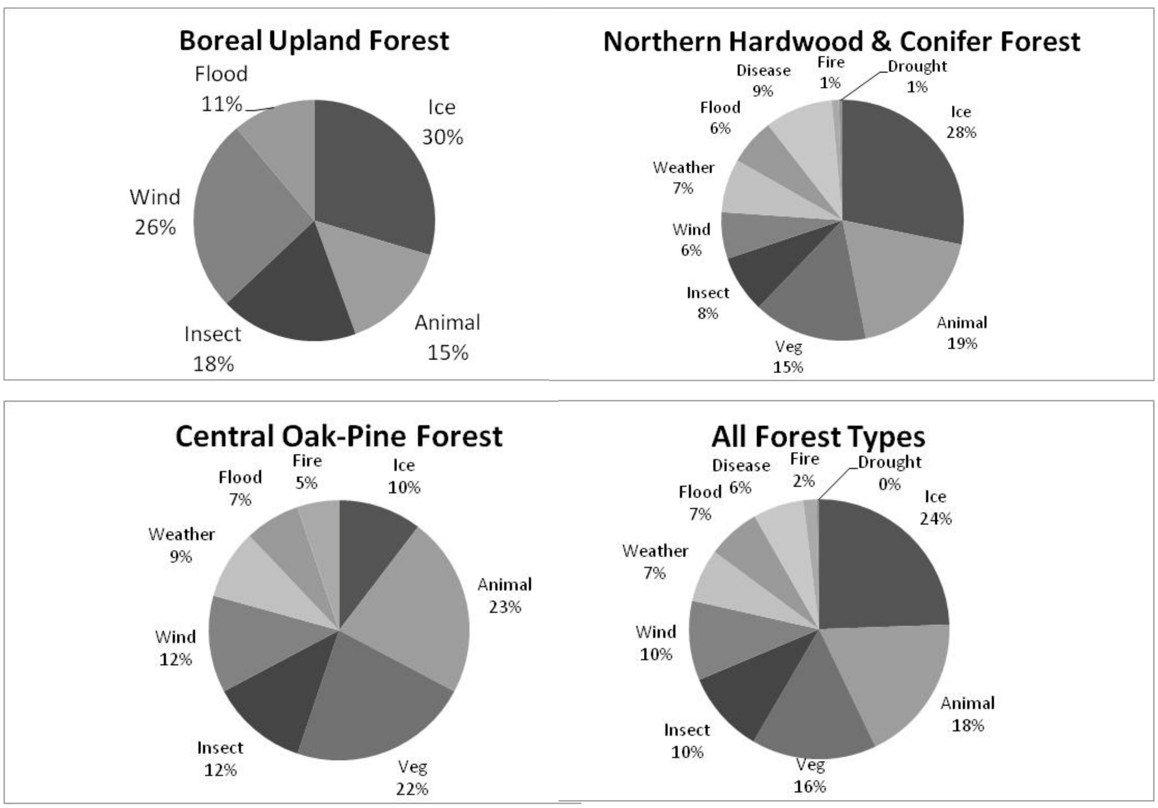
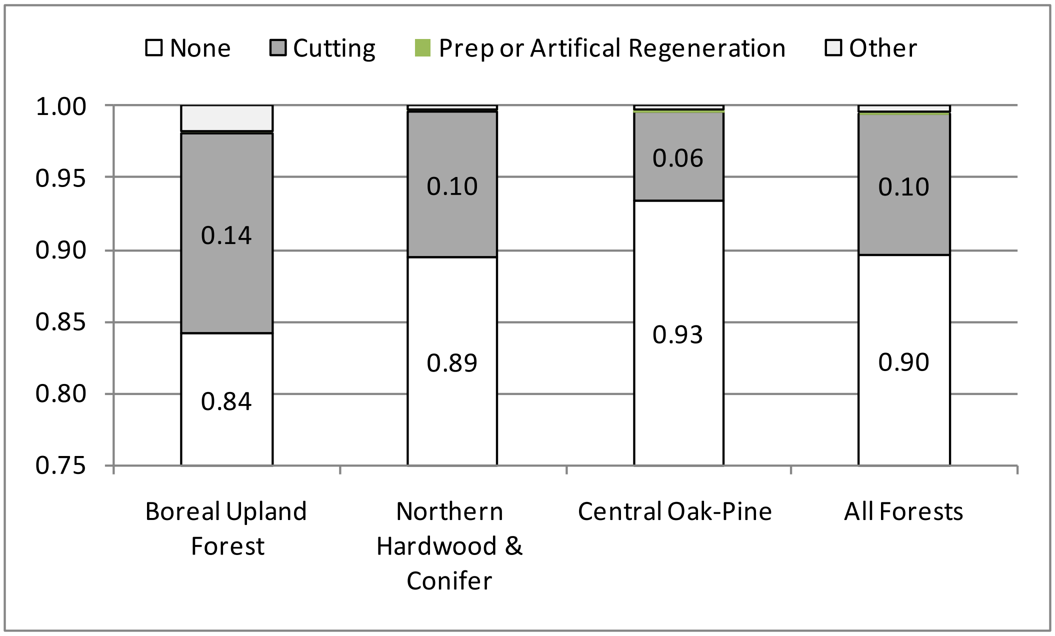


Figure 15. Percent harvest by forest type.



Trends in Forest Bird Abundance

Changes in the abundance of forest breeding birds may give some indication of forest quality and condition. However, because abundance shifts in any individual species may be unrelated to local forest characteristics, bird data is most telling when they show consistent trends across many species and many states. We identified a set of breeding species associated with each of the four forest types based on a published list of preferred breeding habitat for northeast wildlife (DeGraaf and Yamasaki, 2001), and then used breeding bird survey data to examine their regional abundance patterns over the last four decades. The breeding bird survey (BBS) is a long-term, large-scale, avian monitoring program initiated in 1966 to track the status and trends of North American bird populations, and coordinated in the US by the USGS Patuxent Wildlife Research Center. More information on the program may be found here: http://www.pwrc.usgs.gov/bbs/.

The breeding bird survey annually collects bird population data along roadside routes allowing users to inspect trends occurring within states, regions, and continentally. We summarized statistically significant declines and increases for each species in each state, using only species for which there was adequate data (category blue or yellow). Next, we looked at the data across all states to examine how consistent the trend was across the region. In the tables below, for each species we show whether there was a consistent trend across states, whether it was an increase, decrease or mixed signal, how many states it was detected in, and whether the trend was apparent at both the 40 year time interval and a more recent 20 year time interval.

Upland Boreal Forest: DeGraaf and Yamasaki (2001) list 32 species as breeding in spruce or fir forests and the breeding bird survey had sufficient data on 19 of them to examine temporal trends. Results indicated more consistent increases than declines, with four species: **magnolia warbler, red-breasted nuthatch, northern parula,** and **yellow-rumped warbler**, increasing in three or four states over both

Table 3. Forty year trends in the abundance of bird species associated with Boreal Upland Forests. DNS = Declining or not Significant, INS = Increasing or not significant, NS = Not significant. Data quality codes: B= blue adequate data, Y = yellow, usable but with significant gaps, R = red data not usable. The total possible states for this group was six.

BOREAL UPLAND FOREST	40 Year Trend (1966-2007)					20 Year Trend (1980-2007)				
SPECIES	Status	Declines (# of states)	Increases (# of states)	Data Quality	Regional Trend	Status	Declines (# of states)	Increases (# of states)	Data Quality	Regional Trend
Purple Finch	DNS	4	0	B	-0.6	DNS	2	0	B	0.5
Blackburnian Warbler	DNS	2	0	B	0.6	DI	1	1	B	1.1
Olive-sided Flycatcher	DNS	2	0	Y	-5.1	DNS	2	0	Y	-6.7
Bay-breasted Warbler	DNS	1	0	Y	-1	NS	0	0	Y	-1.3
Dark-eyed Junco	DNS	1	0	B	0	NS	0	0	B	0
Ruby-crowned Kinglet	DNS	1	0	B	-4.4	DNS	1	0	B	-2.7
Magnolia Warbler	INS	0	4	B	3.1	INS	0	3	B	2.1
Red-breasted Nuthatch	INS	0	4	B	1.6	INS	0	2	B	0.9
Northern Parula	INS	0	3	B	1.7	INS	0	3	B	1.8
Yellow-rumped Warbler	INS	0	3	Y	2.1	INS	0	2	Y	1.2
Swainson's Thrush	INS	0	1	B	0.5	INS	0	1	B	1
Yellow Warbler	DI	2	1	Y	-0.3	DNS	5	0	Y	-1.1
Hermit Thrush	DI	1	3	Y	2.5	INS	0	3	Y	2.8
Evening Grosbeak	DI	1	2	B	-8.1	DNS	1	0	B	-9.9
Nashville Warbler	DI	1	1	Y	-0.9	DNS	2	0	Y	-2.2
Boreal Chickadee	NS	0	0	Y	1.2	NS	0	0	Y	1.4
Cape May Warbler	NS	0	0	Y	-3.4	DNS	1	0	Y	-5
Golden-crowned Kinglet	NS	0	0	Y	1	DNS	1	0	Y	-0.3
Pine Siskin	NS	0	0	Y	-2.6	NS	0	0	Y	-2
Black-backed Woodpecker	NS	0	0	R	1.3	NS	0	0	R	-2.1
Sharp-shinned Hawk	INS	0	4	R	5.3	INS	0	2	R	3.2
Blackpoll Warbler	NS	0	0	R	-3.8	NS	0	0	R	-2.5
Gray Jay	NS	0	0	R	2.1	NS	0	0	R	-0.9
Merlin	NS	0	0	R	-5.2	NS	0	0	R	-5.6
Red Crossbill	NS	0	0	R	7.1	NS	0	0	R	-0.1
Rusty Blackbird	NS	0	0	R	10.6	NS	0	0	R	10.3
White-winged Crossbill	NS	0	0	R	0.5	NS	0	0	R	-1.2

time intervals (Table 3). Mild declines were apparent in **purple finch** in four states. **Olive-sided flycatchers** have sharply declined in two states over forty years. In the last twenty years, **yellow warblers** have declined in five states and **Nashville warblers** in two, suggesting some concern about these species.

<u>Northern Hardwood and Conifer Forest:</u> DeGraaf and Yamasaki (2001) list 37 species as breeding in Northern Hardwood forest; the breeding bird survey had adequate data on 27 of them (Table 4). Of those 27, six species showed significant declines in four or more states and over multiple decades: **wood thrush, least flycatcher, common yellowthroat, black-and-white warbler, rose-breasted grosbeak**, and **scarlet tanager**. **Wood thrush** declines were the most widespread, occurring in ten states, and worsening in recent years. In contrast, five species showed increases across three or more states: **white-breasted nuthatch, ruby-throated hummingbird, black-capped chickadee, northern parula,** and **ovenbird**. Five of the six declining species are described in the literature (Poole and Gill, 1999-ongoing) as sensitive to forest fragmentation, as are ovenbirds which are increasing in three states. In contrast, the increasing chickadee, nuthatch and hummingbird are common feeder birds that appear to do well in fragmented systems. Among the mixed trend species, **pileated woodpeckers** are apparently rebounding from low population levels associated with forest clearing, but **veery** have declined in six states.

Table 4. Forty year trends in the abundance of bird species associated with Northern Hardwood and Conifer Forest. DNS = Declining or not Significant, INS = Increasing or not significant, NS = Not significant. Data quality codes: B= blue adequate data, Y = yellow, usable but with significant gaps, R = red data not usable.

NORTHERN HARDWOOD & CONIFER	40 Year Trend (1966-2007)					20 Year Trend (1980-2007)				
SPECIES	Status	Declines (# of states)	Increases (# of states)	Data Quality	Regional Trend	Status	Declines (# of states)	Increases (# of states)	Data Quality	Regional Trend
Wood Thrush	DNS	10	0	Y	-2.2	DNS	11	0	Y	-2.3
Least Flycatcher	DNS	8	0	B	-2	DNS	8	0	B	-2.4
Common Yellowthroat	DNS	7	0	Y	-0.4	DNS	10	0	Y	-0.7
Black-and-white Warbler	DNS	6	0	B	-2.5	DNS	6	0	B	-3
Rose-breasted Grosbeak	DNS	4	0	Y	-0.8	DNS	6	0	Y	-2.2
Scarlet Tanager	DNS	4	0	Y	-0.4	DNS	4	0	Y	-0.6
Ruffed Grouse	DNS	2	0	Y	-3	DNS	1	0	Y	-7.4
Broad-winged Hawk	DNS	1	0	Y	1.2	DNS	1	0	Y	1.6
Tennessee Warbler	DNS	1	0	Y	-8.4	DNS	1	0	Y	-12.7
White-breasted Nuthatch	INS	0	5	Y	2.4	INS	0	6	Y	2.4
Ruby-thr. Hummingbird	INS	0	4	Y	2.5	DI	1	3	Y	1.5
Black-capped Chickadee	INS	0	3	B	1	DI	1	1	B	0.2
Ovenbird	INS	0	3	B	1.4	DI	2	3	B	1.1
Northern Parula	INS	0	3	B	1.7	INS	0	3	B	1.8
Philadelphia Vireo	INS	0	1	Y	12.6	INS	0	1	Y	11.1
Swainson's Thrush	INS	0	1	B	0.5	INS	0	1	B	1
Mourning Warbler	INS	0	1	Y	1	NS	0	0	Y	0.5
Prothonotary Warbler	INS	0	1	Y	1.5	NS	0	0	Y	1.6
Chestnut-sided Warbler	DI	5	1	B	-0.5	DI	4	2	B	-0.2
American Redstart	DI	4	1	B	-1.2	DI	4	2	B	-1.2
Veery	DI	4	1	Y	-1.3	DI	6	1	Y	-1.9
Red-eyed Vireo	DI	2	5	Y	1.3	DI	2	5	Y	1.2
Pileated Woodpecker	DI	1	10	B	3.1	DI	1	6	B	2.4
Hermit Thrush	DI	1	3	Y	2.5	INS	0	3	Y	2.8
Hairy Woodpecker	DI	1	2	Y	1.7	INS	0	2	Y	2.8
Downy Woodpecker	DI	1	1	Y	-0.4	DI	1	1	Y	-0.4
Nashville Warbler	DI	1	1	Y	-0.9	DNS	2	0	Y	-2.2

Central Oak-Pine Forest: DeGraaf and Yamasaki (2001) list 45 species as breeding in Oak-Pine forest; the breeding bird survey has adequate data on 40 of them (Table 5). Of those 40, 11 showed significant declines in three or more states and over multiple decades: **eastern towhee, northern flicker, wood thrush, brown thrasher, least flycatcher, common yellowthroat, black-and-white warbler, rose-breasted grosbeak, scarlet tanager, blue-winged warbler**, and **prairie warbler** (six species overlap with northern hardwood forest). Declines of **eastern towhee** and **northern flicker** were the most widespread, occurring in 11 or more states, and continuing in recent years. In contrast, ten species showed increases in three or more states: **tufted titmouse, wild turkey, eastern bluebird, red-bellied woodpecker, pine warbler, red-tailed hawk, white-breasted nuthatch, red-breasted nuthatch, ruby-throated hummingbird**, and **ovenbird**. As for northern hardwood forests, the increasing birds are mostly common birds of rural landscapes, familiar with fragmentation, but other than ovenbird, the five declining species are known to be sensitive to forest fragmentation (Poole and Gill 1999-ongoing). Among the mixed trend species, **mourning dove** and **pileated woodpecker** are increasing in most states, while **blue jay s**howed decreases in six states.

Table 5. Forty year trends in the abundance of bird species associated with Central Oak-Pine Forest. DNS = Declining or not Significant, INS = Increasing or not significant, NS = Not significant. Data quality codes: B= blue adequate data, Y = yellow, usable but with significant gaps, R = red data not usable.

CENTRAL OAK_PINE	40 Year Trend (1966-2007)					20 Year Trend (1980-2007)				
SPECIES	Status	Declines (# of states)	Increases (# of states)	Data Quality	Regional Trend	Status	Declines (# of states)	Increases (# of states)	Data Quality	Regional Trend
Eastern Towhee	DNS	12	0	Y	-2.6	DNS	7	0	Y	-0.7
Northern Flicker	DNS	11	0	Y	-2.9	DNS	8	0	Y	-1.1
Wood Thrush	DNS	10	0	Y	-2.2	DNS	11	0	Y	-2.3
Brown Thrasher	DNS	8	0	B	-2.4	DNS	3	0	B	-0.6
Least Flycatcher	DNS	8	0	B	-2	DNS	8	0	B	-2.4
Common Yellowthroat	DNS	7	0	Y	-0.4	DNS	10	0	Y	-0.7
Black-and-white Warbler	DNS	6	0	B	-2.5	DNS	6	0	B	-3
Rose-breasted Grosbeak	DNS	4	0	Y	-0.8	DNS	6	0	Y	-2.2
Scarlet Tanager	DNS	4	0	Y	-0.4	DNS	4	0	Y	-0.6
Blue-winged Warbler	DNS	3	0	Y	-1.2	DNS	3	0	Y	-2.9
Prairie Warbler	DNS	3	0	B	-2.1	DNS	4	0	B	-1.8
Blackburnian Warbler	DNS	2	0	B	0.6	DI	1	1	B	1.1
Canada Warbler	DNS	2	0	Y	-2.7	DNS	3	0	Y	-2.5
Whip-poor-will	DNS	2	0	Y	-2.9	DNS	2	0	Y	-3.8
Broad-winged Hawk	DNS	1	0	Y	1.2	DNS	1	0	Y	1.6
Yellow-throated Vireo	DNS	1	0	Y	0	DNS	2	0	Y	0
Tufted Titmouse	INS	0	9	Y	1.9	INS	0	8	Y	1.9
Wild Turkey	INS	0	8	Y	8.9	INS	0	7	Y	10.1
Eastern Bluebird	INS	0	7	Y	1.8	INS	0	6	Y	1.6
Red-bellied Woodpecker	INS	0	7	Y	2.4	INS	0	8	Y	3
Pine Warbler	INS	0	6	Y	1.7	INS	0	5	Y	0.3
Red-tailed Hawk	INS	0	6	Y	2.6	INS	0	1	Y	1.7
White-breasted Nuthatch	INS	0	5	Y	2.4	INS	0	6	Y	2.4
Red-breasted Nuthatch	INS	0	4	B	1.6	INS	0	2	B	0.9
Ruby-thr. Hummingbird	INS	0	4	Y	2.5	DI	1	3	Y	1.5
Ovenbird	INS	0	3	B	1.4	DI	2	3	B	1.1
Prothonotary Warbler	INS	0	1	Y	1.5	NS	0	0	Y	1.6
Worm-eating Warbler	INS	0	1	Y	-0.8	DI	1	1	Y	-1.2
Blue Jay	DI	6	2	B	-0.6	DI	6	1	B	-0.5
Gray Catbird	DI	4	2	Y	0.1	DI	3	2	Y	0.2
Black-billed Cuckoo	DI	4	1	Y	-2.6	DI	2	1	Y	-3.4
Chipping Sparrow	DI	3	4	Y	-0.8	DI	3	3	Y	-0.8
Yellow-billed Cuckoo	DI	3	1	Y	-0.6	DNS	3	0	Y	-1
Blue-gray Gnatcatcher	DI	2	1	B	-0.3	DNS	2	0	B	-0.7
Cerulean Warbler	DI	2	1	Y	-3.4	INS	0	1	Y	-1.7
Red-headed Woodpecker	DI	2	1	Y	-1.6	DNS	1	0	Y	1.8
Pileated Woodpecker	DI	1	10	B	3.1	DI	1	6	B	2.4
Mourning Dove	DI	1	8	Y	1.3	DI	2	7	Y	0.7
Hermit Thrush	DI	1	3	Y	2.5	INS	0	3	Y	2.8
Downy Woodpecker	DI	1	1	Y	-0.4	DI	1	1	Y	-0.4
Sharp-shinned Hawk	INS	0	4	R	5.3	INS	0	2	R	3.2
Barred Owl	INS	0	2	R	6	INS	0	2	R	6.3
Cooper's Hawk	INS	0	2	R	10	DI	1	3	R	7.2
Gray Jay	NS	0	0	R	2.1	NS	0	0	R	-0.9

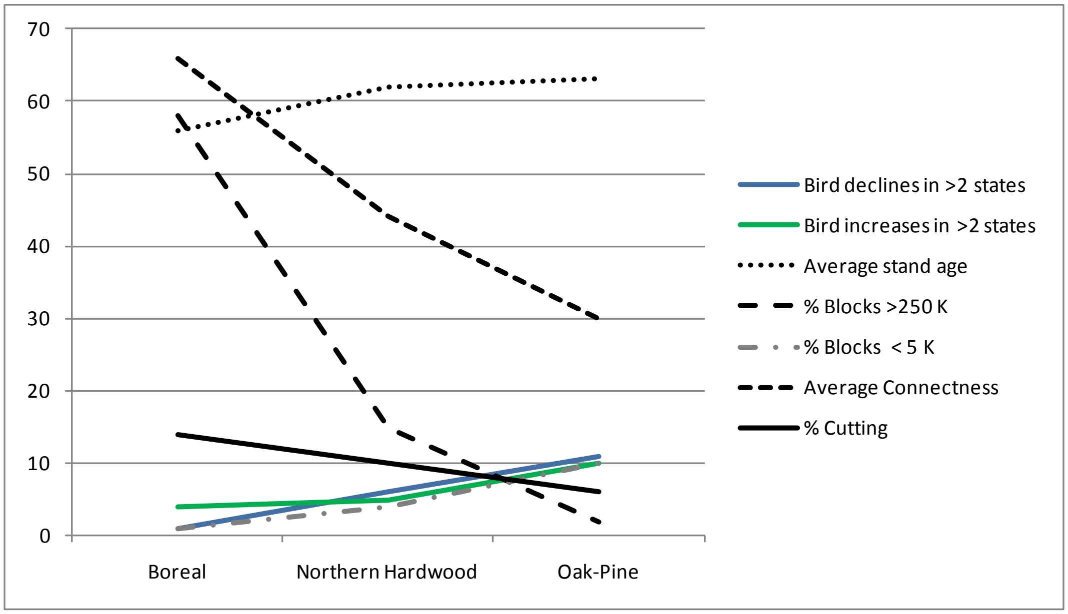
Synthesis of Species Data with Forest Condition

We tested whether significant trends in breeding birds – both increases and decreases – correlated in any way with the metrics of forest condition. To do this, we first tabulated the number of species in each forest type showing a significant trend in three or more states, and the proportion of all possible states that showed trends. Next we tested whether these summary numbers correlated with the average connectedness, mean age, percent cutting, and the percent of the forest in very large or very small blocks. The results suggest that breeding bird changes were most extensive in the oak-pine forest, and changes across the three forest types correlated with increasing forest fragmentation (Figure 15). Degree of harvest was less correlated with changes in bird abundances suggesting that logging has had a less dramatic effect of bird populations than fragmentation. This question, however, needs further research as we did not correct for the different amounts of usable data in the forest types or the degree of overlap between types.

Table 6. Summaries of bird declines and increases. This chart shows stand age, forest fragmentation and local connectedness, by forest types. All of these averages are strongly correlated with forest type but the correlations are highest between the number of declines and the average connectedness and between the total changes in bird composition (summary of declines and increases) and the number of block less than 5,000 acres.

Forest Types	Species Change in >= 3 States			Species Change in >= 30 % of All Possible States			Average stand age	% Blocks >250 K	% Blocks < 5 K	Average Connectness
	Declines	Increases	Total Change	Declines	Increases	Total Change				
Boreal Upland	1	4	5	3	4	7	56	58	1	66
Northern Hardwood	6	5	11	6	5	11	62	15	4	44
Oak-Pine	11	10	21	9	9	18	63	2	10	30

Figure 15. Relationships between bird declines and increases, forest fragmentation, connectivity, mean age, and degree of cutting.



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Please see the data sources (appendix A) and detailed methods(appendix B) sections of the main report for more information on the data sources and analysis methods used in this chapter.

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Species names

American basswood (Tilia americana)

American beech (Fagus grandifolia)

American ginseng (Panax quinquefolius)

American mountain-ash (Sorbus americana)

balsam fir (Abies balsamea)

bear oak (Quercus. ilicifolia)

birch (Betula spp.)

black bugbane (Actaea racemosa)

black bugbane (Cimicifuga racemosa)

black cherry (Prunus serotina)

black oak (Quercus velutina)

Black spruce (Picea mariana)

black walnut (Juglans nigra)

blue cohosh (Caulophyllum thalictroides)

Catawba rosebay (Rhododendron catawbiense)

chalk maple (Acer leucoderme)

chestnut oak (Quercus prinus)

Clayton's sweetroot (Osmorhiza claytonia)

cucumber-tree (Magnolia acuminata)

eastern red-cedar (Juniperus virginiana)

eastern white pine (Pinus strobes)

heartleaf (Hexastylis spp.)

highland doghobble (Leucothoe fontanesiana)

jack in the pulpit (Arisaema triphyllum)

jack pine (Pinus banksiana)

mockernut hickory (Carya alba)

mountain magnolia (Magnolia fraseri)

mountain silverbell (Halesia tetraptera)

mountain woodfern (Dryopteris campyloptera)

mountain woodsorrel (Oxalis montana)

northern maidenhair (Adiantum pedatum)\

northern mountain-ash (Sorbus decora)

northern red oak (Quercus rubra)

paper birch (Betula papyrifera)

pitch pine (Pinus rigida)

red hickory (Carya ovalis)

red maple (Acer rubrum)

red pine (Pinus resinosa)

red spruce (Picea rubens)

running strawberry bush (Euonymus obovatus)

scarlet oak (Quercus coccinea)

shagbark hickory (Carya ovata)

smooth Solomon's seal (Polygonatum biflorum)

sourwood (Oxydendrum arboreum)

southern sugar maple (Acer barbatum)

Spruce (Picea spp.)

stickywilly (Galium aparine)

strawberry bush (Euonymus americana)

sugar maple (Acer saccharum)

sweet birch (Betula lenta)

Table Mountain pine (P. pungens)

tuliptree (Liriodendron tulipifera)

umbrella-tree (Magnolia tripetala)

Virginia pine (Pinus virginiana)

white ash (Fraxinus Americana)

white oak (Quercus alba)

white trillium (Trillium grandiflorum)

wild hydrangea (Hydrangea arborescens)

yellow birch (Betula alleghaniensis)

yellow buckeye (Aesculus flava)

Appendix 4-1Acres of Forest by Type, Major Road Block Size, and Secured Land Status

	Within <5,000 Acre Blocks				Within 5,000 <50,000 Acre Blocks				Within >=50,000 Acre Blocks				Grand Total			
Mid-Atlantic Region	Unprotected	GAP 1 or 2	GAP 3	Total	Unprotected	GAP 1 or 2	GAP 3	Total	Unprotected	GAP 1 or 2	GAP 3	Total	Total Unprotected	GAP Total 1 or 2	Total GAP 3	Total
DC																
Central Oak-Pine	1,069	0	1,655	2,724	3	0	3	6	0	0	0	0	1,071	0	1,659	2,730
Longleaf Pine	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Northern Hardwood & Conifer	105	0	513	617	0	0	0	0	0	0	0	0	105	0	513	617
Plantation and Ruderal Forest	892	0	939	1,831	0	0	0	0	0	0	0	0	892	0	939	1,831
DC Total	2,065	0	3,107	5,173	3	0	3	6	0	0	0	0	2,068	0	3,111	5,179
DE																
Central Oak-Pine	20,064	426	4,423	24,913	146,032	5,494	17,730	169,255	6,224	1,157	2,080	9,461	172,320	7,077	24,232	203,629
Longleaf Pine	36		0	36	209	5	66	280					245	5	66	316
Northern Hardwood & Conifer	437	143	107	687	151	1	82	235					588	144	189	921
Plantation and Ruderal Forest	15,298	156	2,162	17,616	85,536	4,919	19,150	109,605	1,480	364	446	2,290	102,314	5,439	21,758	129,510
DE Total	35,835	724	6,692	43,251	231,928	10,419	37,028	279,375	7,704	1,521	2,526	11,750	275,467	12,665	46,245	334,376
MD																
Boreal Upland Forest					2			2	0			0	2	0	0	2
Central Oak-Pine	192,102	7,417	10,833	210,352	778,541	65,661	77,607	921,808	350,182	24,791	102,835	477,808	1,320,825	97,869	191,275	1,609,968
Longleaf Pine	329	12	32	374	2,281	218	578	3,077	783	14	437	1,235	3,393	244	1,048	4,685
Northern Hardwood & Conifer	19,303	1,994	1,801	23,098	101,210	14,740	6,248	122,198	64,080	6,886	35,375	106,340	184,593	23,620	43,423	251,637
Plantation and Ruderal Forest	112,198	3,176	6,500	121,874	298,165	18,572	56,017	372,754	142,654	7,710	50,855	201,219	553,017	29,457	113,372	695,846
MD Total	323,932	12,599	19,167	355,698	1,180,198	99,191	140,450	1,419,839	557,700	39,401	189,502	786,602	2,061,830	151,190	349,118	2,562,138
NJ																
Central Oak-Pine	414,056	44,322	17,338	475,716	440,735	236,501	16,044	693,280	138,480	161,641	4,913	305,035	993,272	442,464	38,295	1,474,030
Northern Hardwood & Conifer	54,018	7,847	3,848	65,713	132,623	51,664	6,373	190,661	28,923	30,821	2,346	62,091	215,564	90,333	12,568	318,465
Plantation and Ruderal Forest	122,330	4,333	2,779	129,441	81,833	14,782	1,905	98,520	23,625	6,727	297	30,650	227,788	25,842	4,981	258,610
NJ Total	590,403	56,502	23,965	670,870	655,191	302,947	24,322	982,460	191,029	199,190	7,556	397,775	1,436,624	558,638	55,843	2,051,106
PA																
Boreal Upland Forest	9		0	9	68	7	12	86	31	3	7	42	108	10	19	137
Central Oak-Pine	423,523	9,096	7,754	440,373	2,488,847	87,584	400,852	2,977,282	1,433,883	103,330	764,224	2,301,437	4,346,252	200,010	1,172,830	5,719,093
Northern Hardwood & Conifer	483,023	6,199	16,390	505,612	3,996,762	111,628	605,709	4,714,098	2,741,573	205,922	1,630,347	4,577,842	7,221,357	323,749	2,252,446	9,797,552
Plantation and Ruderal Forest	209,544	3,656	2,410	215,609	1,053,087	23,428	68,284	1,144,799	433,120	12,271	131,078	576,469	1,695,750	39,355	201,772	1,936,877
PA Total	1,116,098	18,951	26,555	1,161,603	7,538,763	222,646	1,074,856	8,836,265	4,608,606	321,527	2,525,657	7,455,790	13,263,467	563,124	3,627,067	17,453,658
VA																
Boreal Upland Forest					128	34	6	169	421	1,474	670	2,565	549	1,509	676	2,734
Central Oak-Pine	423,495	2,518	11,251	437,263	2,894,444	54,949	249,502	3,198,895	5,714,231	411,077	912,306	7,037,615	9,032,170	468,545	1,173,059	10,673,774
Northern Hardwood & Conifer	29,709	275	623	30,607	463,666	29,388	58,833	551,887	986,966	288,898	285,913	1,561,777	1,480,341	318,560	345,370	2,144,271
Plantation and Ruderal Forest	52,465	49	1,705	54,219	686,712	5,939	21,579	714,230	914,223	5,420	45,001	964,644	1,653,400	11,408	68,286	1,733,093
VA Total	505,669	2,842	13,579	522,090	4,044,951	90,311	329,920	4,465,181	7,615,841	706,869	1,243,891	9,566,601	12,166,460	800,022	1,587,390	14,553,872
WV																
Boreal Upland Forest	4			4	269	14	1,166	1,449	9,257	15,102	46,945	71,304	9,531	15,116	48,111	72,757
Central Oak-Pine	34,416		189	34,605	1,347,373	2,556	68,395	1,418,324	2,165,623	9,177	307,560	2,482,360	3,547,412	11,733	376,144	3,935,289
Northern Hardwood & Conifer	115,379		362	115,741	3,115,232	5,112	136,995	3,257,339	3,725,688	90,486	765,943	4,582,117	6,956,299	95,598	903,301	7,955,198
Plantation and Ruderal Forest	3,971		19	3,991	194,361	112	1,889	196,361	165,574	602	10,825	177,002	363,906	714	12,733	377,354
WV Total	153,771		570	154,341	4,657,235	7,794	208,445	4,873,474	6,066,142	115,367	1,131,273	7,312,782	10,877,147	123,161	1,340,289	12,340,598
Mid-Atlantic Total	2,727,773	91,617	93,636	2,913,026	18,308,270	733,308	1,815,024	20,856,601	19,047,021	1,383,875	5,100,404	25,531,301	40,083,064	2,208,800	7,009,064	49,300,927

New England/New York Subregion	Within <5,000 Acre Blocks				Within 5,000 <50,000 Acre Blocks				Within >=50,000 Acre Blocks				Grand Total			
	Unprotected	GAP 1 or 2	GAP 3	Total	Unprotected	GAP 1 or 2	GAP 3	Total	Unprotected	GAP 1 or 2	GAP 3	Total	Total Unprotected	Total GAP 1 or 2	Total GAP 3	Total
CT																
Boreal Upland Forest	2	0	0	2	79	7	41	127	35	0	1	36	116	7	42	165
Central Oak-Pine	270,977	9,365	27,919	308,261	767,950	46,853	121,111	935,914	4,404	320	877	5,600	1,043,330	56,538	149,907	1,249,775
Northern Hardwood & Conifer	117,658	4,770	14,676	137,104	359,894	25,132	65,950	450,977	4,157	202	749	5,108	481,709	30,105	81,375	593,189
Plantation and Ruderal Forest	5,633	417	836	6,886	9,203	816	1,843	11,863	7	0	0	7	14,843	1,233	2,679	18,756
CT Total	394,269	14,552	43,431	452,253	1,137,126	72,809	188,945	1,398,880	8,602	522	1,627	10,751	1,539,998	87,883	234,004	1,861,884
MA																
Boreal Upland Forest	162	6	39	207	6,808	3,027	5,093	14,929	3,947	480	2,591	7,018	10,917	3,514	7,723	22,154
Central Oak-Pine	427,088	6,645	94,256	527,988	615,371	29,252	159,744	804,367	69,690	13,014	54,373	137,076	1,112,149	48,910	308,372	1,469,431
Northern Hardwood & Conifer	104,111	1,834	19,105	125,049	584,804	54,566	199,669	839,039	221,870	23,381	99,610	344,861	910,785	79,781	318,384	1,308,950
Plantation and Ruderal Forest	6,542	79	1,815	8,436	10,320	260	3,713	14,292	686	111	587	1,384	17,548	449	6,115	24,112
MA Total	537,902	8,564	115,214	661,681	1,217,304	87,106	368,218	1,672,628	296,193	36,985	157,161	490,339	2,051,398	132,655	640,594	2,824,647
ME																
Boreal Upland Forest	134,721	6,305	7,685	148,710	1,306,104	29,746	28,901	1,364,752	4,476,023	327,084	1,268,660	6,071,767	5,916,847	363,136	1,305,246	7,585,229
Central Oak-Pine	57,638	2,864	1,843	62,345	232,778	10,571	15,865	259,214	23,738	873	2,364	26,976	314,154	14,309	20,072	348,536
Northern Hardwood & Conifer	224,748	3,396	3,963	232,107	2,115,666	20,119	59,740	2,195,525	3,462,103	154,218	830,384	4,446,705	5,802,518	177,733	894,087	6,874,338
Plantation and Ruderal Forest	22,086	360	298	22,743	266,019	3,227	4,178	273,424	287,440	18,380	38,267	344,087	575,545	21,967	42,743	640,254
ME Total	439,193	12,926	13,788	465,906	3,920,566	63,664	108,684	4,092,914	8,249,305	500,555	2,139,676	10,889,536	12,609,064	577,145	2,262,148	15,448,356
NH																
Boreal Upland Forest	3,317	19	1,956	5,292	65,126	17,905	13,216	96,246	218,364	279,161	174,341	671,866	286,807	297,085	189,512	773,404
Central Oak-Pine	54,120	602	5,228	59,950	454,794	11,111	63,020	528,924	103,579	2,839	17,265	123,683	612,492	14,552	85,513	712,557
Northern Hardwood & Conifer	55,040	551	7,624	63,215	1,068,119	39,840	201,337	1,309,296	1,081,075	187,125	512,051	1,780,250	2,204,234	227,516	721,012	3,152,762
Plantation and Ruderal Forest	1,818	11	204	2,033	17,407	798	3,065	21,270	23,364	1,391	8,339	33,095	42,589	2,200	11,609	56,397
NH Total	114,295	1,183	15,012	130,491	1,605,445	69,653	280,638	1,955,736	1,426,382	470,517	711,996	2,608,894	3,146,122	541,353	1,007,645	4,695,121
NY																
Boreal Upland Forest	1,252	379	8	1,639	23,169	27,412	5,576	56,157	139,195	347,152	97,508	583,855	163,615	374,944	103,092	641,651
Central Oak-Pine	307,661	15,017	17,871	340,549	1,280,973	32,914	107,152	1,421,039	1,124,427	49,336	133,776	1,307,538	2,713,061	97,266	258,800	3,069,127
Northern Hardwood & Conifer	315,029	9,984	10,661	335,674	3,344,437	103,128	250,836	3,698,402	5,396,944	2,092,442	1,246,088	8,735,474	9,056,410	2,205,554	1,507,585	12,769,550
Plantation and Ruderal Forest	36,621	520	1,661	38,803	239,083	2,006	23,787	264,877	252,377	11,482	60,092	323,952	528,082	14,008	85,541	627,631
NY Total	660,563	25,900	30,202	716,666	4,887,663	165,460	387,351	5,440,474	6,912,942	2,500,412	1,537,465	10,950,819	12,461,168	2,691,772	1,955,017	17,107,958
RI																
Central Oak-Pine	109,217	5,671	16,662	131,550	126,650	11,382	39,191	177,223	16	0	33	48	235,883	17,053	55,885	308,821
Northern Hardwood & Conifer	8,225	291	949	9,466	6,835	532	1,676	9,044	2	0	14	16	15,063	824	2,639	18,525
Plantation and Ruderal Forest	648	74	113	835	1,027	168	720	1,916	0	0	2	2	1,676	242	835	2,753
RI Total	118,090	6,036	17,724	141,851	134,513	12,082	41,587	188,183	18	0	48	65	252,621	18,119	59,359	330,099
VT																
Boreal Upland Forest	6,429	184	329	6,943	69,973	2,650	7,495	80,118	306,032	53,695	101,469	461,196	382,434	56,529	109,293	548,256
Central Oak-Pine	8,135	40	263	8,438	51,772	897	2,716	55,385	61,026	2,313	2,572	65,912	120,933	3,250	5,551	129,734
Northern Hardwood & Conifer	48,818	277	2,328	51,423	734,826	11,072	56,028	801,926	2,203,445	164,513	523,997	2,891,954	2,987,088	175,861	582,353	3,745,303
Plantation and Ruderal Forest	914	6	34	954	14,586	49	568	15,203	28,167	6,933	8,235	43,336	43,667	6,989	8,837	59,493
VT Total	64,296	506	2,955	67,758	871,157	14,669	66,806	952,631	2,598,669	227,454	636,273	3,462,397	3,534,122	242,629	706,034	4,482,786
New England/New York Total	2,328,609	69,668	238,327	2,636,605	13,773,775	485,443	1,442,229	15,701,447	19,492,110	3,736,445	5,184,245	28,412,800	35,594,494	4,291,556	6,864,801	46,750,852
Region Total	5,056,382	161,286	331,963	5,549,630	32,082,044	1,218,751	3,257,253	36,558,048	38,539,132	5,120,320	10,284,650	53,944,101	75,677,558	6,500,356	13,873,865	96,051,779

Wetlands

Condition and Conservation Status

April 2011

M. Anderson & A. Olivero Sheldon

From marshes, to swamps, to bogs, to fens, to floodplains, wetlands are among the most productive and diverse ecosystems on earth, and a truly distinctive feature of the eastern landscape. Dominated by rooted plants that thrive in saturated, spongy soils, wetlands form in depressions where surface water collects (basin wetlands), in areas subject to regular flooding by stream overflow and ground water discharge (alluvial wetlands), or in places of tidal inundation (tidal wetlands). In this region, there are over 750,000 individual wetlands and collectively they account for 8.4 million acres, representing 5 percent of the land area. In this chapter, we examine their loss and degradation, as well as their conservation, and consider the implications of these factors to wildlife.

Summary of Findings

Distribution, Loss, and Protection: Seven percent of the region was once covered by wetlands, mostly swamps, peatlands, and marshes, but at least one-quarter of that (2.8 million acres) has been converted to agriculture or development. Conservation efforts have secured 25 percent of the remaining 8.4 million wetland acres, equivalent to 19 percent of the historic distribution. Protection has not been spread evenly across wetland types. Almost one-third of the largest tidal marshes are entirely secured, but river-related wetlands, such as floodplain forests, have lost 27 percent of their historic extent and are only 6 percent protected for biodiversity.

Ecological Condition: Sixty-seven percent of all wetlands in this region have paved roads so close to them, and in such high densities, that they have likely experienced a loss of species. Moreover, 66 percent have development or agriculture directly in their buffer zones likely resulting in moderate to severe impacts on biodiversity. On the other hand, the majority of wetlands appear to have expanded slightly in size over the last 20 years.

Trends in Wetland Birds: There have been substantial changes to wetland bird populations over the last 40 years, both increases and declines. Species change is correlated with the degree of conversion in the buffer zone and with the density of nearby roads. Alluvial wetlands have seen the most declines and tidal marshes the least. Ten wetland breeding birds species are declining in five states or more, most notably: red-winged blackbird, common yellowthroat, and savannah sparrow. Other species, such as mallard, Canada goose, and wood duck have increased. Declines and increases appear to be species specific and may not all be related to local wetland characteristics.

Types of Wetlands and their Fauna

Depending on hydrology, wetlands are dominated by forested swamp (82 percent) or open marsh (18 percent), and this difference in structure results in different wildlife communities. However, wetland ecosystems are dynamic over time; during wet years emergent marsh areas expand and during dry years trees and shrubs reclaim ground.

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We used the National Land Cover Dataset (Homer et al. 2004) to map wetlands. Adjacent cells of emergent wetland and woody wetland were extracted to form individual wetland occurrences. These were classified into alluvial, basin, and tidal system types as follows: tidal wetlands had at least half of their occurrence in the less than 6 meter elevation coastal zone, alluvial wetlands had half or more of their occurrence located in the floodplain of rivers with over 100 sq.km drainage areas, the remaining occurrences were classified as basin wetlands.

	Wetland Type	Acres	Percent
Emergent Marsh	Alluvial Marsh	205,750	2%
	Basin Marsh	460,715	5%
	Tidal Marsh	878,839	10%
Forested Swamp	Alluvial Swamp	1,358,464	16%
	Basin Swamp	4,967,799	59%
	Tidal Swamp	550,799	7%
All Types		8,422,366	100%
Settings	Alluvial Total	1,564,214	19%
	Basin Total	5,428,514	64%
	Tidal Total	1,429,638	17%

<u>Marshes:</u> These wetlands are formed by herbaceous vegetation, usually fast-growing clonal species such as cattail, which die back in the winter and reemerge in the spring. Marsh systems are wetter than swamps and typically contain a mix of open water and vegetated habitat. Marshes occur naturally in three settings -- basins, alluvial zones, and tidal areas -- and cover 1.5 million acres (Map 1).

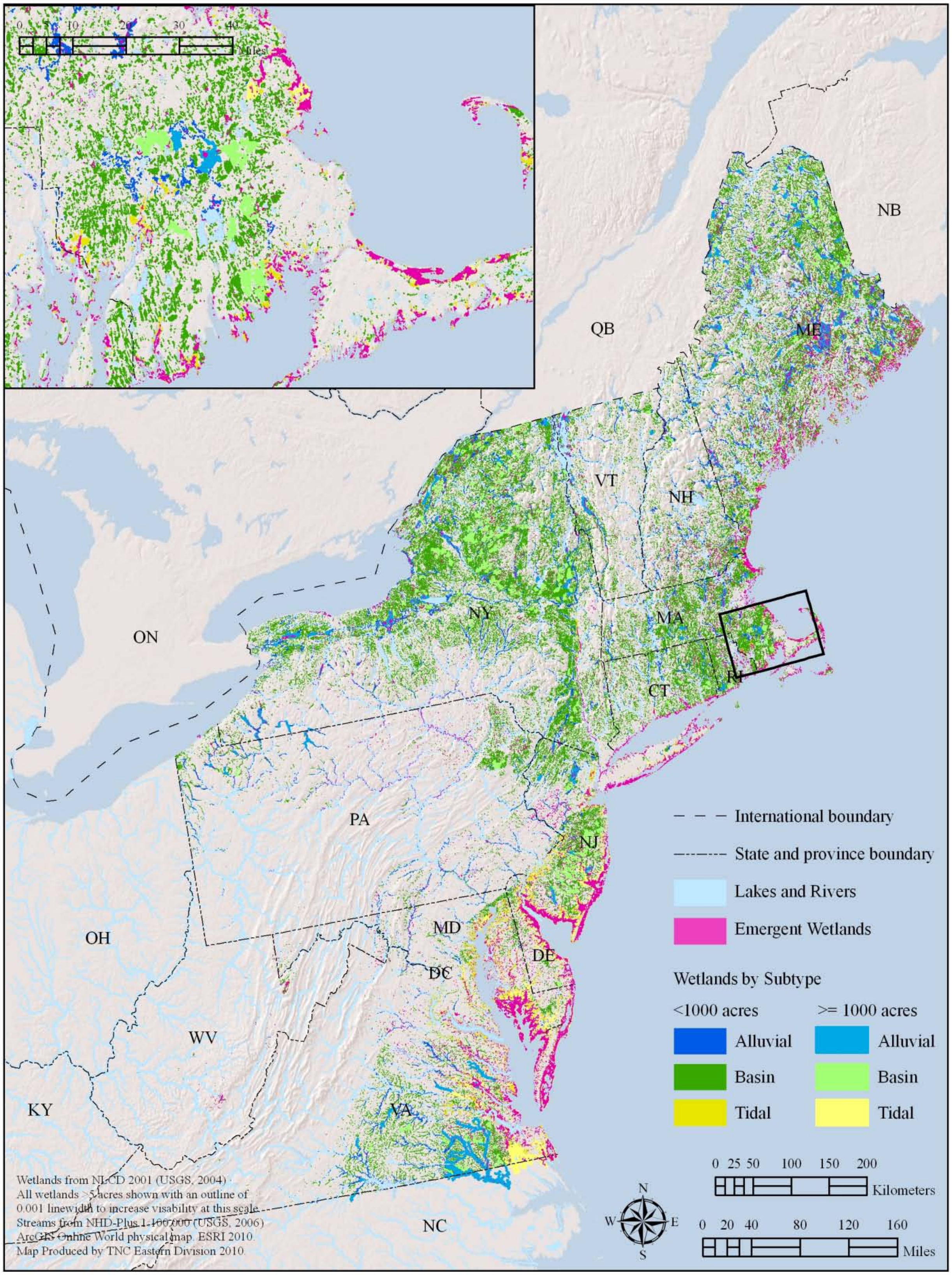
Basin marshes are the most numerous type of herbaceous wetland, and were found throughout the region in depressions where water collects and organic matter accumulates. Eighty percent are under 1,000 acres in size, and collectively they cover almost half a million acres. They sustain an abundant and diverse invertebrate fauna and support a wide array of wildlife.

Alluvial marshes are associated with flowing streams and periodic inundation. During floods, they provide critical nursery and breeding areas for fish and provide food resources to a wide variety of wildlife. Alluvial marshes were the least common wetland type in the region, having less than half the extent of basin marshes (250,000 acres), but individual marshes could be extensive, and a quarter of them were over 1,000 acres. Common species associated with both basin and alluvial marshes include: water snake, green frog, bullfrog, grey treefrog, spring peeper, painted turtle, star-nosed mole, muskrat, and mink. Common marsh birds include 17 species and are discussed later in this chapter.

Tidal marshes are a distinct type of emergent wetlands forming in the intertidal coastal fringe and inundated regularly by salt water. Only a few plant species, such as cordgrass, saltgrass, and glasswort, can tolerate both salt and freshwater inundation, and these species dominate these unique wetlands. Tidal marshes provide habitat for a remarkable set of species from fiddler crab to clapper rail, and are important nursery areas for a variety of marine species. Fringing the coast from Virginia to Maine, tidal marsh was the most extensive type of emergent marsh in the region, accounting for about 800,000 acres with 53 percent of them being over 1,000 acres in extent.

<u>Forested Swamps</u>: These wetlands are dominated by trees and shrubs that tolerate occasional inundation. They often surround and interweave with permanently saturated marshes, and also occur in basins, riversides, and tidal areas (Map 1).

Map 1. Wetlands be subtype.



Basin swamps are typified by species such as red maple and spotted alder. They support a diverse invertebrate fauna, and provide breeding habitat for species like: four-toed salamander, blue-spotted salamander, American toad, water shrew, and southern flying squirrel. Vernal ponds, and their associate species, are a common feature of the hummock and hollow structure of forested swamps. Northward, basin swamps are often dominated by conifers such as spruce and cedar, and may form highly acidic bog ecosystems characterized by leatherleaf, bog laurel, and Labrador tea. Forested bogs support specialist species such as carnivorous plants, and the fauna includes: spotted salamander, eastern newt, pickerel frog, northern leopard from, bog turtle, spotted turtle, and southern bog lemming. Forest swamps provide habitat for over 40 birds and were the most common wetland in the region (5 million acres).

Alluvial swamps are river-side forests that form in floodplains, old oxbows, or backwater depressions. Dominated by trees that tolerate dry soils as well as long periods of inundation, such as silver maple, green ash, and American elm, they often support river-adapted birds such as Acadian flycatcher, cerulean warbler, hooded warbler, Kentucky warbler, belted king fisher, and bank swallow.

Tidal swamps are a coastal fringe forest that forms on the edges of salt marshes, and are periodically subject to inundation by fresh or brackish water.

Distribution, Loss, and Protection Status

Wetland Conversion: Wetlands comprise only 5percent of the total land area in this region, but this small percentage of land supports a large piece of the total biodiversity of the region, including over 1,500 plants considered obligate or facultative wetland species (Reed and Porter 1988), and at least 475 rare species (see chapter on unique habitats). The immense value of wetlands was unrecognized for most of the last two centuries during which time they were systematically drained to create land suitable for agriculture and development.

How many wetlands were lost to conversion? Using historical literature, Dahl (1990) estimated that across all 14 states in the region, about 7.2 million acres were lost between 1780 and 1980. We revised these estimates using spatially-specific flow accumulation models combined with topographic position to identify areas where wetlands occur naturally. Our model encompassed all the known wetlands mapped by NWI and NLCD, but also identified wet flat settings where wetlands should naturally occur, but that are now filled with development or agriculture. The results of this analysis suggest that a minimum of 2.8 million and a maximum of 5.6 million acres have been converted: 25 to 50 percent of all historic wetlands. Our estimate was smaller than Dahl’s, even using our maximum, but there is agreement in the pattern and magnitude of loss in many individual states, with the discrepancies being mostly in Maine and Maryland (Figure 1). In our discussion of conversion and securement below, we use the minimum estimate of wetland loss.

Based on our minimum estimate, results suggest that of all 2.8 million acres of wetlands lost, 14 percent were converted to agriculture and 10 percent to development. Alluvial wetland had the largest proportion converted, 27 percent, followed by basin wetlands, 25 percent, and tidal wetlands, 19 percent. (Table 1, Figure 2).

Figure 1. Estimates of wetland loss: A state by state comparison of Dahl's (1990) estimate with those derived from new spatially explicit models. There is considerable agreement in most states, but large discrepancies were in Maine and Maryland where Dahl's estimates were much higher.

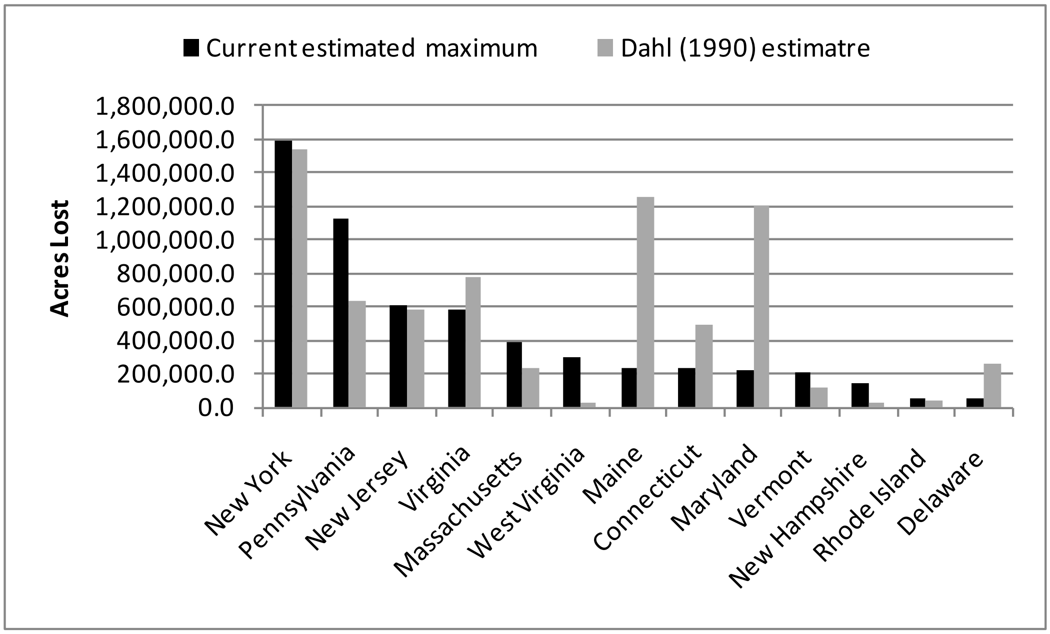
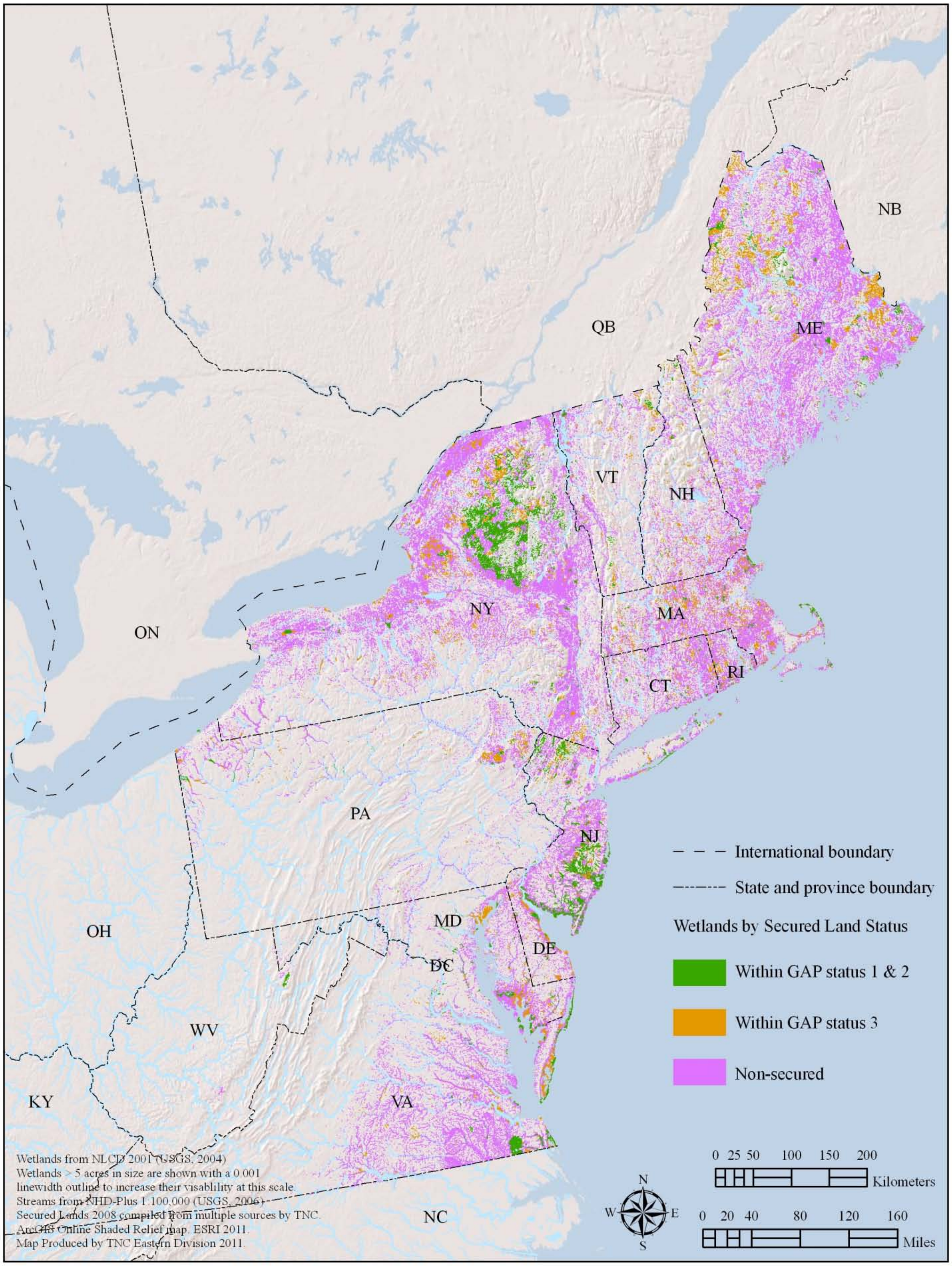


Table 1. Amounts of conversion and securement. The units are in acres, organized by wetland type. The term "securement" refers to GAP status 1-3 and "protection" to GAP 1-2 only. The ratio of conversion to securement (CRI-S) and conversion to protection (CRI-P) were calculated with respect to the total historic acres. %C = percent converted, % S = percent secured.

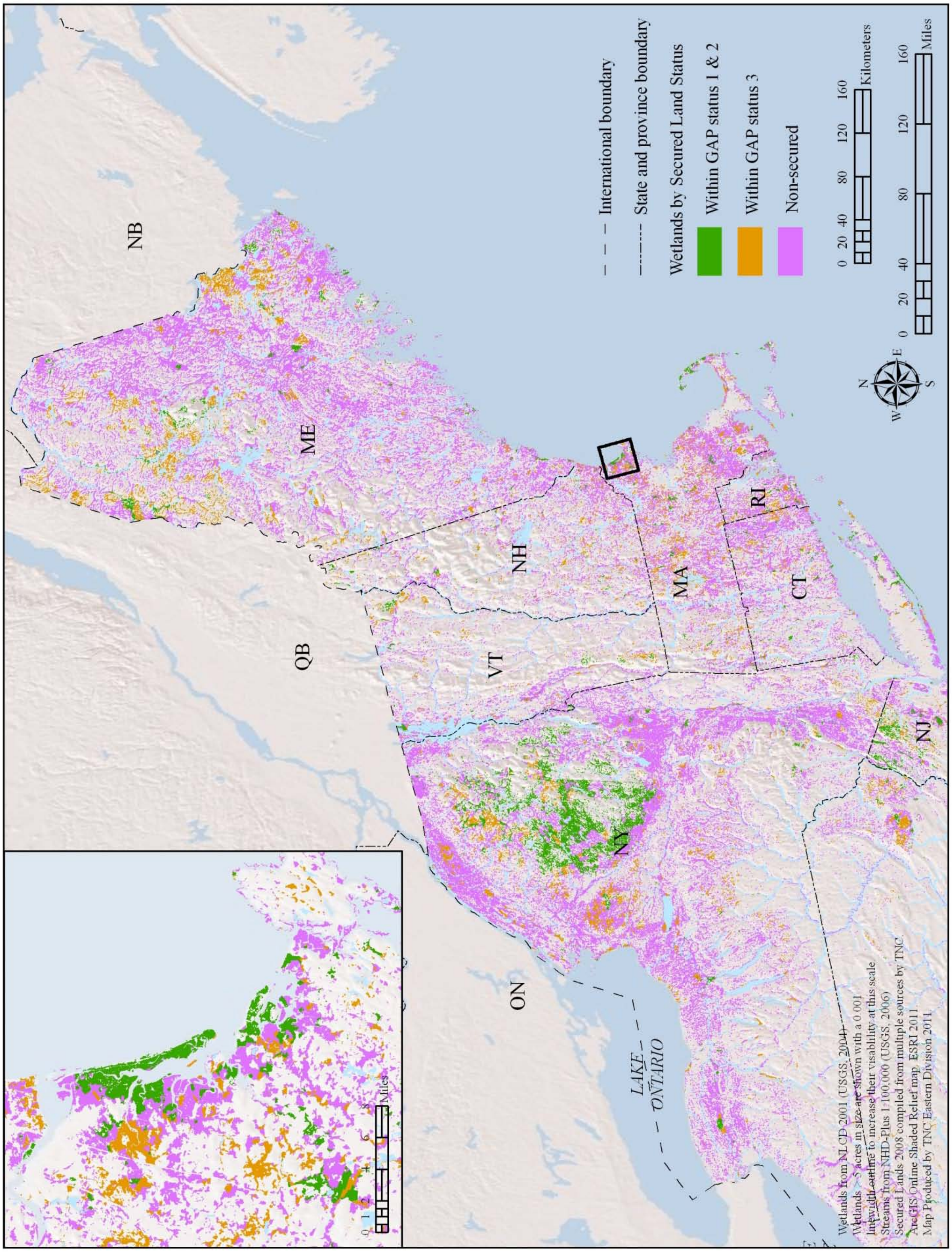
Types	Agriculture	%A	Developed	%D	Gap 1-2	%G1	Gap 3	%G3	Un-secured	%U	Total Current	Total Historic	% C	% S	CRI-S	CRI-P
Tidal	119,202	0.07	222,445	0.13	359,046	0.20	227,008	0.13	843,584	0.48	1,429,638	**1,771,285**	0.19	0.33	0.6	1.0
Alluvial	338,004	0.16	251,889	0.12	121,888	0.06	194,541	0.09	1,247,785	0.58	1,564,214	**2,154,107**	0.27	0.15	1.9	4.8
Basin	1,074,815	0.15	745,886	0.10	535,418	0.07	666,621	0.09	4,226,475	0.58	5,428,514	**7,249,215**	0.25	0.17	1.5	3.4
All Wetlands	**1,579,431**	**0.14**	**1,206,335**	**0.11**	**1,016,352**	**0.09**	**1,088,169**	**0.10**	**6,317,844**	**0.56**	**8,422,366**	**11,208,132**	**0.25**	**0.19**	**1.3**	**2.7**

Conversion versus Securement: Protection of wetlands effectively began in the 1970's. During this time, their value was recognized and quantified and federal and state laws were enacted to curb their loss (Mitsch and Gosselink 1986). To quantify the amount of wetland securement, we overlaid the TNC secured land dataset on the wetland occurrences and tabulated the degree of securement for each occurrence. The results of the overlay indicate that 25 percent of the current wetland (19 percent of historic) now occurr on land that is either permanently protected for biodiversity conservation (9 percent of historic) or secured for multiple uses (10 percent of historic). Thus, there is now almost as much wetland acreage secured as was lost by conversion (Table1, Figure 2). However, the overall pattern largely reflects the conservation of extensive tidal marshes, where conversion is lower than securement (ratio = 0.3) and conversion equals protection 1:1. The situation is different for other wetland types. For basin wetlands conversion exceeds securement about 2:1 and protection 3:1. Alluvial wetlands are the most converted and least secured with conversion exceeding securement 2:1 and outweighing protection 5:1 (Maps 2-4, Table 1, Figure 2)

Map 2. Wetlands by secured area status.



Map 3. Wetlands by secured area status, New England and New York.



Map 3. Wetlands by secured area status, Mid-Atlantic.

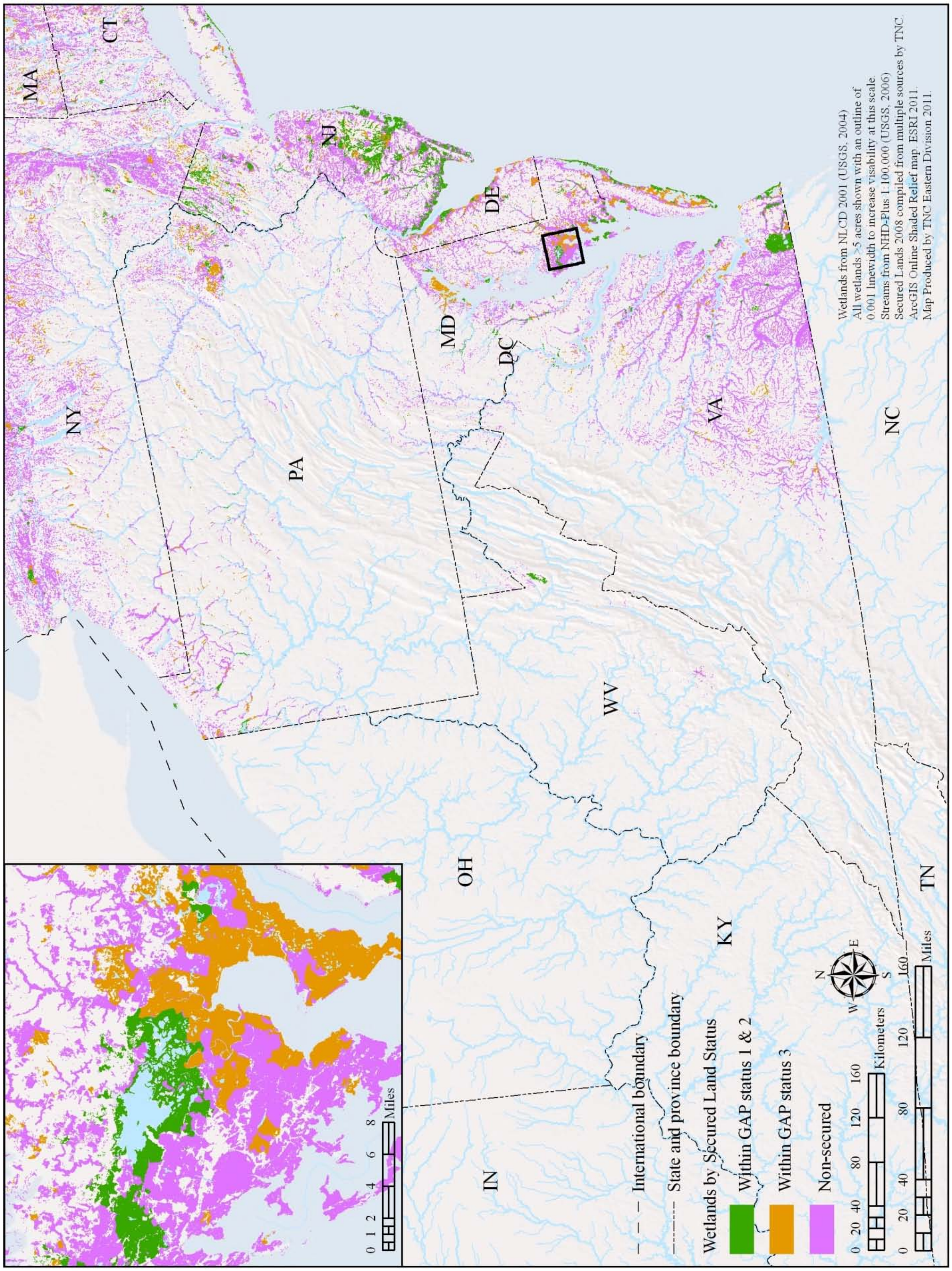
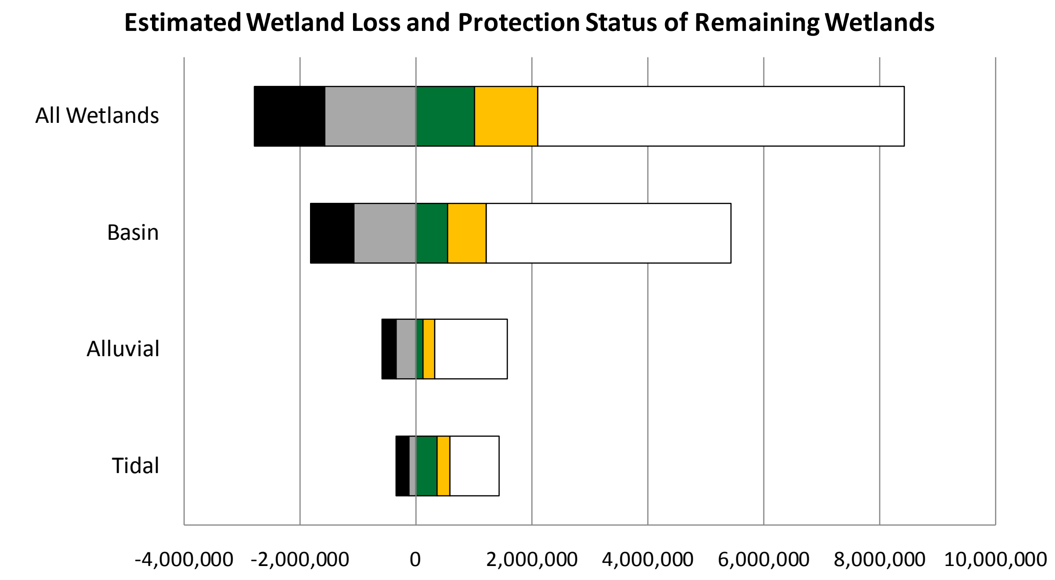


Figure 2. Estimates of historic wetland conversion to agriculture or development compared with the current status of wetland protection. Protection is defined as wetlands secured against conversion for biodiversity concerns (GAP 1 or 2) or multiple uses (GAP 3). Each bar represents 100 percent of the historic wetlands. Area to the left of the "0" axis indicates acreage lost to development or agriculture. Area to the right of the "0" axis indicates remaining wetlands.

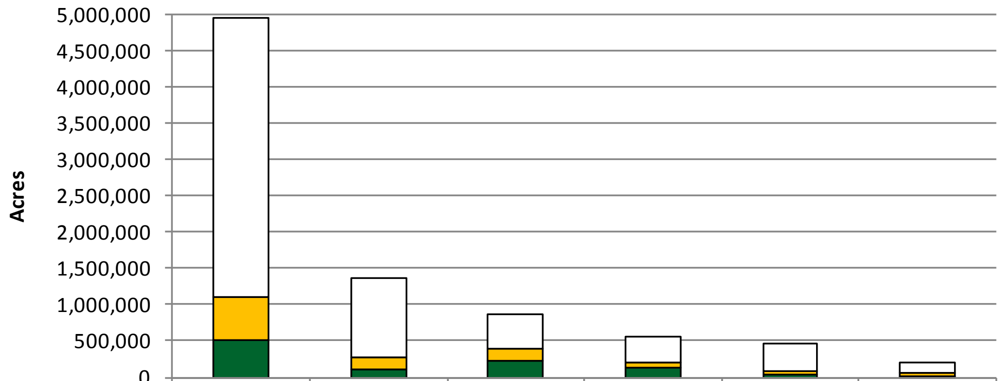


	Tidal	Alluvial	Basin	All Wetlands
Agriculture	-119,202	-338,004	-1,074,815	-1,579,431
Developed	-222,445	-251,889	-745,886	-1,206,335
Wetlands: Gap 1 & 2	359,046	121,888	535,418	1,016,352
Wetlands: Gap 3	227,008	194,541	666,621	1,088,169
Wetlands: Unprotected	843,584	1,247,785	4,226,475	6,317,844

Alluvial wetlands, such as floodplain forests and river marshes, emerged as the wetland type of greatest concern in the region as 27 percent of their historic extent has been converted, mostly to agriculture. Although 15 percent of the historic area is now secured, only 6 percent is protected for biodiversity, so conversion exceeds protection 5:1 (Table 1). Floodplain forests and alluvial swamps have the lowest level of biodiversity protection (7 percent) and alluvial marshes are only slightly higher at 10 percent of the remaining area (Figure 3). Because these particularly diverse ecosystems contribute important services related to flood storage, and because agricultural lands have the potential to be restored to natural systems, these findings suggest alluvial wetland should be a focus for conservation over the next decade.

The extremely valuable tidal wetlands have received proportionally the greatest conservation activity with 33 percent of the historic distribution (40 percent of remaining wetlands) secured against conversion, including 20 percent protected for biodiversity values (Table 1 and Figure 3).

Figure 3. Conservation status by percent and acreage, of the six wetland types defined above. These numbers are based on the current area and do not account for the historic distribution.



	Basin Swamp	Alluvial Swamp	Tidal Marsh	Tidal Swamp	Basin Marsh	Alluvial Marsh
% Unsecured	0.78	0.80	0.56	0.63	0.80	0.75
% G3	0.12	0.12	0.18	0.13	0.12	0.15
% G1-2	0.10	0.07	0.26	0.24	0.08	0.10
Unsecured	3,856,862	1,093,470	496,357	347,227	369,612	154,315
GAP3	610,097	164,478	157,406	69,602	56,524	30,063
GAP1 & GAP2	500,840	100,516	225,076	133,970	34,579	21,373

Conservation and Wetland Size: Studies suggest that the number of species supported by an individual wetland is correlated with its size. In this region, 40 percent of all individual wetlands are less than 2 acres, and collectively they cover only 5 percent of the area. Only 605 individual wetlands are larger than 1,000 acres each, but in aggregate these huge wetlands account for 22 percent of the total wetland acreage in the region (Maps 2-4, Table 2). Large wetlands play a disproportionally important role in supporting biodiversity, storing water, and mitigating against extreme events. Most states contain at least one of these huge wetlands; large forested swamps are concentrated in ME, NY, Eastern MA, RI, and NJ while the tidal marshes are most extensive in NJ, DE, MD, and VA (Table 1, Map 1). Examining the secured land status of large wetlands revealed that 30-50 percent of these huge wetlands were on secured land, that this was true across all wetland types (Figure 4, Table 3), and this included over half of the large tidal marshes.

Table 2. Percent of regional area covered by wetlands in each size class.

	Area covered by wetlands in each size class			Area covered as % of total Area
Wetland Type	**<2 acres**	**2 - 1000 acres**	**>=1000 acres**	
Alluvial	3%	65%	32%	19%
Basin	6%	82%	12%	64%
Tidal	2%	47%	50%	17%
Grand Total	**5%**	**73%**	**22%**	**100%**
Emergent Marsh	8%	64%	28%	18%
Forested Swamp	5%	77%	18%	82%
Grand Total	**5%**	**73%**	**22%**	**100%**

Figure 4. The conservation status of large wetlands over 1000 acres. Each column shows the percent of the total acreage that is found in large individual wetlands, and the percent of the large wetlands in each GAP status.

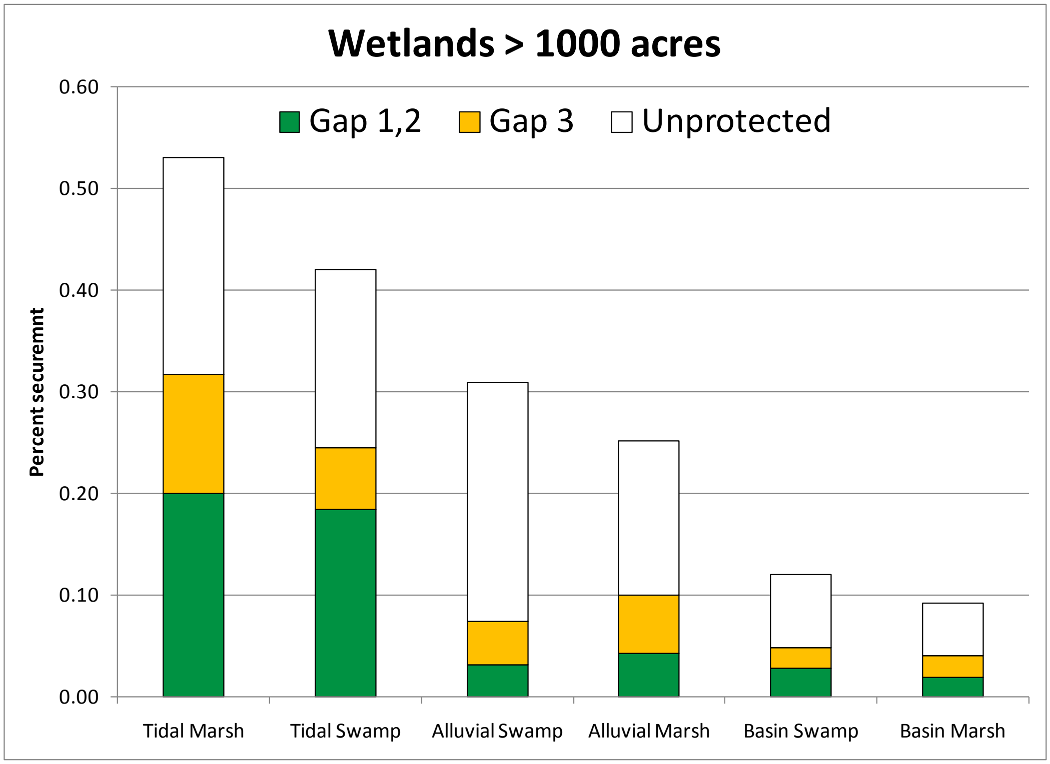


Table 3. Conservation status by size and protection types. These numbers reflect the remaining wetland area and do not account for the historic distribution.

	Size <2 acres				Size >= 2 < 1000			
Wetland Type	Gap 1 & 2	Gap 3	Unsecured	Total Acres	Gap 1 & 2	Gap 3	Unsecured	Total Acres
Alluvial Marsh	4%	6%	90%	9,420	8%	12%	79%	144,393
Alluvial Swamp	5%	7%	87%	38,078	6%	12%	82%	900,336
Alluvial Total	5%	7%	88%	47,498	6%	12%	82%	1,044,729
Basin Marsh	3%	6%	90%	38,892	6%	12%	82%	379,050
Basin Swamp	8%	9%	83%	287,250	8%	12%	80%	4,083,816
Basin Total	7%	9%	84%	326,142	8%	12%	80%	4,462,866
Tidal Marsh	4%	5%	91%	17,500	12%	13%	74%	395,077
Tidal Swamp	11%	10%	79%	16,915	10%	11%	78%	302,247
Tidal Total	8%	7%	85%	34,415	11%	13%	76%	697,324
Region Total	7%	9%	84%	408,056	8%	12%	80%	6,204,919
	Size >= 1,000				**All Wetlands (regardless of size)**			
Wetland Type	Gap 1 & 2	Gap 3	Unsecured	Total Acres	Gap 1 & 2	Gap 3	Unsecured	Total Acres
Alluvial Marsh	17%	23%	60%	51,937	10%	15%	75%	205,750
Alluvial Swamp	10%	14%	76%	420,050	7%	12%	80%	1,358,464
Alluvial Total	11%	15%	74%	471,987	8%	12%	80%	1,564,214
Basin Marsh	21%	24%	56%	42,772	8%	12%	80%	460,715
Basin Swamp	24%	16%	60%	596,733	10%	12%	78%	4,967,799
Basin Total	24%	17%	60%	639,506	10%	12%	78%	5,428,514
Tidal Marsh	38%	22%	40%	466,262	26%	18%	56%	878,839
Tidal Swamp	44%	14%	42%	231,637	24%	13%	63%	550,799
Tidal Total	40%	20%	41%	697,899	25%	16%	59%	1,429,638
Region Total	27%	17%	56%	1,809,392	12%	13%	75%	8,422,366

Ecological Condition

Impacts in the Buffer Zone: The area immediately surrounding a wetland, its buffer zone, has a strong influence on the quality and diversity of the wetland. To assess the condition of this area, we defined a 100 m zone around each individual wetland greater than 2 acres in size and calculated the amount of development, agriculture, and natural vegetation within it. We summarized this information in an index of disturbance, by calculating a weighted sum of the anthropogenic features present and weighting the effect of development more than agriculture. Scores ranged from 100 for a wetland with its buffer zone totally developed, to 0 where the buffer was completely within natural cover types:

> *Disturbance Score = 1.0 times the percent high intensity development + 0.75 times the percent low intensity development, + 0.50 time the percent agriculture*

To interpret the index, we developed categories of impact based on the correlation of the impact scores to observed measurements of shoreline human disturbance for sites sampled by the National Lake Assessment (EPA National Lake Assessment 2009, R^2 squared = 0.56, $p < 0.0001$). We matched the three disturbance categories used in the lake assessment by calculating the mean impact score for the set of known sites in each disturbance category, using the point halfway (log scale) between the means as the cutoffs:

- Low disturbance 0 < 3.7
- Moderate disturbance >= 3.7 < 15.0
- Severe disturbance >=15.0

Across all wetlands, the results indicated a nearly equal distribution of total acres in each of the three impact categories (Map 5, Table 4, Figure 5). By type, tidal wetlands were the most disturbed, with only 15 percent of them in the undisturbed class. Basin wetlands were the least disturbed with 43 percent undisturbed, and alluvial wetlands were intermediate with 31 percent undisturbed. The percent of wetlands in the undisturbed class in New England and New York (43 percent) was over twice that of the Mid-Atlantic (18 percent) although this largely reflected the basin wetlands. Alluvial and tidal wetlands were relatively less impacted in the Mid-Atlantic (Table 4).

Map 5. Wetland occurences by impact classes.

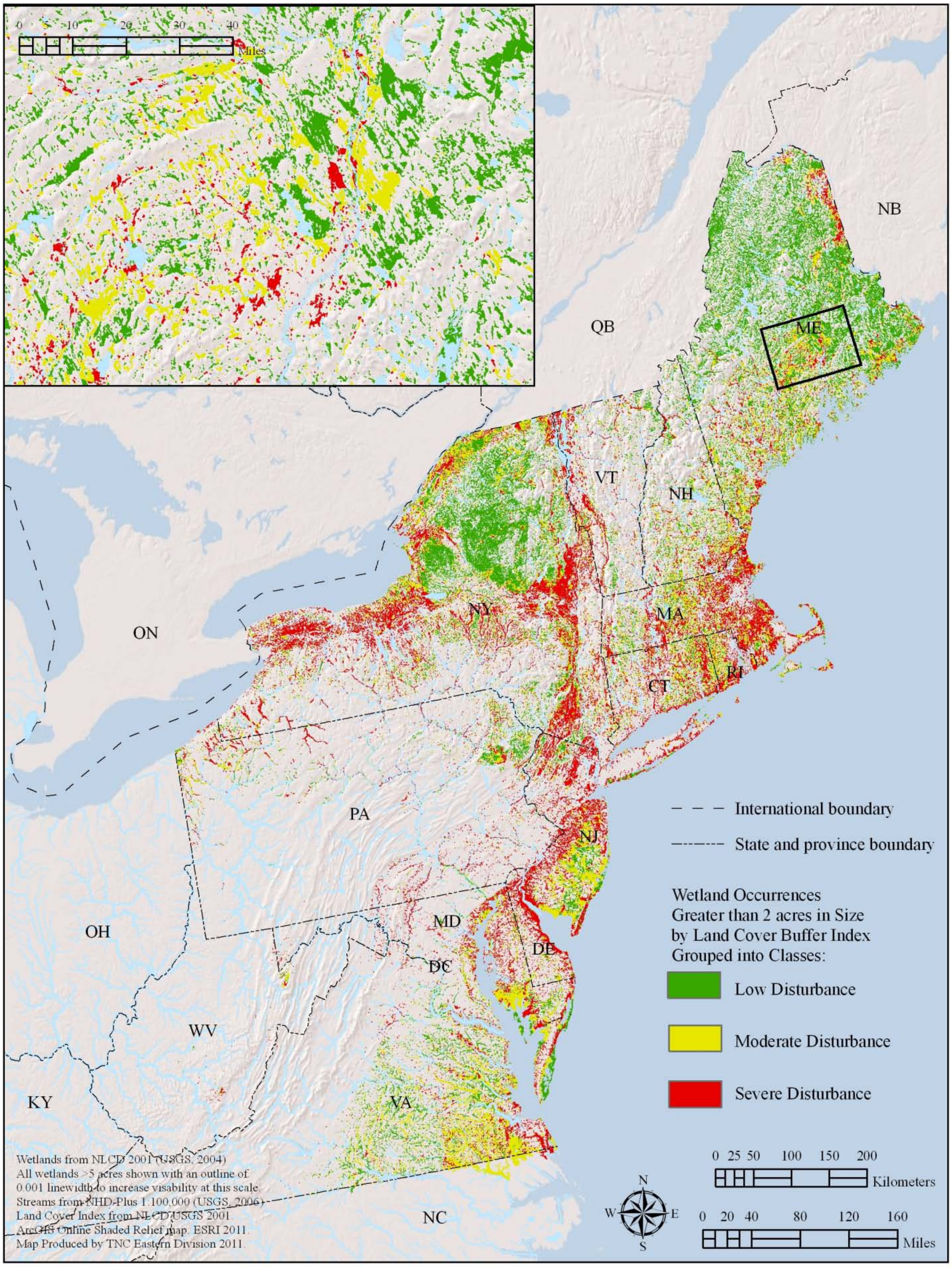
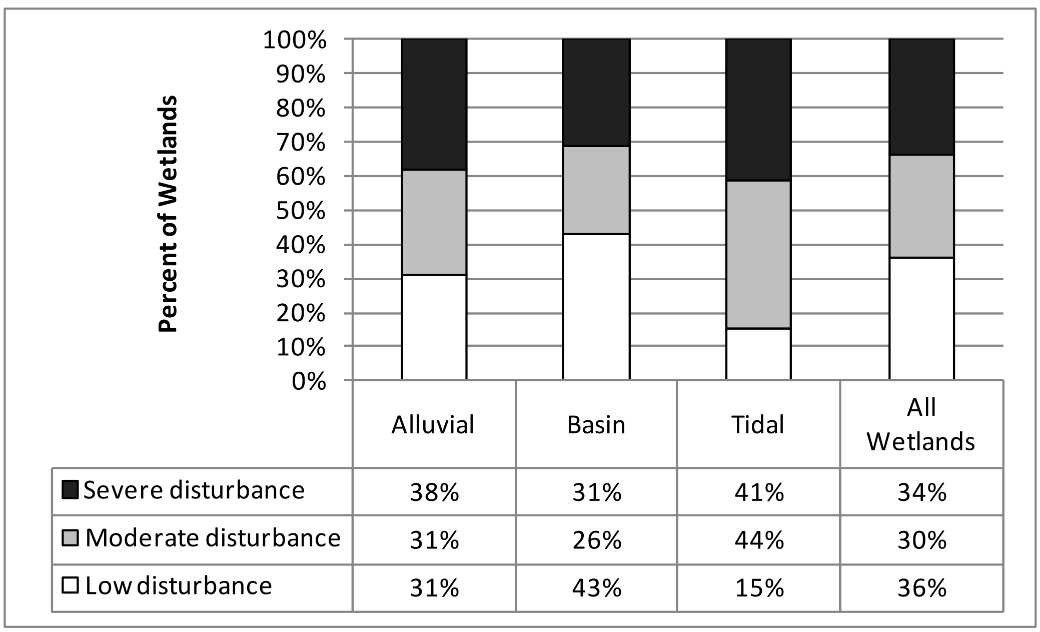


Table 4. Percent of wetland acreage in each impact class across wetland types and subregions.

Region	Type	Low disturbance	Moderate disturbance	Severe Disturbance
Mid-Atlantic	Alluvial	15%	55%	30%
	Basin	26%	37%	37%
	Tidal	14%	49%	37%
Mid-Atlantic Total		18%	46%	36%
New England & New York	Alluvial	37%	23%	40%
	Basin	47%	24%	29%
	Tidal	18%	24%	58%
New England & New York Total		43%	24%	33%
Region	Alluvial	31%	31%	38%
	Basin	43%	26%	31%
	Tidal	15%	44%	41%
Region Total	All Wetlands	36%	30%	34%

Figure 5. Disturbance in the 100 m buffer zone. This chart shows the percentage of 435,000 individual wetlands in each disturbance class. Only wetlands >2 acres were included.



<u>Road Density:</u> The species richness of birds, amphibians, reptiles, and plants within an individual wetland is negatively correlated with the density of paved roads surrounding a wetland (Forman 2003), with the sensitive impact distances varying from 500 m to 2,000 m depending on the taxa (Findlay and Houlahan, 1997). To measure this, we created a road density data layer for the whole region by calculating the density of roads (meters/hectare) within a 1,000 meter radius of each 30 m pixel of land ar

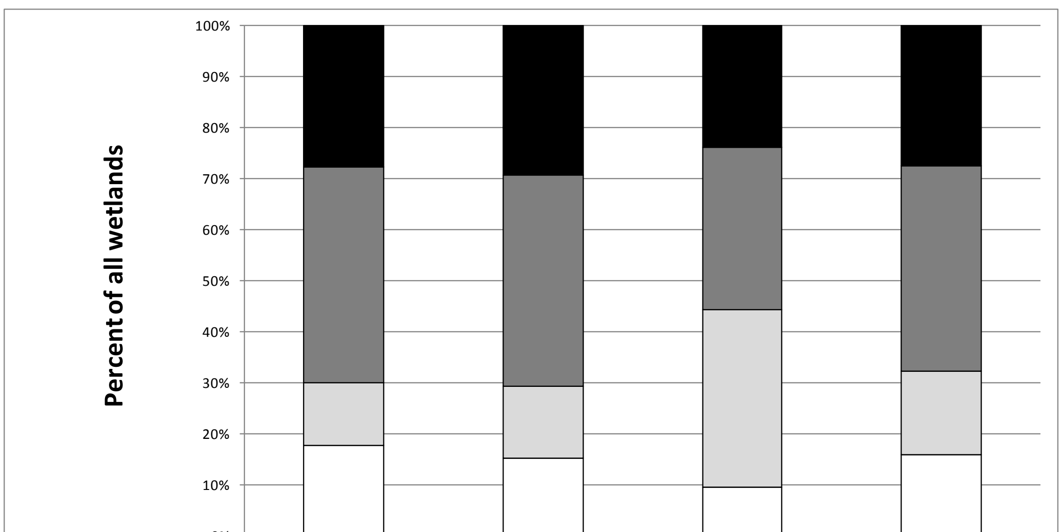
in the region. Subsequently, we calculated the mean road density value for each wetland by taking the average of all pixels within each occurrence. This method takes into account roads in the buffer zone as well as the total size of the wetland, so that large wetlands show fewer impacts from roads.

We created a road impact index for each wetland occurrence based on Findlay and Houlahan (1997) who found that plant species richness decreased 13 percent with every 2 m/ha of paved roads within a buffer zone, and showed similar patterns for other taxa. The road dataset we used consisted primarily of paved roads including major highway, local thoroughfares, neighborhood connectors, and rural roads, but we do not know the number of unpaved road in the dataset (Tele Atlas North America, Inc 2009). Four-wheel drive roads and other trails were not included due to inconsistencies in their mapping across the region in the source dataset. Our index, based on roads in the 1,000 m buffer, was as follows:

- No impact: 0- 2 m/ha roads of roads (estimated 80-100% of natural species richness)
- Moderate impact: 2 to 6 m/ha of roads (estimated 50-80% of natural species richness)
- Impacted: 6 to 18 m/ha of roads (estimated 25-50 of natural species richness)
- Severe impact: >18 m/ha of roads (estimated >25% of natural species richness)

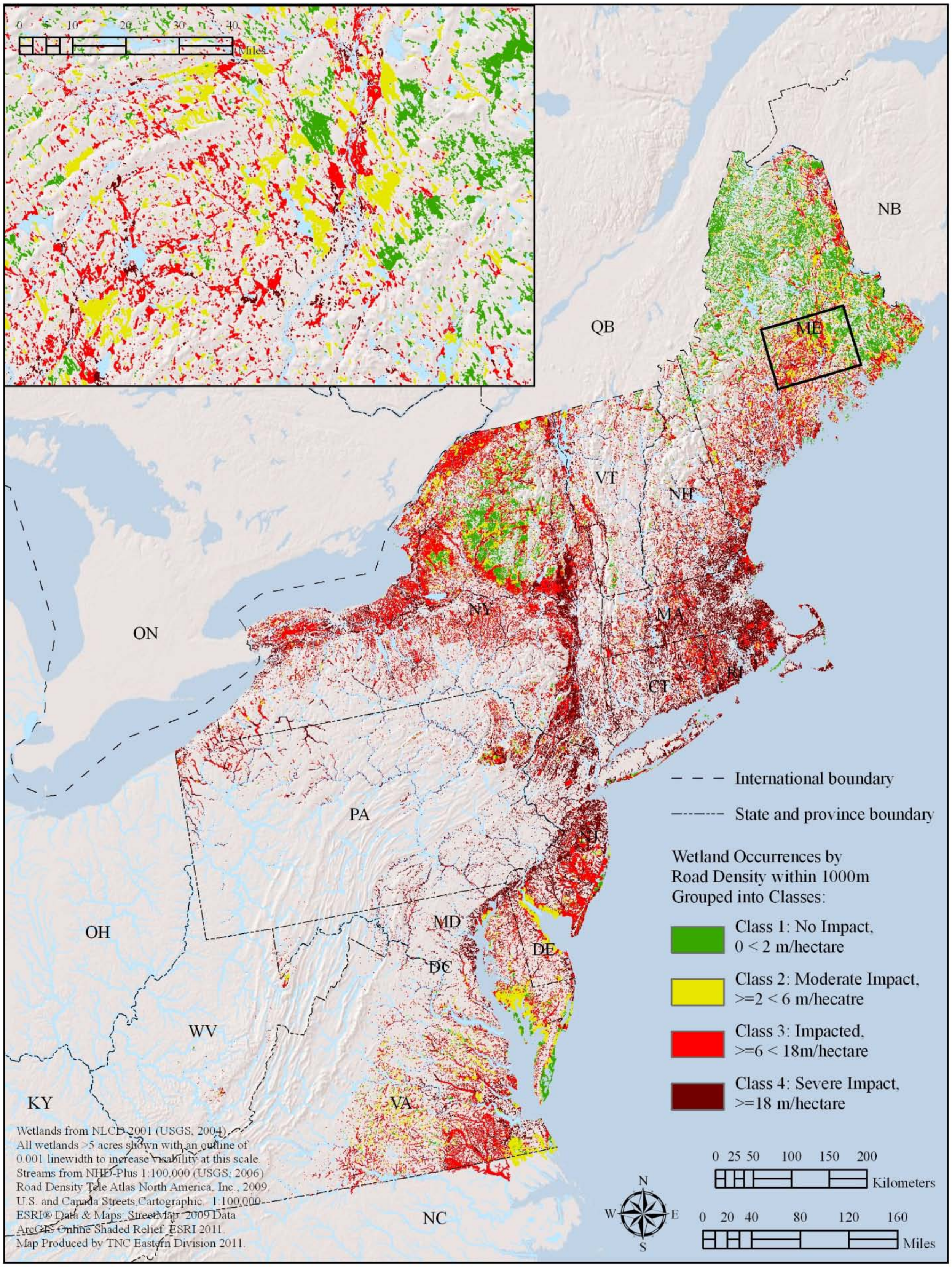
The results of applying the index to all wetlands indicated that only 16 percent of all wetlands in this region were free of road impacts. Sixty-seven percent were in the impacted to severe impact categories, suggesting that most wetlands in the region do not support a full complement of native species. The alluvial and basin wetlands had the largest proportion of impacted wetlands, perhaps because they were smaller than tidal wetlands (Figure 6, Map 6).

Figure 6. Acres of wetlands in each road impact category across wetland types. This metric was calculated for a 1,000 m buffer zone around each individual wetland.



	Basin	Alluvial	Tidal	All Wetlands
■ Class 4: Severe Impact (>=18 m/hectare)	28%	29%	24%	27%
■ Class 3: Impacted (>=6 < 18m/hectare)	42%	41%	32%	40%
□ Class 2: Moderate Impact (>=2 < 6 m/hecatre)	12%	14%	35%	16%
□ Class 1: No Impact (0 < 2 m/hectare)	18%	15%	10%	16%

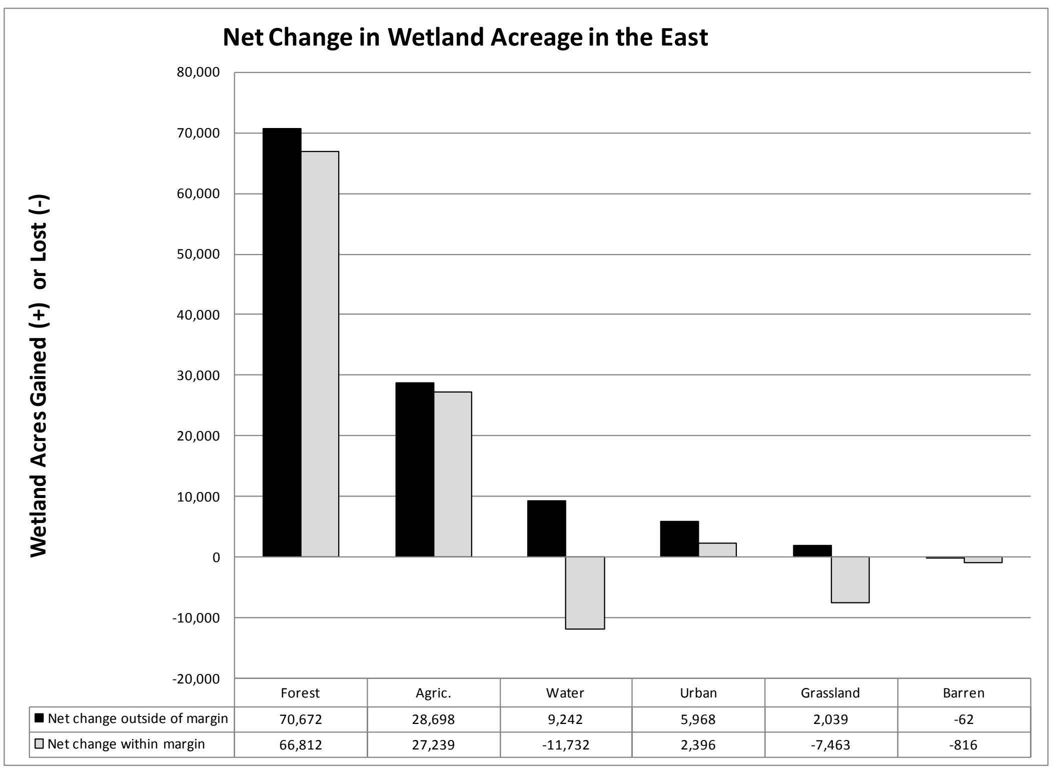
Map 6. Wetland occurrences by road impact category.



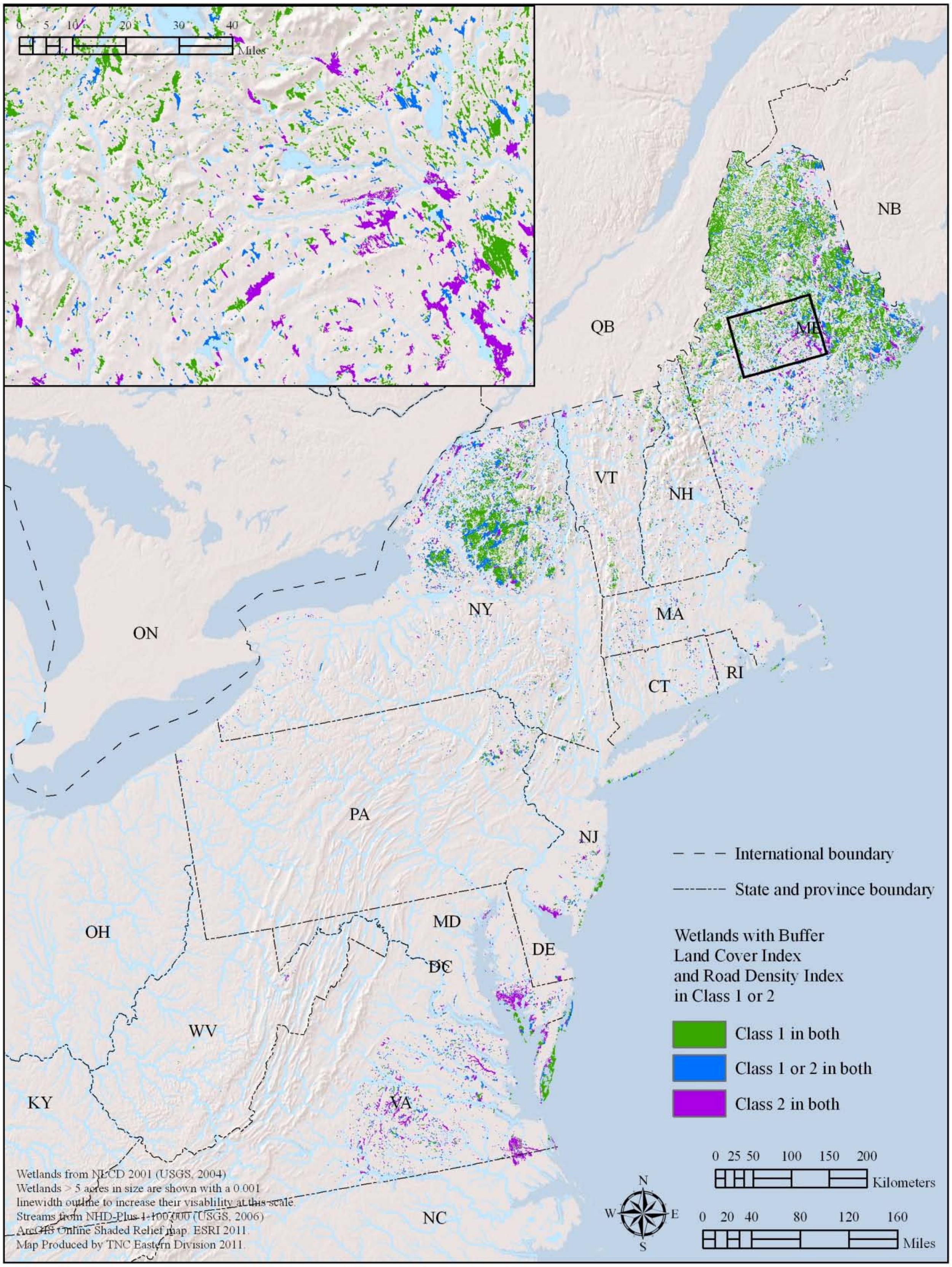
Lastly, to identify the wetlands in the best condition with respect to both roads and land use, we combined the buffer impact index and the road density index and selected those wetlands that were above the average value for both attributes (Map 7). This highlighted wetlands in northern Maine, the Adirondacks, southern New Jersey, the Chesapeake Bay region, and the Virginia coast.

<u>Changes in Wetland Acreage over Time:</u> Over the last two decades, the region has seen both losses and gains in wetland acreage. The National Land Cover Database (NLCD) 1992–2001 Land Cover Change Retrofit Product (Fry et al. 2009) was developed to provide a more accurate and useful land cover change dataset. At a resolution of 30 meters, this dataset contains unchanged pixels that have been cross-walked to a modified Anderson Level I class code along with changed pixels labeled with a "from-to" class code. Judging from this dataset, wetlands appear to have increased by roughly 100,000 acres since 1992 (Figure 7). Close examination of the data revealed that, 91 percent of this change was explained by small increases in the size of thousands of existing forested wetlands. Because 63 percent of the gained acres were located within the 1 pixel edge of existing wetlands, this trend might reflect mapping error between the between the 1992 and 2001 satellite-derived maps in the exact boundaries of each wetland. However, when the acres of wetland gained beyond those in the 1 pixel edge zone were examined independently, the data still suggested a net gain of wetlands in the region of about 9,000 acres. The largest and most consistent transitions to wetlands appear to be from forests, agriculture, and open water (Figure 7), but the data on transitions were occasionally contradictory.

Figure 7. Estimated net change in wetland acreage from 1992 to 2001. The chart compares changes within and without of the 1 pixel margin. Data from The National Land Cover Database (NLCD) 1992–2001 Land Cover Change Retrofit Product (Fry et al. 2009)



Map 7. Wetland occurrences with buffer land cover index and road density index in class 1 or 2.



Trends in Wetland Bird Abundance

Changes in the abundance of wetland breeding birds may give some indication of wetland quality. However, because shifts in any individual species may be unrelated to local wetland characteristics, the data are most telling when they show consistent trends across many species, many states, and many time intervals. We used a two-step process to examine trends in wetland breeding birds. First, we identified a set of breeding species associated with each of the wetland types using a published list of preferred breeding habitat for northeast wildlife DeGraaf and Yamasaki (2001). Second, we used breeding bird survey data to examine each species' regional and state abundance patterns over the last four decades. The breeding bird survey (BBS) is a long-term, large-scale, avian monitoring program initiated in 1966 to track the status and trends of North American bird populations, and coordinated in the US by the USGS Patuxent Wildlife Research Center. More information on the program may be found here: http://www.pwrc.usgs.gov/bbs/.

The BBS annually collects bird population data along roadside routes allowing users of the data to look at trends occurring within states, regions, and continentally. *Importantly, because the BBS uses roads and was designed for terrestrial surveys, it thus lacks adequate information on many wetland birds.* We used only species for which there was adequate data (data categories blue or yellow). We summarized statistically significant declines and increases for each species by each state; next we looked at the data across all states to examine how consistent the trend was across states, as well as how consistent it was across two time intervals. In the tables below, we note whether there was a consistent trend in three or more states, whether it was an increase, decrease, or mixed signal, and how many states total it was detected in. We also show whether the trend was apparent at both the 40 year time interval and a more recent 20 year time interval.

Freshwater Emergent Marsh: Seventeen species preferentially breed in emergent marsh (DeGraaf and Yamasaki, 2001), and the breeding bird survey had sufficient data to examine temporal trends for eight of them. Results indicated consistent declines in two species: **red-winged blackbird** and **green heron** and consistent increases in two species: **Canada goose** and **mallard** (Table 5). **Great blue heron** was increasing in most states, but declining in one. Other species had mixed or insignificant trends or inadequate data. Increases in Canada goose and mallard were also found by the Atlantic Flyway Breeding Waterfowl Survey (https://migbirdapps.fws.gov).

Table 5. Freshwater emergent marsh: forty year trends in the abundance of associated bird species. DNS = Declining or not significant, INS = Increasing or not significant, NS = Not significant. Data quality codes: B= blue, adequate data, Y = yellow, usable but with significant gaps, R = red, data not usable.

EMERGENT MARSH	40 Year Trend (1966-2007)					20 Year Trend (1980-2007)				
SPECIES	Status	Declines (# of states)	Increases (# of states)	Data Quality	Regional Trend	Status	Declines (# of states)	Increases (# of states)	Data Quality	Regional Trend
Red-winged Blackbird	DNS	6	0	B	-2	DNS	2	0	B	-0.4
Green Heron	DNS	4	0	Y	-1.7	DNS	3	0	Y	10.2
American Black Duck	DNS	1	0	Y	-0.5	DNS	1	0	Y	2.5
Canada Goose	INS	0	9	Y	12.6	INS	0	8	Y	0.2
Mallard	INS	0	7	Y	3.8	INS	0	6	Y	1
American Bittern	NS	0	0	Y	1.3	NS	0	0	Y	1.2
American Goldfinch	DI	3	1	Y	-0.5	DI	1	7	Y	5
Great Blue Heron	DI	1	7	Y	2.5	DI	1	3	Y	-17.2
American Coot	NS	0	0	R	-13.8	NS	0	0	R	5.9
Blue-winged Teal	NS	0	0	R	-9.2	NS	0	0	R	36.9
Common Moorhen	NS	0	0	R	1.3	NS	0	0	R	-2
Gadwall	NS	0	0	R	20.5	NS	0	0	R	4.8
King Rail	NS	0	0	R	-2.8	NS	0	0	R	2.4
Least Bittern	NS	0	0	R	3.7	NS	0	0	R	-9.5
Northern Harrier	NS	0	0	R	0.8	INS	0	2	R	4.7
Sedge Wren	NS	0	0	R	1.2	NS	0	0	R	-9.5
Virginia Rail	NS	0	0	R	1.6	NS	0	0	R	4.7

Salt Marsh: Six species preferentially breed in salt marsh (DeGraaf and Yamasaki 2001), and the breeding bird survey had sufficient data to examine temporal trends for five of them. Results indicated declines in five states for **savannah sparrow** and increases in three states for **osprey** (Table 6). There was no data on **salt marsh sparrow**, a cryptic species of high conservation concern. Other species had either mixed or insignificant trends, or trends that were detected only in one state.

Table 6. Salt marsh: forty year trends in the abundance of associated bird species. DNS = Declining or not significant, INS = Increasing or not significant, NS = Not significant. Data quality codes: B= blue, adequate data, Y = yellow, usable but with significant gaps, R = red, data not usable.

SALT MARSH	40 Year Trend (1966-2007)					20 Year Trend (1980-2007)				
SPECIES	Status	Declines (# of states)	Increases (# of states)	Data Quality	Regional Trend	Status	Declines (# of states)	Increases (# of states)	Data Quality	Regional Trend
Savannah Sparrow	DNS	5	0	B	-2.6	DNS	3	0	B	-2.1
Marsh Wren	DNS	1	0	Y	-5	NS	0	0	Y	-3.5
Osprey	INS	0	3	Y	7.6	INS	0	3	Y	7.2
Mute Swan	INS	0	2	Y	17.5	INS	0	1	Y	13.1
Clapper Rail	NS	0	0	Y	5.7	NS	0	0	Y	5.1
American Coot	NS	0	0	R	-13.8	NS	0	0	R	5

Alluvial and Riparian Habitat: Twenty-four species preferentially breed in riparian forest and alluvial marsh (DeGraaf and Yamasaki 2001), and the breeding bird survey had sufficient data to examine temporal trends for 22 of them. Results indicated declines in three or more states for five species: **eastern wood-pewee, song sparrow, common yellowthroat**, **Baltimore oriole**, and yellow-breasted chat, offset by consistent increases in six species: **tufted titmouse, red-bellied woodpecker, orchard oriole, alder flycatcher, red-shouldered hawk,** and **wood duck** (Table 7). Among the species with mixed trends, **pileated woodpecker** had increased in ten states. In contrast, **veery** and **yellow warbler** showed recent decreases in five or six states.

Table 7. Alluvial forest and marsh: forty year trends in the abundance of associated bird species. DNS = Declining or not significant, INS = Increasing or not significant, NS = Not significant. Data quality codes: B= blue, adequate data, Y = yellow, usable but with significant gaps, R = red, data not usable.

Alluvial / Riparian Habitat	40 Year Trend (1966-2007)					20 Year Trend (1980-2007)				
SPECIES	Status	Declines (# of states)	Increases (# of states)	Data Quality	Regional Trend	Status	Declines (# of states)	Increases (# of states)	Data Quality	Regional Trend
Eastern Wood-Pewee	DNS	8	0	B	-2.4	DNS	8	0	B	-2.8
Song Sparrow	DNS	8	0	Y	-1	DNS	6	0	Y	-0.7
Common Yellowthroat	DNS	7	0	Y	-0.4	DNS	10	0	Y	-0.7
Baltimore Oriole	DNS	5	0	Y	-0.8	DI	5	1	Y	-0.8
Yellow-breasted Chat	DNS	4	0	Y	-2.4	DNS	4	0	Y	-2.1
Yellow-throated Vireo	DNS	1	0	Y	0	DNS	2	0	Y	0
Tufted Titmouse	INS	0	9	Y	1.9	INS	0	8	Y	1.9
Red-bellied Woodpecker	INS	0	7	Y	2.4	INS	0	8	Y	3
Orchard Oriole	INS	0	4	B	2	INS	0	2	B	1.8
Alder Flycatcher	INS	0	3	B	1.2	INS	0	1	B	1.3
Red-shouldered Hawk	INS	0	3	Y	0.6	NS	0	0	Y	1.6
Wood Duck	INS	0	3	Y	5.4	INS	0	3	Y	2.2
Gray Catbird	DI	4	2	Y	0.1	DI	3	2	Y	0.2
Veery	DI	4	1	Y	-1.3	DI	6	1	Y	-1.9
Cerulean Warbler	DI	2	1	Y	-3.4	INS	0	1	Y	-1.7
Yellow Warbler	DI	2	1	Y	-0.3	DNS	5	0	Y	-1.1
Pileated Woodpecker	DI	1	10	B	3.1	DI	1	6	B	2.4
Warbling Vireo	DI	1	4	B	1.8	DI	1	3	B	2.1
Hairy Woodpecker	DI	1	2	Y	1.7	INS	0	2	Y	2.8
Downy Woodpecker	DI	1	1	Y	-0.4	DI	1	1	Y	-0.4
Northern Rough-winged Sw	NS	0	0	B	0.9	INS	0	1	B	1.9
Louisiana Waterthrush	NS	0	0	Y	-0.1	DNS	1	0	Y	-0.2
Common Merganser	INS	0	4	R	9.9	INS	0	3	R	8.6
Barred Owl	INS	0	2	R	6	INS	0	2	R	6.3

Forested and Shrub Swamp: DeGraaf and Yamasaki (2001) do not explicitly list species that breed in forested swamp; the closest types being red maples forest (44 birds) or shrub swamp (14). We combined these two overlapping categories, and removed 11 species associated with upland red maple forests* according to Birds of North America (Poole and Gill, 1999 - ongoing). This resulted in 41 species associated with forested swamps. The breeding bird survey had sufficient data to examine temporal trends for 32 of them. Results indicated declines in three or more states for four species: **song sparrow, common yellowthroat, common grackle** and **green heron**. Consistent increases were seen in six: **Carolina wren, red-bellied woodpecker, hooded warbler, alder flycatcher, red-shouldered hawk**, and **wood duck** (Table 8). Many species had inconsistent trends across the states: **pileated woodpecker, great blue heron** and **warbling vireo** were mostly increasing while **veery** was mostly decreasing.

*black-capped chickadee, blue jay, cedar waxwing, chestnut-sided warbler, downy woodpecker, eastern screech-owl, least flycatcher, northern cardinal, northern mockingbird, ruby-throated hummingbird, white-eyed vireo

Table 8. Forested swamp: forty year trends in the abundance of associated bird species. DNS = Declining or not significant, INS = Increasing or not significant, NS = Not significant. Data quality codes: B= blue adequate data, Y = yellow, usable but with significant gaps, R = red, data not usable.

Forested & Shrub Swamp	40 Year Trend (1966-2007)					20 Year Trend (1980-2007)					Type	
SPECIES	Status	Declines (# of states)	Increases (# of states)	Data Quality	Regional Trend	Status	Declines (# of states)	Increases (# of states)	Data Quality	Regional Trend	Red Maple	Shrub Swamp
Song Sparrow	DNS	8	0	Y	-1	DNS	6	0	Y	-0.7	1	1
Common Yellowthroat	DNS	7	0	Y	-0.4	DNS	10	0	Y	-0.7	1	1
Common Grackle	DNS	6	0	B	-2.1	DNS	8	0	B	-2.3	1	1
Green Heron	DNS	4	0	Y	-1.7	DNS	3	0	Y	-1.9	1	
Canada Warbler	DNS	2	0	Y	-2.7	DNS	3	0	Y	-2.5	1	
Olive-sided Flycatcher	DNS	2	0	Y	-5.1	DNS	2	0	Y	-6.7		1
Yellow-throated Vireo	DNS	1	0	Y	0	DNS	2	0	Y	0	1	
Carolina Wren	INS	0	9	B	2.1	INS	0	8	B	2.7	1	
Red-bellied Woodpecker	INS	0	7	Y	2.4	INS	0	8	Y	3	1	
Hooded Warbler	INS	0	4	Y	2.4	INS	0	2	Y	2.3	1	1
Alder Flycatcher	INS	0	3	B	1.2	INS	0	1	B	1.3	1	1
Red-shouldered Hawk	INS	0	3	Y	0.6	NS	0	0	Y	1.6	1	
Wood Duck	INS	0	3	Y	5.4	INS	0	3	Y	2.2	1	
Swamp Sparrow	INS	0	2	Y	1.5	INS	0	1	Y	1.7		1
Mourning Warbler	INS	0	1	Y	1	NS	0	0	Y	0.5	1	
Gray Catbird	DI	4	2	Y	0.1	DI	3	2	Y	0.2	1	
American Redstart	DI	4	1	B	-1.2	DI	4	2	B	-1.2	1	
Veery	DI	4	1	Y	-1.3	DI	6	1	Y	-1.9	1	
American Goldfinch	DI	3	1	Y	-0.5	DI	1	7	Y	1	1	1
Tree Swallow	DI	2	5	B	0.7	DI	2	8	B	0.6	1	
Blue-gray Gnatcatcher	DI	2	1	B	-0.3	DNS	2	0	B	-0.7	1	
Red-headed Woodpecker	DI	2	1	Y	-1.6	DNS	1	0	Y	1.8	1	
Yellow Warbler	DI	2	1	Y	-0.3	DNS	5	0	Y	-1.1	1	
Pileated Woodpecker	DI	1	10	B	3.1	DI	1	6	B	2.4	1	
Great Blue Heron	DI	1	7	Y	2.5	DI	1	3	Y	1.2	1	
Warbling Vireo	DI	1	4	B	1.8	DI	1	3	B	2.1	1	
Hairy Woodpecker	DI	1	2	Y	1.7	INS	0	2	Y	2.8	1	
Northern Waterthrush	DI	1	1	Y	-1.5	DNS	1	0	Y	-1.3	1	
Winter Wren	DI	1	1	Y	0.4	INS	0	2	Y	1.1	1	
Common Snipe	NS	0	0	Y	0.3	DNS	1	0	Y	-0.6		1
Lincoln's Sparrow	NS	0	0	Y	1	INS	0	1	Y	3.5		1
Louisiana Waterthrush	NS	0	0	Y	-0.1	DNS	1	0	Y	-0.2	1	
Common Goldeneye	NS	0	0	R	-6.4	NS	0	0	R	-13.6	1	
American Woodcock	DNS	1	0	R	-2.6	DNS	2	0	R	-5	1	
Barred Owl	INS	0	2	R	6	INS	0	2	R	6.3	1	
Common Merganser	INS	0	4	R	9.9	INS	0	3	R	8.6	1	
Great Horned Owl	DI	1	1	R	-1.6	DNS	1	0	R	-6.2	1	
Hooded Merganser	INS	0	1	R	13.2	NS	0	0	R	10.6	1	
Palm Warbler	NS	0	0	R	11.4	NS	0	0	R	5.4		1
Rusty Blackbird	NS	0	0	R	10.6	NS	0	0	R	10.3		1
Wilson's Warbler	NS	0	0	R	-0.5	NS	0	0	R	2.3		1

Correlations Between Species Patterns and Wetland Condition

Finally, we tested whether significant trends in the breeding birds – both increases and decreases – correlated with wetland condition or degree of conversion. To do this, we tabulated the number of species in the three wetland types showing a consistent trend in three or more states and examined whether these patterns correlated with the degree of conversion (agriculture plus development), the percent of occurrences having severe road impacts, or the percent of occurrences with high degree of disturbance inthe wetland buffer. While we cannot draw strong conclusions from the results, because tidal marshes do not occur in all states and the wetland types had different numbers of species associated with them, still, there were some relationships that appear fairly straightforward. Notably, alluvial wetlands had the most declines, the most overall species change, the largest degree of conversion, and the highest percent of severe road impact (Figure 8). The patterns suggest that changes to the wetland breeding birds are related to habitat conversion and fragmentation.

Lastly, across all wetland types, seven wetland breeding species have declined in five or more states and may need special conservation attention; in contrast, seven species have shown increases in five or more states (Table 9).

Figure 8. Correspondence between bird declines and increases, degree of conversion and severity of road impacts.

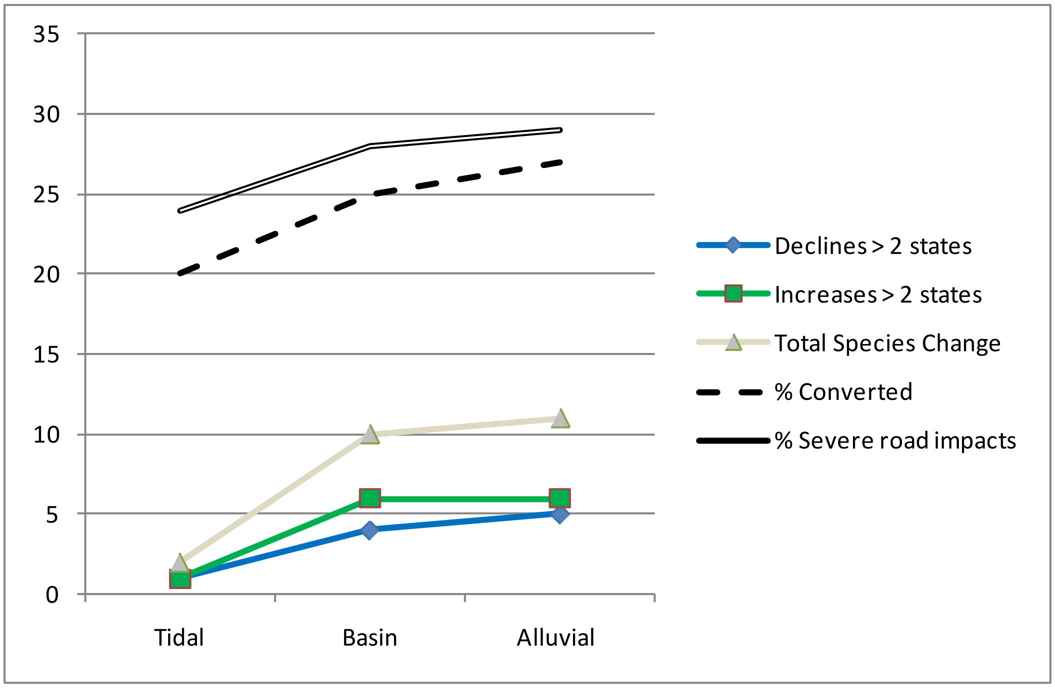


Table 9. Species that have consistently declined or increased in five or more states.

Decines in 5 or more States	# States	Increases in 5 or more states	# States
Eastern Wood-Pewee	8	Pileated Woodpecker	10
Song Sparrow	8	Canada Goose	9
Common Yellowthroat	7	Tufted Titmouse	9
Red winged blackbird	6	Carolina Wren	9
Common Grackle	6	Mallard	7
savannah sparrow	5	Great Blue Heron	7
Baltimore Oriole	5	Red-bellied Woodpecker	7

References

Please see the data sources (appendix A) and detailed methods (appendix B) sections of the main report for more information on the data sources and analysis methods used in this chapter.

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Appendix 5-1. Acres of wetland by subregion, state, and secured land status.

	Size <2 acres				Size >= 2 < 1000				Size >= 1,000				All Wetlands (regardless of size)			
Wetland Type	Gap 1 & 2	Gap 3	Unprotected	Total	Gap 1 & 2	Gap 3	Unprotected	Total	Gap 1 & 2	Gap 3	Unprotected	Total	Gap 1 & 2	Gap 3	Unprotected	Total
DC																
Alluvial Marsh	0	0	0	0	0	0	24.46	24.46	0	0	0	0	0	0	24.46	24.46
Alluvial Swamp	0	0	20.02	20.02	0.44	0	66.27	66.71	0	0	0	0	0.44	0	86.29	86.73
Alluvial Total	0	0	20.02	20.02	0.44	0	90.73	91.17	0	0	0	0	0.44	0	110.75	111.19
Basin Marsh	0	0	7.78	7.78	0	0	27.35	27.35	0	0	0	0	0	0	35.13	35.13
Basin Swamp	0	0	101.85	101.85	0	0	211.27	211.27	0	0	0	0	0	0	313.12	313.12
Basin Total	0	0	109.63	109.63	0	0	238.62	238.62	0	0	0	0	0	0	348.25	348.25
Tidal Marsh	0	0	43.81	43.81	0	0	112.08	112.08	0	0	0	0	0	0	155.89	155.89
Tidal Swamp	0	0	6.23	6.23	0	0	74.28	74.28	0	0	0	0	0	0	80.51	80.51
Tidal Total	0	0	50.04	50.04	0	0	186.36	186.36	0	0	0	0	0	0	236.4	236.4
DC Total	0	0	179.69	179.69	0.44	0	515.71	516.15	0	0	0	0	0.44	0	695.4	695.84
DE																
Alluvial Marsh		2.22	16.68	18.9	10.01	29.8	149	188.81	0	0	0	0	10.01	32.02	165.68	207.71
Alluvial Swamp	7.34	18.9	69.83	96.07	51.82	283.99	1052.13	1387.94	0	0	0	0	59.16	302.89	1121.96	1484.01
Alluvial Total	7.34	21.12	86.51	114.97	61.83	313.79	1201.13	1576.75	0	0	0	0	69.17	334.91	1287.64	1691.72
Basin Marsh	16.23	73.17	963.17	1052.57	98.3	628.47	4976.2	5702.97	0	7.56	1.33	8.89	114.53	709.2	5940.7	6764.43
Basin Swamp	198.15	604.46	3956.54	4759.15	2033.76	4277.23	15407.18	21718.17	0	3397.01	775.25	4172.26	2231.91	8278.7	20138.97	30649.58
Basin Total	214.38	677.63	4919.71	5811.72	2132.06	4905.7	20383.38	27421.14	0	3404.57	776.58	4181.15	2346.44	8987.9	26079.67	37414.01
Tidal Marsh	19.35	95.18	549.08	663.61	287.77	4262.1	9135.11	13684.98	12450.06	16280.95	21185.32	49916.33	12757.18	20638.23	30869.51	64264.92
Tidal Swamp	55.38	213.27	920.25	1188.9	1065.03	3065.2	13592.92	17723.15	2168.08	4224.3	9840.54	16232.92	3288.49	7502.77	24353.71	35144.97
Tidal Total	74.73	308.45	1469.33	1852.51	1352.8	7327.3	22728.03	31408.13	14618.14	20505.25	31025.86	66149.25	16045.67	28141	55223.22	99409.89
DE Total	296.45	1007.2	6475.55	7779.2	3546.69	12546.79	44312.54	60406.02	14618.14	23909.82	31802.44	70330.4	18461.28	37463.81	82590.53	138515.62
MD																
Alluvial Marsh	43.81	14.68	251.08	309.57	770.8	122.09	2517.9	3410.79	0	0	0	0	814.61	136.77	2768.98	3720.36
Alluvial Swamp	294.67	150.11	1294.53	1739.31	2265.49	1079.48	8511.31	11856.28	0	0	0	0	2560.16	1229.59	9805.84	13595.59
Alluvial Total	338.48	164.79	1545.61	2048.88	3036.29	1201.57	11029.21	15267.07	0	0	0	0	3374.77	1366.36	12574.82	17315.95
Basin Marsh	48.04	153.89	3761.5	3963.43	249.74	616.24	12617.74	13483.72	0	0	0	0	297.78	770.13	16379.24	17447.15
Basin Swamp	544.41	1125.52	16376.35	18046.28	3312.94	7255.03	51036.06	61604.03	0	0	10.9	10.9	3857.35	8380.55	67423.31	79661.21
Basin Total	592.45	1279.41	20137.85	22009.71	3562.68	7871.27	63653.8	75087.75	0	0	10.9	10.9	4155.13	9150.68	83802.55	97108.36
Tidal Marsh	91.4	286.88	3537.11	3915.39	4851.44	6095.71	51832.44	62779.59	30050.9	40073.34	62402.19	132526.43	34993.74	46455.93	117771.74	199221.41
Tidal Swamp	239.96	893.79	4321.48	5455.23	4557.44	15907.78	56545.1	77010.32	10171.23	15869.53	29251.18	55291.94	14968.63	32671.1	90117.76	137757.49
Tidal Total	331.36	1180.67	7858.59	9370.62	9408.88	22003.49	108377.54	139789.91	40222.13	55942.87	91653.37	187818.37	49962.37	79127.03	207889.5	336978.9
MD Total	1262.29	2624.87	29542.05	33429.21	16007.85	31076.33	183060.55	230144.73	40222.13	55942.87	91664.27	187829.27	57492.27	89644.07	304266.87	451403.21
NJ																
Alluvial Marsh	19.13	14.9	160.34	194.37	577.77	268.2	1517.14	2363.11	719.44	404.08	348.93	1472.45	1316.34	687.18	2026.41	4029.93
Alluvial Swamp	433.43	143.66	1238.93	1816.02	7712.26	3013.16	19317.68	30043.1	6702.39	2529.02	8552.9	17784.31	14848.08	5685.84	29109.51	49643.43
Alluvial Total	452.56	158.56	1399.27	2010.39	8290.03	3281.36	20834.82	32406.21	7421.83	2933.1	8901.83	19256.76	16164.42	6373.02	31135.92	53673.36
Basin Marsh	259.3	232.4	3252.68	3744.38	3892.49	1387.71	19445.11	24725.31	1492.68	353.6	1577.63	3423.91	5644.47	1973.71	24275.42	31893.6
Basin Swamp	3512.87	1749.1	19047.7	24309.67	51855.56	17990.68	141740.49	211586.73	43548.18	6368.8	28769.7	78686.68	98916.61	26108.58	189557.89	314583.08
Basin Total	3772.17	1981.5	22300.38	28054.05	55748.05	19378.39	161185.6	236312.04	45040.86	6722.4	30347.33	82110.59	104561.08	28082.29	213833.31	346476.68
Tidal Marsh	189.92	13.34	1449.32	1652.58	13503.07	1069.7	24136.21	38708.98	100961.5	3949.42	50015.51	154926.43	114654.49	5032.46	75601.04	195287.99
Tidal Swamp	814.4	143.44	2859.49	3817.33	11115.27	2770.76	43607.79	57493.82	23384.75	5824.84	21063.67	50273.26	35314.42	8739.04	67530.95	111584.41
Tidal Total	1004.32	156.78	4308.81	5469.91	24618.34	3840.46	67744	96202.8	124346.25	9774.26	71079.18	205199.69	149968.91	13771.5	143131.99	306872.4
NJ Total	**5229.05**	**2296.84**	**28008.46**	**35534.35**	**88656.42**	**26500.21**	**249764.42**	**364921.05**	**176808.94**	**19429.76**	**110328.34**	**306567.04**	**270694.41**	**48226.81**	**388101.22**	**707022.44**
PA																
Alluvial Marsh	149.67	142.11	2469.2	2760.98	2123.38	1166.44	18292.69	21582.51	25.35	181.25	338.48	545.08	2298.4	1489.8	21100.37	24888.57
Alluvial Swamp	216.61	190.59	3921.85	4329.05	5068.27	4025.04	45129.38	54222.69	1211.36	1714.18	8228.87	11154.41	6496.24	5929.81	57280.1	69706.15
Alluvial Total	366.28	332.7	6391.05	7090.03	7191.65	5191.48	63422.07	75805.2	1236.71	1895.43	8567.35	11699.49	8794.64	7419.61	78380.47	94594.72
Basin Marsh	141.66	232.84	7642.88	8017.38	1010.76	2582.84	22414.69	26008.29	69.83	185.03	75.61	330.47	1222.25	3000.71	30133.18	34356.14
Basin Swamp	475.24	1119.96	21598.74	23193.94	7432.27	26175.53	111353.34	144961.14	1143.3	8300.48	3669.43	13113.21	9050.81	35595.97	136621.51	181268.29
Basin Total	616.9	1352.8	29241.62	31211.32	8443.03	28758.37	133768.03	170969.43	1213.13	8485.51	3745.04	13443.68	10273.06	38596.68	166754.69	215624.43
Tidal Marsh	6.89	0	178.13	185.02	113.86	0	916.91	1030.77	0	0	0	0	120.75	0	1095.04	1215.79
Tidal Swamp	29.13	0	167.9	197.03	471.68	0	2422.27	2893.95	0	0	0	0	500.81	0	2590.17	3090.98
Tidal Total	36.02	0	346.03	382.05	585.54	0	3339.18	3924.72	0	0	0	0	621.56	0	3685.21	4306.77
PA Total	**1019.2**	**1685.5**	**35978.7**	**38683.4**	**16220.22**	**33949.85**	**200529.28**	**250699.35**	**2449.84**	**10380.94**	**12312.39**	**25143.17**	**19689.26**	**46016.29**	**248820.37**	**314525.92**

Wetland Type	Size <2 acres				Size >= 2 < 1000				Size >= 1,000				All Wetlands (regardless of size)			
	Gap 1 & 2	Gap 3	Unprotected	Total	Gap 1 & 2	Gap 3	Unprotected	Total	Gap 1 & 2	Gap 3	Unprotected	Total	Gap 1 & 2	Gap 3	Unprotected	Total
VA																
Alluvial Marsh	3.11	36.47	982.3	1021.88	6.67	613.8	8317.61	8938.08	25.13	18.24	4801.4	4844.77	34.91	668.51	14101.31	14804.73
Alluvial Swamp	15.34	187.47	4509.62	4712.43	301.12	6076.14	74107.02	80484.28	943.16	1937.02	91078.49	93958.67	1259.62	8200.63	169695.13	179155.38
Alluvial Total	18.45	223.94	5491.92	5734.31	307.79	6689.94	82424.63	89422.36	968.29	1955.26	95879.89	98803.44	1294.53	8869.14	183796.44	193960.11
Basin Marsh	24.9	140.55	5432.32	5597.77	301.56	1452.43	27031.73	28785.72	0	0	290	290	326.46	1592.98	32754.05	34673.49
Basin Swamp	146.78	827.07	21435.95	22409.8	998.09	5091.17	192356.68	198445.94	0	0	19873.88	19873.88	1144.87	5918.24	233666.51	240729.62
Basin Total	171.68	967.62	26868.27	28007.57	1299.65	6543.6	219388.41	227231.66	0	0	20163.88	20163.88	1471.33	7511.22	266420.56	275403.11
Tidal Marsh	101.64	233.95	4016.36	4351.95	7999.15	19079.95	73451.19	100530.29	27192.52	36071.21	39233.6	102497.33	35293.31	55385.11	116701.15	207379.57
Tidal Swamp	653.38	261.53	3641.86	4556.77	5276.65	5177.24	67926.36	78380.25	65114.02	4470.04	32856.12	102440.18	71044.05	9908.81	104424.34	185377.2
Tidal Total	755.02	495.48	7658.22	8908.72	13275.8	24257.19	141377.55	178910.54	92306.54	40541.25	72089.72	204937.51	106337.36	65293.92	221125.49	392756.77
VA Total	**945.15**	**1687.04**	**40018.41**	**42650.6**	**14883.24**	**37490.73**	**443190.59**	**495564.56**	**93274.83**	**42496.51**	**188133.49**	**323904.83**	**109103.22**	**81674.28**	**671342.49**	**862119.99**
WV																
Alluvial Marsh	19.79	30.47	257.08	307.34	31.58	105.86	1019.21	1156.65	0	0	0	0	51.37	136.33	1276.29	1463.99
Alluvial Swamp	10.9	57.38	689.85	758.13	4.45	228.84	1538.49	1771.78	0	0	0	0	15.35	286.22	2228.34	2529.91
Alluvial Total	30.69	87.85	946.93	1065.47	36.03	334.7	2557.7	2928.43	0	0	0	0	66.72	422.55	3504.63	3993.9
Basin Marsh	64.27	41.14	1070.36	1175.77	929.82	44.03	3801.31	4775.16	1415.96	0	0	1415.96	2410.05	85.17	4871.67	7366.89
Basin Swamp	108.53	68.05	1191.79	1368.37	1632.12	78.95	3811.99	5523.06	1685.49	0	0	1685.49	3426.14	147	5003.78	8576.92
Basin Total	172.8	109.19	2262.15	2544.14	2561.94	122.98	7613.3	10298.22	3101.45	0	0	3101.45	5836.19	232.17	9875.45	15943.81
WV Total	203.49	197.04	3209.08	3609.61	2597.97	457.68	10171	13226.65	3101.45	0	0	3101.45	5902.91	654.72	13380.08	19937.71
Mid-Atlantic Totals																
Alluvial Marsh	235.51	240.85	4136.68	4613.04	3520.21	2306.19	31838.01	37664.41	769.92	603.57	5488.81	6862.3	4525.64	3150.61	41463.5	49139.75
Alluvial Swamp	978.29	748.11	11744.63	13471.03	15403.85	14706.65	149722.28	179832.78	8856.91	6180.22	107860.26	122897.39	25239.05	21634.98	269327.17	316201.2
Alluvial Total	1213.8	988.96	15881.31	18084.07	18924.06	17012.84	181560.29	217497.19	9626.83	6783.79	113349.07	129759.69	29764.69	24785.59	310790.67	365340.95
Basin Marsh	554.4	873.99	22130.69	23559.08	6482.67	6711.72	90314.13	103508.52	2978.47	546.19	1944.57	5469.23	10015.54	8131.9	114389.39	132536.83
Basin Swamp	4985.98	5494.16	83708.92	94189.06	67264.74	60868.59	515917.01	644050.34	46376.97	18066.29	53099.16	117542.42	118627.69	84429.04	652725.09	855781.82
Basin Total	5540.38	6368.15	105839.61	117748.14	73747.41	67580.31	606231.14	747558.86	49355.44	18612.48	55043.73	123011.65	128643.23	92560.94	767114.48	988318.65
Tidal Marsh	409.2	629.35	9773.81	10812.36	26755.29	30507.46	159583.94	216846.69	170654.98	96374.92	172836.62	439866.52	197819.47	127511.73	342194.37	667525.57
Tidal Swamp	1792.25	1512.03	11917.21	15221.49	22486.07	26920.98	184168.72	233575.77	100838.08	30388.71	93011.51	224238.3	125116.4	58821.72	289097.44	473035.56
Tidal Total	2201.45	2141.38	21691.02	26033.85	49241.36	57428.44	343752.66	450422.46	271493.06	126763.63	265848.13	664104.82	322935.87	186333.45	631291.81	1140561.13
Mid-Atlantic Total	**8955.63**	**9498.49**	**143411.94**	**161866.06**	**141912.83**	**142021.59**	**1131544.09**	**1415478.51**	**330475.33**	**152159.9**	**434240.93**	**916876.16**	**481343.79**	**303679.98**	**1709196.96**	**2494220.73**
CT																
Alluvial Marsh	8.9	6.23	98.74	113.87	79.84	56.26	603.57	739.67	0	0	0	0	88.74	62.49	702.31	853.54
Alluvial Swamp	11.79	31.8	476.14	519.73	1336.56	1561.84	15137.2	18035.6	0	0	0	0	1348.35	1593.64	15613.34	18555.33
Alluvial Total	20.69	38.03	574.88	633.6	1416.4	1618.1	15740.77	18775.27	0	0	0	0	1437.09	1656.13	16315.65	19408.87
Basin Marsh	11.56	29.8	484.37	525.73	474.8	1670.59	5671.17	7816.56	0.67	20.9	22.91	44.48	487.03	1721.29	6178.45	8386.77
Basin Swamp	181.92	485.25	5511.71	6178.88	7317.08	17316.62	139947.8	164581.5	937.59	1420.63	3993.46	6351.68	8436.59	19222.5	149452.97	177112.06
Basin Total	193.48	515.05	5996.08	6704.61	7791.88	18987.21	145618.97	172398.06	938.26	1441.53	4016.37	6396.16	8923.62	20943.79	155631.42	185498.83
Tidal Marsh	20.91	6.45	485.7	513.06	1765.56	2998.48	10567.75	15331.79	54.71	444.11	377.62	876.44	1841.18	3449.04	11431.07	16721.29
Tidal Swamp	3.11	0.22	61.16	64.49	502.16	514.17	3135.48	4151.81	39.14	109.86	196.82	345.82	544.41	624.25	3393.46	4562.12
Tidal Total	24.02	6.67	546.86	577.55	2267.72	3512.65	13703.23	19483.6	93.85	553.97	574.44	1222.26	2385.59	4073.29	14824.53	21283.41
CT Total	238.19	559.75	7117.82	7915.76	11476	24117.96	175062.97	210656.93	1032.11	1995.5	4590.81	7618.42	12746.3	26673.21	186771.6	226191.11
MA																
Alluvial Marsh	6.01	58.49	225.95	290.45	351.6	1647.02	3109.01	5107.63	574.88	87.84	471.91	1134.63	932.49	1793.35	3806.87	6532.71
Alluvial Swamp	20.68	119.87	701.42	841.97	2311.3	12802.77	34071.26	49185.33	2579.72	2347.99	4870.79	9798.5	4911.7	15270.63	39643.47	59825.8
Alluvial Total	26.69	178.36	927.37	1132.42	2662.9	14449.79	37180.27	54292.96	3154.6	2435.83	5342.7	10933.13	5844.19	17063.98	43450.34	66358.51
Basin Marsh	44.7	283.32	1181.11	1509.13	883.55	6082.14	16423.28	23388.97	165.68	134.32	215.94	515.94	1093.93	6499.78	17820.33	25414.04
Basin Swamp	316.23	1506.25	7259.7	9082.18	11094.14	72468.01	242568.56	326130.71	4573.45	6327.89	10130.75	21032.09	15983.82	80302.15	259959.01	356244.98
Basin Total	360.93	1789.57	8440.81	10591.31	11977.69	78550.15	258991.84	349519.68	4739.13	6462.21	10346.69	21548.03	17077.75	86801.93	277779.34	381659.02
Tidal Marsh	68.5	99.85	1126.18	1294.53	6942.57	8736.81	33214.84	48894.22	3415.69	5304.67	8927.62	17647.98	10426.76	14141.33	43268.64	67836.73
Tidal Swamp	25.35	28.69	246.85	300.89	2517.9	3076.54	13477.06	19071.5	280.88	928.92	2567.71	3777.51	2824.13	4034.15	16291.62	23149.9
Tidal Total	93.85	128.54	1373.03	1595.42	9460.47	11813.35	46691.9	67965.72	3696.57	6233.59	11495.33	21425.49	13250.89	18175.48	59560.26	90986.63
MA Total	**481.47**	**2096.47**	**10741.21**	**13319.15**	**24101.06**	**104813.29**	**342864.01**	**471778.36**	**11590.3**	**15131.63**	**27184.72**	**53906.65**	**36172.83**	**122041.39**	**380789.94**	**539004.16**
ME																
Alluvial Marsh	77.84	109.19	1494.68	1681.71	5372.5	5158.78	44232.48	54763.76	2074.45	4701.55	18588.47	25364.47	7524.79	9969.52	64315.63	81809.94
Alluvial Swamp	294.44	871.99	6642.12	7808.55	10441.65	37372.64	216568.5	264382.79	13864.46	26014.96	130661.24	170540.66	24600.55	64259.59	353871.86	442732
Alluvial Total	372.28	981.18	8136.8	9490.26	15814.15	42531.42	260800.98	319146.55	15938.91	30716.51	149249.71	195905.13	32125.34	74229.11	418187.49	524541.94
Basin Marsh	183.02	442.33	4273	4898.35	4270.33	14360.17	112763.52	131394.02	509.05	3858.02	13341.84	17708.91	4962.4	18660.52	130378.36	154001.28
Basin Swamp	1137.53	5806.6	42074.63	49018.76	22138.7	142650.73	890767.36	1055556.79	7816.12	20746.76	117718.81	146281.69	31092.35	169204.09	1050560.8	1250857.24
Basin Total	1320.55	6248.93	46347.63	53917.11	26409.03	157010.9	1003530.88	1186950.81	8325.17	24604.78	131060.65	163990.6	36054.75	187864.61	1180939.16	1404858.52
Tidal Marsh	79.17	107.19	2991.81	3178.17	5126.98	4325.04	43237.29	52689.31	0	909.35	1629.45	2538.8	5206.15	5341.58	47858.55	58406.28
Tidal Swamp	61.16	38.03	734.33	833.52	2085.8	1689.05	20660.7	24435.55	0	141.66	932.48	1074.14	2146.96	1868.74	22327.51	26343.21
Tidal Total	140.33	145.22	3726.14	4011.69	7212.78	6014.09	63897.99	77124.86	0	1051.01	2561.93	3612.94	7353.11	7210.32	70186.06	84749.49
ME Total	**1833.16**	**7375.33**	**58210.57**	**67419.06**	**49435.96**	**205556.41**	**1328229.85**	**1583222.22**	**24264.08**	**56372.3**	**282872.29**	**363508.67**	**75533.2**	**269304.04**	**1669312.71**	**2014149.95**

Wetland Type	Size <2 acres Gap 1 & 2	Gap 3	Unprotected	Total	Size >= 2 < 1000 Gap 1 & 2	Gap 3	Unprotected	Total	Size >= 1,000 Gap 1 & 2	Gap 3	Unprotected	Total	All Wetlands (regardless of size) Gap 1 & 2	Gap 3	Unprotected	Total
NH																
Alluvial Marsh	6.68	29.13	427.43	463.24	113.64	1009.21	4630.83	5753.68	212.38	54.49	135.66	402.53	332.7	1092.83	5193.92	6619.45
Alluvial Swamp	39.59	316.02	1664.37	2019.98	2428.27	11739.75	38898.01	53066.03	975.85	931.15	1654.58	3561.58	3443.71	12986.92	42216.96	58647.59
Alluvial Total	46.27	345.15	2091.8	2483.22	2541.91	12748.96	43528.84	58819.71	1188.23	985.64	1790.24	3964.11	3776.41	14079.75	47410.88	65267.04
Basin Marsh	24.9	262.64	947.16	1234.7	529.29	4969.75	17932.64	23431.68	21.79		0.89	22.68	575.98	5232.39	18880.69	24689.06
Basin Swamp	236.4	1406.84	7111.59	8754.83	6075.69	26344.99	113350.85	145771.53	921.81	129.65	42.03	1093.49	7233.9	27881.48	120504.47	155619.85
Basin Total	261.3	1669.48	8058.75	9989.53	6604.98	31314.74	131283.49	169203.21	943.6	129.65	42.92	1116.17	7809.88	33113.87	139385.16	180308.91
Tidal Marsh	4	4.67	74.95	83.62	232.84	927.59	2697.37	3857.8	280.21	197.93	2107.59	2585.73	517.05	1130.19	4879.91	6527.15
Tidal Swamp	1.33	5.78	32.69	39.8	30.92	197.26	614.91	843.09	2.67	0.22	95.18	98.07	34.92	203.26	742.78	980.96
Tidal Total	5.33	10.45	107.64	123.42	263.76	1124.85	3312.28	4700.89	282.88	198.15	2202.77	2683.8	551.97	1333.45	5622.69	7508.11
NH Total	312.9	2025.08	10258.19	12596.17	9410.65	45188.55	178124.61	232723.81	2414.71	1313.44	4035.93	7764.08	12138.26	48527.07	192418.73	253084.06
NY																
Alluvial Marsh	29.35	93.18	1817.15	1939.68	2412.49	5812.61	25339.12	33564.22	3555.58	5977.84	5092.29	14625.71	5997.42	11883.63	32248.56	50129.61
Alluvial Swamp	700.75	693.63	10723.42	12117.8	20873.3	21642.99	252195.15	294711.44	11196.22	17594.83	63288.19	92079.24	32770.27	39931.45	326206.76	398908.48
Alluvial Total	730.1	786.81	12540.57	14057.48	23285.79	27455.6	277534.27	328275.66	14751.8	23572.67	68380.48	106704.95	38767.69	51815.08	358455.32	449038.09
Basin Marsh	394.97	399.63	5225.5	6020.1	11143.29	8409.46	58118.96	77671.71	5087.17	5072.05	8165.05	18324.27	16625.43	13881.14	71509.51	102016.08
Basin Swamp	14665.28	10864.86	86239.73	111769.87	211312.53	139005.54	1230112.03	1580430.1	80705.1	46170.83	167360.71	294236.64	306682.91	196041.23	1483712.47	1986436.61
Basin Total	15060.25	11264.49	91465.23	117789.97	222455.82	147415	1288230.99	1658101.81	85792.27	51242.88	175525.76	312560.91	323308.34	209922.37	1555221.98	2088452.69
Tidal Marsh	59.82	61.16	1133.52	1254.5	7047.98	4463.37	37896.59	49407.94	1081.48	256.19	1409.29	2746.96	8189.28	4780.72	40439.4	53409.4
Tidal Swamp	35.8	20.46	332.25	388.51	2709.38	1906.99	13147.7	17764.07	231.95	1802.25	68.5	2102.7	2977.13	3729.7	13548.45	20255.28
Tidal Total	95.62	81.62	1465.77	1643.01	9757.36	6370.36	51044.29	67172.01	1313.43	2058.44	1477.79	4849.66	11166.41	8510.42	53987.85	73664.68
NY Total	15885.97	12132.92	105471.57	133490.46	255498.97	181240.96	1616809.55	2053549.48	101857.5	76873.99	245384.03	424115.52	373242.44	270247.87	1967665.15	2611155.46
RI																
Alluvial Marsh	0	1.33	42.92	44.25	6.45	178.58	929.37	1114.4	62.94	42.7	66.94	172.58	69.39	222.61	1039.23	1331.23
Alluvial Swamp	1.11	2.67	59.82	63.6	105.41	822.84	2234.35	3162.6	863.54	598.67	1152.42	2614.63	970.06	1424.18	3446.59	5840.83
Alluvial Total	1.11	4	102.74	107.85	111.86	1001.42	3163.72	4277	926.48	641.37	1219.36	2787.21	1039.45	1646.79	4485.82	7172.06
Basin Marsh	12.01	34.25	205.49	251.75	253.08	657.38	3392.11	4302.57	7.12	166.79	64.72	238.63	272.21	858.42	3662.32	4792.95
Basin Swamp	90.06	232.18	1190.01	1512.25	4589.24	9789.16	43116.31	57494.71	563.54	2848.15	2859.05	6270.74	5242.84	12869.49	47165.37	65277.7
Basin Total	102.07	266.43	1395.5	1764	4842.32	10446.54	46508.42	61797.28	570.66	3014.94	2923.77	6509.37	5515.05	13727.91	50827.69	70070.65
Tidal Marsh	15.34	7.12	341.37	363.83	1060.8	1044.34	5943.82	8048.96	0	0	0	0	1076.14	1051.46	6285.19	8412.79
Tidal Swamp	6.67	4.23	55.82	66.72	319.57	315.57	1770.22	2405.36	0	0	0	0	326.24	319.8	1826.04	2472.08
Tidal Total	22.01	11.35	397.19	430.55	1380.37	1359.91	7714.04	10454.32	0	0	0	0	1402.38	1371.26	8111.23	10884.87
RI Total	125.19	281.78	1895.43	2302.4	6334.55	12807.87	57386.18	76528.6	1497.14	3656.31	4143.13	9296.58	7956.88	16745.96	63424.74	88127.58
VT																
Alluvial Marsh	4.22	16.46	252.86	273.54	396.08	1393.05	3896.05	5685.18	1500.91	478.14	1395.94	3374.99	1901.21	1887.65	5544.85	9333.71
Alluvial Swamp	31.14	47.81	1156.43	1235.38	2068.44	4047.5	31843.8	37959.74	5132.32	3281.59	10143.88	18557.79	7231.9	7376.9	43144.11	57752.91
Alluvial Total	35.36	64.27	1409.29	1508.92	2464.52	5440.55	35739.85	43644.92	6633.23	3759.73	11539.82	21932.78	9133.11	9264.55	48688.96	67086.62
Basin Marsh	34.69	134.32	724.55	893.56	511.05	1129.3	5895.34	7535.69	0	274.65	173.69	448.34	545.74	1538.27	6793.58	8877.59
Basin Swamp	379.17	920.47	5444.33	6743.97	7160.74	18000.25	84639.63	109800.62	0	1226.26	2698.04	3924.3	7539.91	20146.98	92782	120468.89
Basin Total	413.86	1054.79	6168.88	7637.53	7671.79	19129.55	90534.97	117336.31	0	1500.91	2871.73	4372.64	8085.65	21685.25	99575.58	129346.48
VT Total	449.22	1119.06	7578.17	9146.45	10136.31	24570.1	126274.82	160981.23	6633.23	5260.64	14411.55	26305.42	17218.76	30949.8	148264.54	196433.1
New England & New York																
Alluvial Marsh	133	314.01	4359.73	4806.74	8732.6	15255.51	82740.43	106728.54	7981.14	11342.56	25751.21	45074.91	16846.74	26912.08	112851.37	156610.19
Alluvial Swamp	1099.5	2083.79	21423.72	24607.01	39564.93	89990.33	590948.27	720503.53	34612.11	50769.19	211771.1	297152.4	75276.54	142843.31	824143.09	1042262.94
Alluvial Total	1232.5	2397.8	25783.45	29413.75	48297.53	105245.84	673688.7	827232.07	42593.25	62111.75	237522.31	342227.31	92123.28	169755.39	936994.46	1198873.13
Basin Marsh	705.85	1586.29	13041.18	15333.32	18065.39	37278.79	220197.02	275541.2	5791.48	9526.73	21985.04	37303.25	24562.72	48391.81	255223.24	328177.77
Basin Swamp	17006.59	21222.45	154831.7	193060.74	269688.12	425575.3	2744502.54	3439765.96	95517.61	78870.17	304802.85	479190.63	382212.32	525667.92	3204137.09	4112017.33
Basin Total	17712.44	22808.74	167872.88	208394.06	287753.51	462854.09	2964699.56	3715307.16	101309.09	88396.9	326787.89	516493.88	406775.04	574059.73	3459360.33	4440195.1
Tidal Marsh	247.74	286.44	6153.53	6687.71	22176.73	22495.63	133557.66	178230.02	4832.09	7112.25	14451.57	26395.91	27256.56	29894.32	154162.76	211313.64
Tidal Swamp	133.42	97.41	1463.1	1693.93	8165.73	7699.58	52806.07	68671.38	554.64	2982.91	3860.69	7398.24	8853.79	10779.9	58129.86	77763.55
Tidal Total	381.16	383.85	7616.63	8381.64	30342.46	30195.21	186363.73	246901.4	5386.73	10095.16	18312.26	33794.15	36110.35	40674.22	212292.62	289077.19
NE & NY Total	19326.1	25590.39	201272.96	246189.45	366393.5	598295.14	3824751.99	4789440.63	149289.07	160603.81	582622.46	892515.34	535008.67	784489.34	4608647.41	5928145.42
Region																
Alluvial Marsh	368.51	554.86	8496.41	9419.78	12252.81	17561.7	114578.44	144392.95	8751.06	11946.13	31240.02	51937.21	21372.38	30062.69	154314.87	205749.94
Alluvial Swamp	2077.79	2831.9	33168.35	38078.04	54968.78	104696.98	740670.55	900336.31	43469.02	56949.41	319631.36	420049.79	100515.59	164478.29	1093470.26	1358464.14
Alluvial Total	2446.3	3386.76	41664.76	47497.82	67221.59	122258.68	855248.99	1044729.26	52220.08	68895.54	350871.38	471987	121887.97	194540.98	1247785.13	1564214.08
Basin Marsh	1260.25	2460.28	35171.87	38892.4	24548.06	43990.51	310511.15	379049.72	8769.95	10072.92	23929.61	42772.48	34578.26	56523.71	369612.63	460714.6
Basin Swamp	21992.57	26716.61	238540.62	287249.8	336952.86	486443.89	3260419.55	4083816.3	141894.58	96936.46	357902.01	596733.05	500840.01	610096.96	3856862.18	4967799.15
Basin Total	23252.82	29176.89	273712.49	326142.2	361500.92	530434.4	3570930.7	4462866.02	150664.53	107009.38	381831.62	639505.53	535418.27	666620.67	4226474.81	5428513.75
Tidal Marsh	656.94	915.79	15927.34	17500.07	48932.02	53003.09	293141.6	395076.71	175487.07	103487.17	187288.19	466262.43	225076.03	157406.05	496357.13	878839.21
Tidal Swamp	1925.67	1609.44	13380.31	16915.42	30651.8	34620.56	236974.79	302247.15	101392.72	33371.62	96872.2	231636.54	133970.19	69601.62	347227.3	550799.11
Tidal Total	2582.61	2525.23	29307.65	34415.49	79583.82	87623.65	530116.39	697323.86	276879.79	136858.79	284160.39	697898.97	359046.22	227007.67	843584.43	1429638.32
Region Total	28281.73	35088.88	344684.9	408055.51	508306.33	740316.73	4956296.08	6204919.14	479764.4	312763.71	1016863.39	1809391.5	1016352.46	1088169.32	6317844.37	8422366.15

CHAPTER

6

Unique Habitats in the Northeast

Condition and Conservation Status

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The rich biodiversity of the Northeast and Mid-Atlantic is largely associated with unique habitats that reflect the complex geologic history and varied landscape of the region. The region is one of the few places in North America where one can find coastal beaches, alpine summits, limestone valleys, silty floodplains, and sandstone ridges all in relatively close proximity. Within a landscape dominated by forests, these unique habitats typically occur as patches of contrasting elements. People have long been aware of the interesting wildlife associated with these settings, as well as with the properties of their various soils. In this chapter we examine their distribution, condition, and securement.

Summary of Findings

Unique Habitats and Rare Species: Eleven unique habitats, from sandy pine barrens to limestone glades, support over 2,700 restricted rare species. Four geologic settings have much higher densities of rare species than would be expected based on the extent of the habitat: coarse-grained sand, calcareous bedrock, fine-grained silt, and ultramafic serpentine.

Distribution, Loss, and Protection: Remarkably, habitat protection was equal to, or greater than, conversion on granite settings, on summits and cliffs, and at high elevations. In stark contrast, habitat conversion exceeds habitat protection 51:1 on calcareous settings, 29:1 on shale settings, 23:1 on dry flat settings, 19:1 on moderately calcareous settings and 18:1 on low elevations. These habitats need concerted conservation action.

Fragmentation and Connectivity: Fragmentation and loss of connectivity is pervasive at lower elevations across all geology classes. Even the least fragmented setting, granite, retains only 43 percent of its natural connectedness. The highest level of fragmentation, with over an 80 percent loss of connectedness, was found in calcareous settings, coarse-grained sands, fine-grained silts and elevations under 800 feet.

Rare species and Fragmentation. The highest densities of rare species were found in the three habitats with the most conversion and the highest fragmentation: coarse-grained sand, calcareous bedrock, and fine-grained silt. The latter two also had the least amounts of habitat securement. The extremely rare ultramafic environments were an exception to this pattern being relatively intact, somewhat well secured, and dense with rare species.

Community Types

This section is organized by geologic, elevational, and landform settings that have distinct ecological and biological expressions (Maps 1-3). Total species diversity in the region is highly correlated with the variety of geophysical settings, and here we use the geological classes and elevation zones as described in Anderson and Ferree (2010), who tested those correlations to group and summarize the habitats:

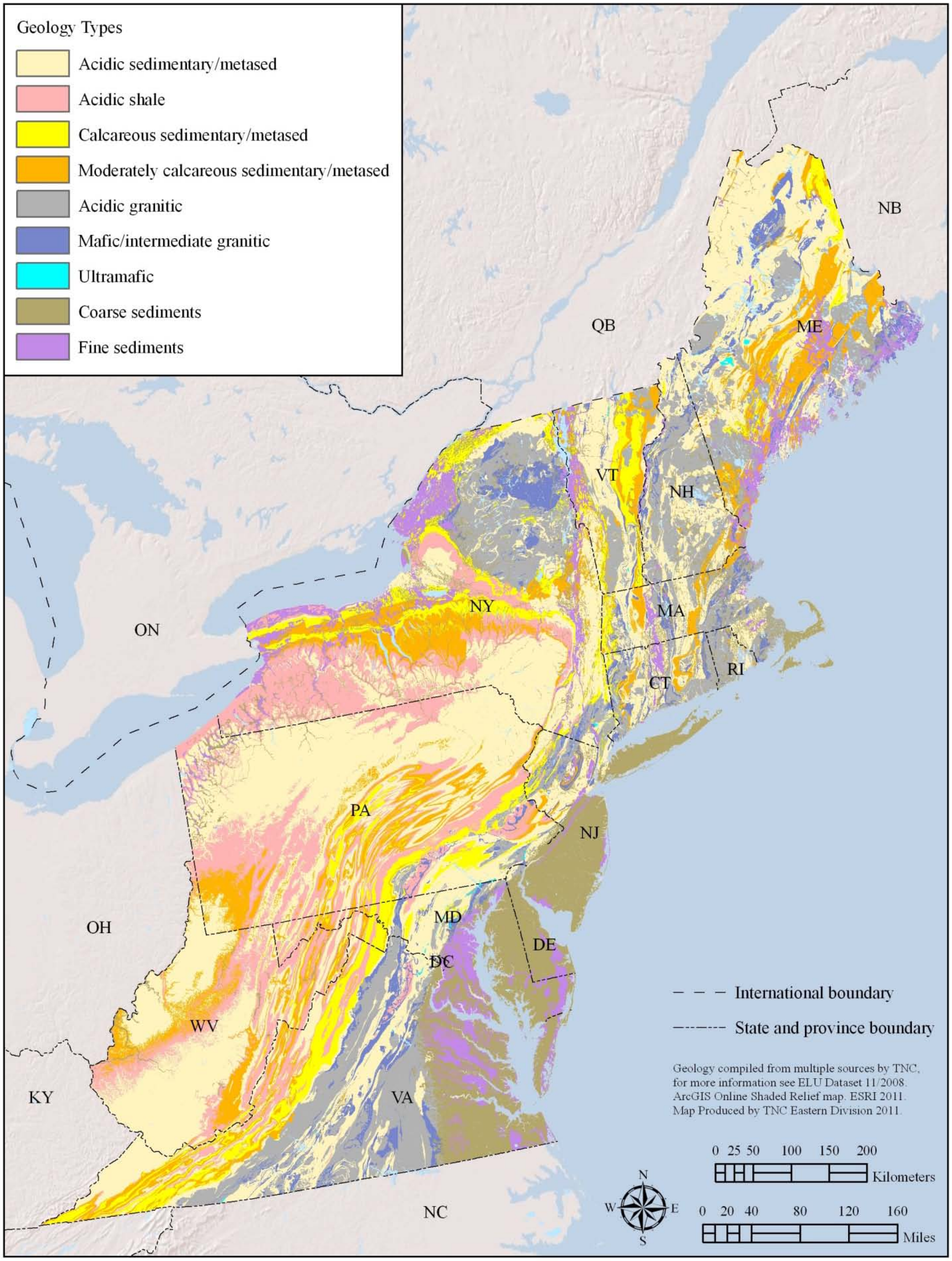
The unique habitats include:

- Limestone valleys, wetlands and glades (Calcareous settings)
- Soft sedimentary valleys and hills (Moderately calcareous settings)
- Acidic sedimentary pavements and ridges (Acidic sedimentary settings)
- Shale barrens and slopes (Shale settings)
- Granitic mountains and wetlands (Granite and Mafic settings)
- Serpentine outcrops (Ultramafic settings)
- Coarse sand barrens and dunes (Coarse-grained sediment settings)
- Silt floodplains and clayplain forests (Fine-grained sediment settings)
- Alpine meadows and krumholz (High elevation settings)
- Steep cliff communities (Cliff landforms)

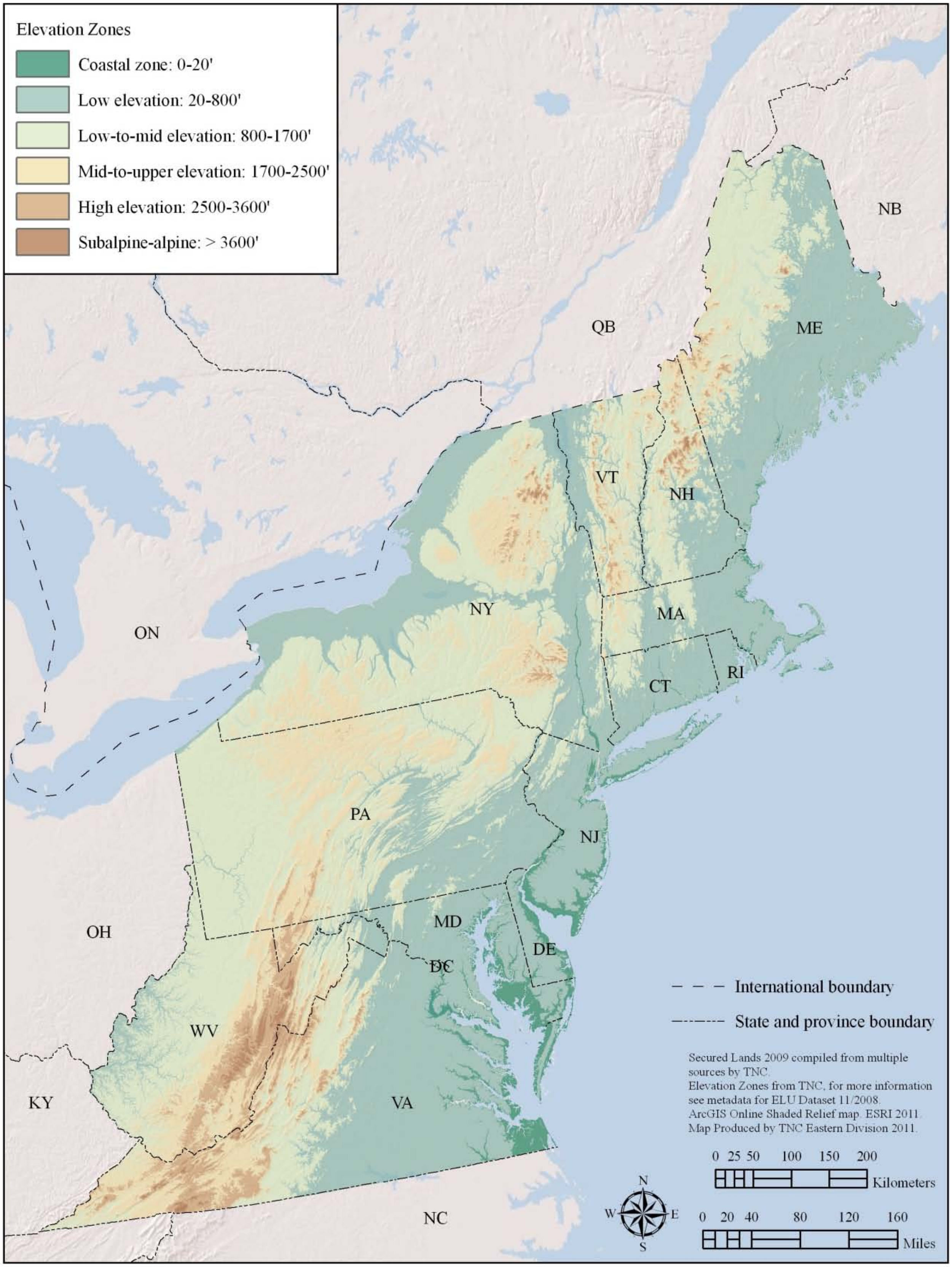
To evaluate the biodiversity associated with each setting, we compiled information on the location of natural communities and rare species tracked by the 14 State Natural Heritage programs. We overlaid the locations on geology, elevation and landform maps, and summarized the patterns to characterize each setting. The results are presented below, followed in later sections by information on the conservation status and condition of each setting. *Note*: the rare species counts are only a rough approximation of the true values because the state data sources vary in effort and focus. Resolution differences in various data layers may create error as, for example, a wetland species can appear to be on a nearby cliff. We used the information to elucidate only broad general patterns and the reported details should be taken this way.

<u>Calcareous Settings:</u> Limestone, dolomite, and marble are sedimentary rocks composed largely of calcite derived from the remains of marine organisms and deposited in a shallow water environment. Calcareous settings make up 6 percent of the region (Map 1) and have notable properties that increase their value to biodiversity. First, limestone is soluble in water and calcareous settings are often riddled with caves, springs, and alkaline fens, the latter supporting botanical jewels like pumpkin sedge. Second, although soils derived from limestone are high in pH and productive for agriculture, in bedrock form the variously named calcareous barrens, glades, and alvars are low in biomass but rich species diversity. Calcareous settings support over 100 restricted species, especially plants and mussels (Table 1), plus they support over 40 unique cave invertebrates half which are known from less than two locations.

Map 1. Geology Types.



Map 2. Elevation zones.



Map 3. Landforms

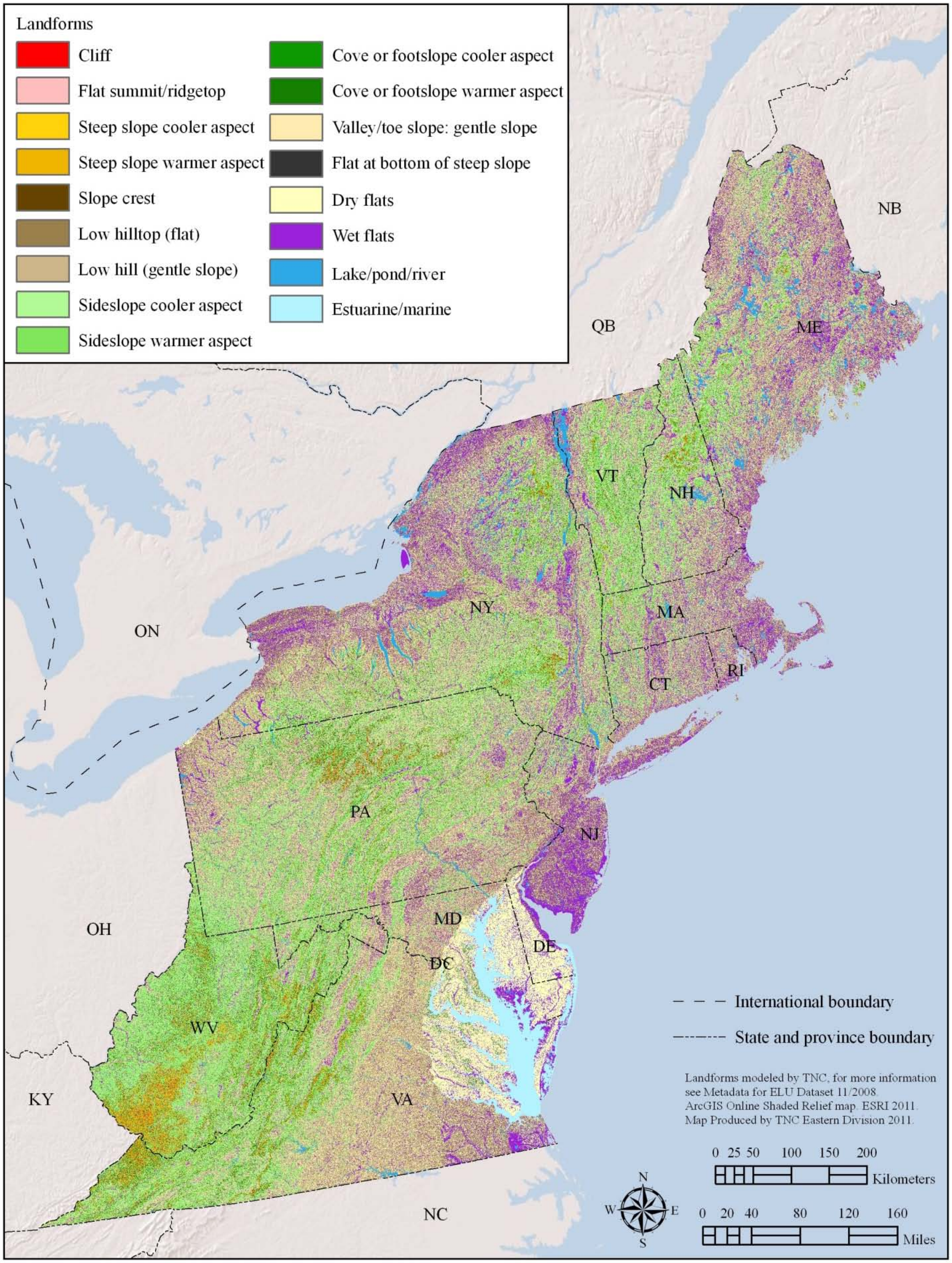


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Table 1. Communities and species associated with calcareous settings in this region. Restricted species have over 50 percent of their locations found in this setting based on 4 or more occurrences.

Calcareous Settings				106 rare species
Tracked Communities		Species Groups	Number of Restricted Species	Example
Cave		Fish	4	Slimy Sculpin
Calcareous fen & seep		Mammal	1	Gray Myotis
Dry Calcareous forest		Reptiles	2	Lake Erie Water Snake
Calcareous cliff and summit		Arthropods	19	Price's Cave Isopod
Calcareous shrublands		Insects	6	Pseudanophthalmus delicatus
Calcareous meadow		Mollusks	14	Spiny Riversnail
Calcareous shrublands		Mosses	3	Bryohaplocladium microphyllum
		Plants	54	Small Yellow Lady's-slipper
		Ferns	3	Hart's-tongue Fern

<u>Moderately Calcareous Settings</u>: Moderately calcareous bedrocks are substrates composed of sand or silt particles cemented by a calcareous matrix and having a neutral pH (for example, calcareous shale). This setting shares many of the attributes of calcareous limestone settings, but is less extreme in alkalinity and more widespread in extent: 11 percent of the region (Map 1). Caves, rich woods, underground streams, and alkaline waters are all typical, but glades and pavements are not. Rare species, especially plants, arthropods, and mollusks are common (Table 2) and trees like black locust, hackberry, redbud, and American elm are abundant in this setting.

Table 2. Species and communities associated with moderately calcareous settings. Restricted species have over 50 percent of their locations found in this setting based on 4 or more occurrences.

Moderately calcareous				120 rare species
Tracked Communities		Species Groups	Restricted Species #	Example
Yellow oak - redbud woodland		Amphibians	1	Cave Salamander
Significant karst area		Fish	6	Golden Darter
Underground pond and stream		Mammals	1	Virginia Big-eared Bat
Appalachian Terrestrial Riparian Cave		Reptiles	2	Copperbelly Water Snake
Freshwater Mussel Concentration Area		Arthropod	29	Holsinger's Cave Isopod
		Insects	19	Pseudanophthalmus Cave beetles
		Mollusks	11	Organ Cavesnail
		Plants	48	Crested Coralroot
		Ferns & Bryophytes	3	Black-stem Spleenwort

<u>Shale Settings:</u> Shale is a mud-based fine-grained fissile sedimentary rock that characteristically flakes into thin layers along bedding planes, creating unstable hill slopes. Shale underlies many common forest habitats, amounting to 11 percent of the region (Map 1), but is best known for creating the unique shale barrens and cliff communities found in the Appalachians. Plant rarities, such as shale barren rockcress and shale barren evening primrose, are adapted to hot dry slopes and continually creeping bedrock. Although some species of fish, reptiles and small mammals are found almost exclusively in shale settings it is not certain whether there is an ecological reason for their distribution patterns (Table 3).

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Table 3. Communities and species associated with shale in this region. Restricted species have over 50 percent of their locations found in this setting based on 4 or more occurrences.

Shale Settings				71 rare species
Tracked Communities		Species Groups	Restricted Species #	Example
Appalachian Shale Barren		Amphibians	1	Mud Salamander
Shale Cliff And Talus Community		Fish	5	Roughhead shiner
Red-cedar - hardwood rich shale woodland		Mammals	1	Prairie Vole
		Reptiles	2	Ground Skink
		Arthropod	2	Northern Clearwater Crayfish
		Insects	4	Appalachian grizzled skipper
		Mollusks	1	James Spinymussel
		Plants	53	Shalebarren Pussytoes
		Ferns	2	Appalachian Woodsia

Acidic Sedimentary Settings: This is a catch-all group of similar granular rock formed by consolidation and compaction of weathered mineral grains and rock fragments: sandstone, mudstone, siltstone, conglomerate, breccia, and greywacke, and their metamorphic equivalents, from slate to granofels. Most are relatively erodible, but some, like quartzite, are highly resistant and underlie ridges and slopes. This widespread class makes up a full 40 percent of the region (Map 1) and supports most of the common communities. Although this setting has its unique habitats and plenty of rarities (Table 4), by nature of its frequency, it is also the main setting for rare species that are not specific to any geology.

Table 4. Communities and species associated with acidic sedimentary settings in this region. Restricted species have over 50 percent of their locations found in this setting based on 4 or more occurrences. Note that because this setting is so widespread (40 percent of the region) species that are non-specific in their preferences will show up most commonly in this setting.

Acidic Sedimentary				656 rare species
Tracked Communities		Species Groups	Restricted Species #	Example
The majority of forest and wetland communities		Amphibians	8	Cheat Mountain Salamander
occur in this setting.		Birds	35	Philadelphia Vireo
		Fish	11	Northern Redbelly Dace
Unique communities include:		Mammals	24	Allegheny Woodrat
Sandstone Pavement Barrens		Reptiles	5	Timber Rattlesnake
Acidic cliff and talus		Arthropod	1	Cambarus crayfish
Riverwash Bedrock Prairie		Insects	69	Lilypad Clubtail
Sand / Gravel / Mud Bar and Shore		Vascular Plants	436	Northern Monk's-hood
Acidic Cove Forest		Bryophytes & Lichens	25	Appalachian Trail Lichen
		Ferns	42	Mountain Spleenwort

Granitic Settings: Granitic bedrocks include all forms of igneous or metamorphic rocks with interlocking grains dominated by siliceous minerals: granite, granodiorite, rhyolite, felsite, pegmatite, granitic gneiss, and others. Similar rocks with a high proportion of mafic minerals are described under mafic or ultra mafic rock. Granites weather to acid, nutrient poor, shallow soils and are not particularly rich in rare species, but because they are very resistant to weathering, granites underlay many of the regions mountain ranges and rocky coasts. The combination of poor soil and spectacular rugged scenery make granite areas a favorite places for hiking and conservation, so much so that, although granite covers only 11 percent of the region, it makes up 38 percent of the protected land (see below).

Table 5. Communities and species associated with acidic granitic settings in this region. Restricted species have over 50 percent of their locations found in this setting based on 4 or more occurrences.

Acidic Granitic				**66 rare species**
Tracked Communities		**Species Groups**	**Restricted Species #**	**Example**
Granitic flatrock		Amphibians	2	Slimy Salamander
Jack or Red Pine woodland		Birds	3	Common Loon
Montane acidic cliff and summit		Fish	6	Kanawha Minnow
Boreal Talus Woodland		Mammals	0	
Boreal heath barrens		Reptiles	5	Fence Lizard
Low-elevation Bald		Mollusk	1	Virginia Pigtoe
Lowland spruce flat		Insects	8	Appalachian Azure
Red oak woodland		Vascular Plants	35	Silverling
Alpine heath & tundra		Bryophytes & Lichens	5	Narrowleaf Peatmoss
Spruce hardwood forest		Ferns	1	Pennsylvania ostrich fern

<u>Mafic Settings:</u> Mafic bedrocks include forms of volcanic, plutonic or metamorphic rocks with a high proportion of dark colored minerals high in magnesium and iron (the term comes from contracting "magnesium and ferric"), often the result of rapid cooling, such as in the extrusive basalts. Rock types include: anorthosite, gabbro, diabase, basalt, diorite, andesite, and others, as well as their metamorphic equivalents: greenstone, and amphibolites. Mafic rocks weather to a richer soil than granites, but like granites they are resistant to weathering and underlay many of the region's ridges, mountains, and rocky coasts. Derived soils may be of neutral pH, hence the name "basic" in many community names, and they share species with moderately calcareous soils. In the extreme, mafic substrates may share flora with the ultramafic serpentines. Mafic soils only account for 5 percent of the region but underlay large sections of the Adirondack Mountains (Map 1).

Table 6. Communities and species associated with mafic bedrock settings in this region. Restricted species have over 50 percent of their locations found in this setting based on 4 or more occurrences.

Mafic Intermediate				**33 rare species**
Tracked Communities		**Species Groups**	**Restricted Species #**	**Example**
Alpine Krummholz & Meadow		Fish	0	
Circumneutral Rocky Summit/Rock Outcrop		Mammals	0	
Mountain fir forest		Reptiles	1	Copperhead
Basic Oak - Hickory Forest		Mollusk	2	Depressed Glyph
Mountain / Piedmont Basic Woodland		Insects	1	Currant Spanworm
High-elevation Outcrop Barren		Vascular Plants	26	Deer's Hair Sedge
Low-elevation Basic Outcrop Barren		Ferns	3	Appalachian Firmoss

<u>Ultramafic Settings:</u> Ultramafic bedrocks include igneous and meta-igneous rocks that are very high in magnesium and iron, and very low in silica and potassium: serpentine, soapstone, pyroxenite, dunite, peridotite, talc schist. These substrates weather to soils that are rich in magnesium, but poor in calcium, and they may have elevated levels of chromium or nickel. These extreme soils are toxic to many plants and a unique flora of tolerant species has evolved. Serpentine barrens tend to be open woodlands with stunted trees and an endemic herb flora. This setting covers less than 1 percent of the region (Map 1).

Table 7. Communities and species associated with ultramafic bedrock settings in this region. Restricted species have over 50 percent of their locations found in this setting based on 4 or more occurrences.

Ultramafic Settings				19 rare species
Tracked Communities		Species Groups	Restricted Species #	Example
Serpentine Barren		Inverts	5	Joyful Holomelina moth
Serpentine Outcrop		Plants	11	Serpentine aster
Mafic Fen				Roundleaf fameflower
				Annual fimbry
				Small's ragwort
		Ferns	3	Green Mountain maidenhair-fern
				Smooth cliffbrake
				Indian's dream

Fine-grained Mud and Silt Settings: This setting refers to deep deposits of fine-grained mud and silt, such as found on the clayplains of old lake beds, silt floodplains created by river deposits, and muddy tidal marshes on the coast. The characteristic communities are mostly marshes, floodplains, and swamps, and this setting favors species that tolerate poorly drained soils. Forests that form on these enriched plains often have a diversity of trees species uncommon in the surrounding landscape. This setting covers 6 percent of the region and supports numerous rare species (Table 8)

Table 8. Communities and species associated with fine-grained sediments in this region. Restricted species have over 50 percent of their locations found in this setting based on 4 or more occurrences.

Fine-grained Sediment Settings				88 rare species
Tracked Communities		Species Groups	Restricted Species #	Example
Deep Bulrush Marsh		Amphibians		
Freshwater Tidal Swamp & Marsh		Fish	17	Slenderhead Darter
Lakeside Floodplain Forest		Reptiles	6	Smooth Softshell
Major-river Floodplain Forest		Insects	7	Plains Clubtail
Pond Pine Woodland / Pocosin		Mollusks	15	Pink Papershell
Valley Clayplain Forest		Plants	43	Elongated Lobelia

Coarse-grained Sand Settings: Deep, coarse, sandy soils are characteristic of the outwash plains, coastal shorelines, and large riverbeds, generally sandy areas where the bedrock is too deeply buried to have a direct influence on the ecology. It accounts for 9 percent of the landscape. Habitats associated with coarse-grained sediments fall into two groups: the first are coastal beaches, dunes, grasslands and maritime forests, and the second are inland marshes, pond shores, and pine barrens. These habitats intermix, and both occur in highly fragmented human-dominated landscapes, where it is difficult to maintain natural fire regimes or allow for shore migration. Many common and well known species are associated with these environments, and they support a large number of rarities, including several federally listed species (Table 9). Species that thrive in this environment often have adaptations for sand burial or fire..

Table 9. Communities and species associated with coarse-grained sands in this region. Restricted species have over 50 percent of their locations found in this setting based on 3 or more occurrences.

Coarse Sand Setting				395 rare species
Typical Communities		Species Groups	Restricted Species #	Example
COASTAL				
Coastal Oak-Hickory Forest		Amphibians	2	Southern Leopard Frog
Beach and Dune communties		Birds	4	Piping Plover
Tidal marsh: salt, brackish, fresh		Fish	2	Inland Silverside
Sandplain and Maritime grassland		Mammals	2	Maritime Shrew
Coastal Pitch Pine barren		Reptiles	1	Loggerhead
Sea level Fen		Crustacean	2	Tidewater interstitial amphipod
Maritime interdunal swale		Insects	9	NE beach tiger beetle
		Mollusks	2	New England Siltsnail
		Plants	71	Seabeach knotweed
INLAND / PINE BARRENS				
Pitch Pine-Scrub Oak Barrens		Amphibians	12	Eastern Spadefoot
Pitch Pine swamp, lowlands		Birds	6	Red-cockaded Woodpecker
Coastal Plain Pond		Fish	14	Lined Topminnow
Coastal Plain White Cedar Swamp		Mammals	1	Rafinesque's Big-eared Bat
Sandplain and Maritime grassland		Reptiles	2	Northern Red-bellied Cooter
Vernal Pond		Insects	59	Coastal Barrens Buckmoth
Hudsonia Inland Beach Strand		Mollusks	2	Northern Lance
Silver Maple - Elm Forest		Bryophytes	4	Largeleaf Sphagnum
Swamp White Oak Floodplain Forest		Plants	198	Pine Barren Gentian
Kettle Hole Bog System		Ferns	2	Northern Appressed Clubmoss

Species Restrictedness Patterns: In order to compare the relative importance of each geology class to the taxonomic groups, we calculated the total number of species with over 50 percent of their known locations restricted to each geology class. In the tables above, we required a species to have at least four known locations to be called restricted, but in this broader analysis we relaxed that criterion and summed the total number of restricted species for each group. We calculated the expected distribution of species across the geology classes, if species were distributed in proportion to the amount of each geologic setting present in the region ("E"), and contrasted this with the observed distribution of species across geology classes ("O"). Subtracting O from E highlighted four settings that supported more rare species than expected based on their abundance in the region: calcareous, coarse-grained, fine-grained, and ultramafic (Figure 1).

To specifically examine which rare species groups favored which geology classes, we calculated the observed to expected ratios for each species on each geology class. The results of this analysis indicated that coarse-grained sediment not only supported more restricted species than expected, but that this was individually true for each of 13 taxonomic groups - all the types tested except ferns and arthropods (Table 10). Calcareous geologies were important to 9 taxonomic groups particularly invertebrates, fish, and bryophytes. Fine-grained sediments were important to 7 groups, especially fish, mollusks, and reptiles. Ultramafic geologies were important to insects, plants, and ferns (Table 10).

Figure 1. The observed and expected number of restricted rare species arranged by geology class. A restricted species was defined as having greater than 50 percent of its tracked locations on a particular geology. The expected number was the number of restricted species than would be expected if the species were distributed in proportion to the amount of the geology class present in the region.

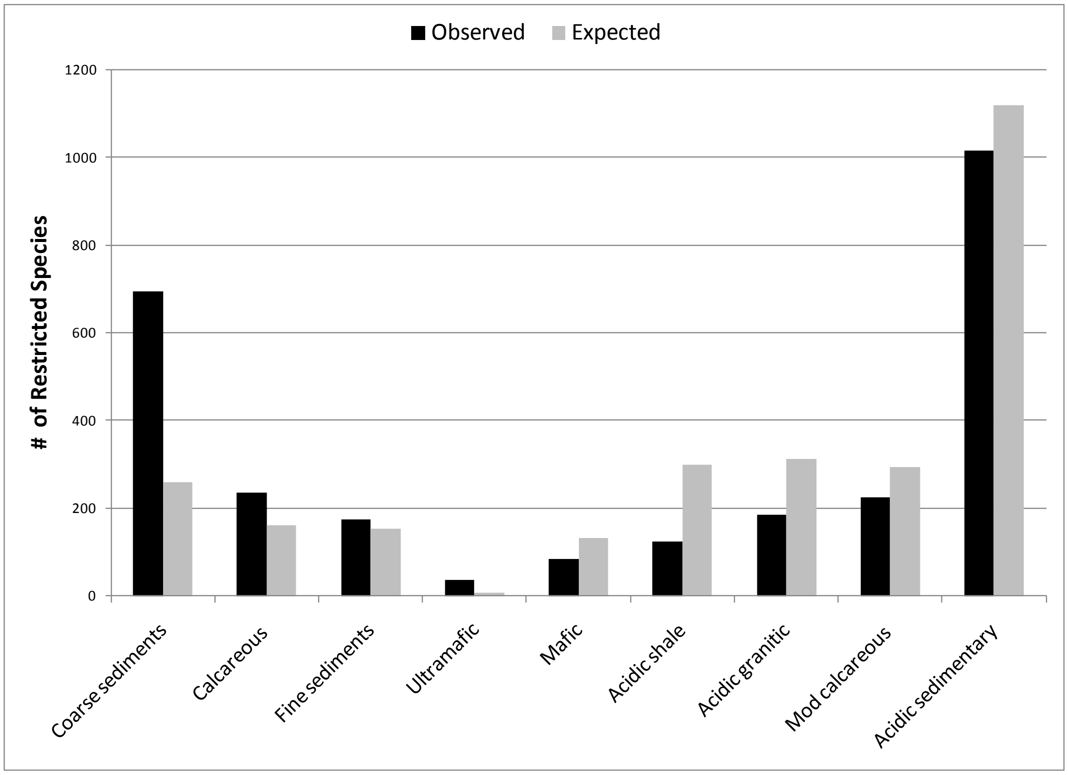


Table 10. The number of more-than-expected restricted rare species arranged by taxonomic group and geology class. O-E indicates the number of observed species ("O") on the geology class minus the number of expected species ("E") Positive numbers indicate more species than expected, and the All-Count row sums the number of taxa that had more than expected rare species on the geology class.

TAXA GROUP	Coarse sediments	Calcareous	Fine sediments	Mod calcareous	Acidic sedimentary	Ultra-mafic	Acidic shale	Acidic granitic	Mafic
Amphbian O-E	13	-2	-2	-1	-6	0	-2	2	-1
Reptiles O-E	3	1	4	1	-6	0	0	-3	-1
Fish O-E	8	5	20	-4	-19	0	-1	-4	-3
Mammals O-E	2	-1	0	-4	11	0	-3	-3	-1
Bird O-E	12	-4	0	-8	12	0	-6	-2	-3
VERTS- COUNT	**5**	**2**	**3**	**1**	**2**	**0**	**1**	**1**	**0**
Insects O-E	90	15	-1	8	-59	17	-43	-9	-11
Mollusk O-E	1	15	19	5	-23	0	-8	-6	-1
Arthropods O-E	-7	40	-7	35	-35	0	-10	-11	-4
INVERT - COUNT	**3**	**4**	**2**	**4**	**1**	**1**	**1**	**1**	**0**
Dicots O-E	166	0	-8	-53	11	7	-45	-54	-12
Monocot O-E	125	0	3	-37	-8	3	-40	-33	-8
Bryophytes O-E	16	3	-2	-7	4	0	-12	2	-1
Lichen O-E	3	0	0	0	-1	0	1	-2	-1
Ferns O-E	0	0	-4	-6	16	5	-6	-5	0
PLANTS-COUNT	**5**	**3**	**2**	**1**	**3**	**3**	**1**	**1**	**1**
ALL-COUNT	**13**	**9**	**7**	**6**	**6**	**4**	**3**	**3**	**1**

Elevation and Landform-based Communities

Extreme elevation influences species diversity patterns, and nowhere is this more apparent than in the mountainous high elevation settings where wind, ice and snow create alpine-like conditions. Altitudes above 3600 ft. cover less than one percent of the region, but these areas support a distinctive flora and fauna that share elements with alpine regions around the world. Habitats tracked by the heritage network include alpine meadows, bogs, tundra, snowbanks, and krummholz communities formed by stunted and wind-twisted trees. In the north, spruce and fir are characteristic of these habitats, but in the Central Appalachians gnarled red oaks are one of the dominant trees. Many rare species are associated with high elevation communities, the majority of them being plants (Table 11).

Table 11. Communities and species associated with high elevation and alpine settings in this region. Restricted species have over 50 percent of their locations found in this setting based on 4 or more occurrences.

High Elevation & Alpine (>3600')				55 rare species
Tracked Communities		**Species Groups**	**Restricted Species #**	**Example**
Alpine Krummholz/Mt fir forest		Amphibians	1	Cheat Mountain Salamander
Alpine tundra, wind-swpt ridge		Bird	1	Red-breasted Nuthatch
Alpine bog, meadow, sliding fen		Mammals	1	Virginia Northern Flying Squirrel
Central Appalachian soft sedge fen		Insects	3	Anarta Noctuid Moth
High elevation red oak forest		Bryophyte	1	Red Peatmoss
High-elevation boulderfield woodland		Plants	47	Alpine Azalea
High-elevation Cove Forest		Ferns	1	Appalachian Firmoss
Alpine/subalpine Pond				

Topographic settings also influence the distribution of species because local relief controls the distribution of solar radiation and moisture. The relationship between most landforms and specific habitats is less direct than for geology or high elevation, except for wetlands and cliffs; these settings create unique conditions that demand specific adaptations. Wetlands are by far the most widespread (14 percent of the region) and species rich of the landform habitats (Table 12), and they are discussed in their own chapter. Cliffs and steep slopes (3 percent of the region) offer a challenging setting for many species. Species that thrive on cliffs range from tenacious wiry herbs, to large predatory birds such as ledge nesting falcons and ravens (Table 13). Note, this dataset maps large cliffs and does not accurately reflect all small cliffs and outcrop; for example, only 35 percent of peregrine falcon nests show up on the mapped cliffs, although, according to the descriptive information, almost all of the nests are on cliffs.

Table 12. Communities and species associated with wet flat settings in this region. Restricted species have over 50 percent of their locations found in this setting based on 3 or more occurrences.

Wet flats				479 rare species
Tracked Communities		Species Groups	Restricted Species #	Example
Bogs - 27 named types		Amphibians	6	Southern leopard frog
*Example: Black spuce bog		Birds	25	Black rail
Swamp - 50 named types		Fish	36	Lined Topminnow
*Example: Buttonbush Swamp		Mammals	1	Northern flying squirrel (dead trees)
Marsh -25 named types		Reptiles	7	Wood Turtle
*Example: Brackish Tidal Marsh		Arthropod	5	Chowanoke Crayfish
Fen - 34 named types		Insects	56	Bog Copper
*Example: Limestone Fen		Mollusks	34	Creek Heelsplitter
Floodplain - 18 named types		Vascular Plants	297	Swamp Fly-honeysuckle
*Example: Lakeside Floodplain Forest		Bryophytes	6	Carolina sphagnum
		Ferns	6	Bog Fern

Table 13. Communities and species associated with cliffs and steep slope settings in this region. Restricted species have over 50 percent of their locations found in this setting based on 4 or more occurrences.

Cliff and Steep Slopes				55 rare species
Tracked Communities		Species Groups	Restricted Species #	Example
Acidic Cliff		Amphibians	1	Shenandoah Salamander
Acidic Talus Slope Woodland		Insect/Arthropod	2	White Mountain Fritillary
Circumneutral Outcrop		Plants-dicots	39	Indian Milk-vetch
Boreal Circumneutral Outcrop		Plant-monocots	10	Purple Sedge
Boreal Talus Woodland		Ferns	2	Smooth Cliff Brake
Calcareous Cliff Community		Bird	1	Peregrin Falcon (35%)
Sandstone cliff				
High-elevation Boulderfield Forest / Woodland				
Northern White-Cedar Slope Forest				
Shale Cliff And Talus Community				
Ice Cave Talus Community				

Distribution, Loss, and Protection Status

To understand the relative levels of habitat conversion and securement within each geologic setting, we overlaid the TNC secured lands data (TNC 2009) and the National Land Cover Dataset (Homer et al. 2004) on the geophysical maps, and tabulated the amount of each securement type or land cover class, on each geology type, elevation zone, or landform type.

Results of this analysis revealed six environments where habitat conversion exceeds habitat securement by a ratio of 4:1 or greater (Table 14, Figure 2, Map 4-5). Among the geology classes, calcareous settings were 52 percent converted and only 3 percent secured, with conversion outweighing securement 17:1. Conversion exceeded protection 51:1 the highest of any setting in the region. Coarse-grained settings were the next most converted, but had higher levels of securement and protection: 43 percent converted and 11 percent secured, a 4:1 ratio, and a conversion to protection ratio of 8:1. Fine–grained settings with

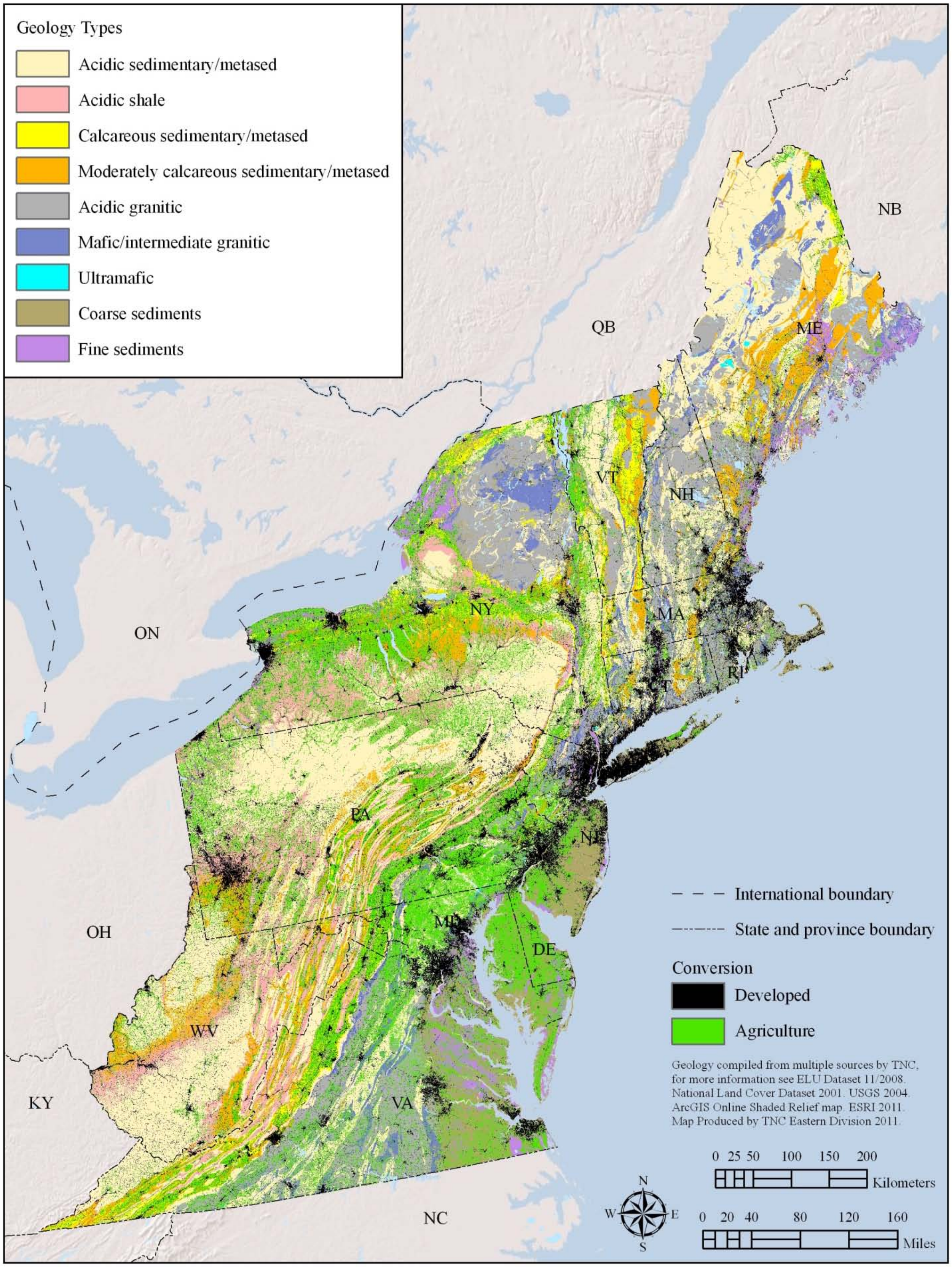
38 percent converted to 8 percent secured were at higher risk 5:1, and conversion exceeded protection 11:1. Acidic shale was also at high risk, having a conversion to securement ratio of 4:1 and a conversion to protection ratio of 29:1. Conversion in ultramafic settings had a 3:1 ratio to securement and a 6:1 ratio to protection. In stark contrast, granitic and mafic settings had more securement that conversion, and the proportions were equal in acidic sedimentary settings (Table 14).

Habitat conversion decreased with elevation, and securement increased (Figure 2, Map 6). At elevations under 800 feet, conversion exceeds securement 6:1, but the relationship reversed at 1700 ft, where securement outweighs conversion 2:1. At high elevations, conversion was virtually absent and almost 68 percent of the area was secured (Table 14, Figure 2). Alpine is a tiny proportion of the landscape, however, and the total acreage of securement, 480,000 acres was small compared to the 4 million acres devoted to low elevation land (Figure 3). Coastal ecosystems have appropriately received more conservation attention and the ratio of conversion to securement was only 2:1, reflecting the important network of coastal protection including places like Cape May National Wildlife Refuge and Cape Cod National Seashore.

Table 14. The percent of habitat conversion compared to percent of habitat securement and protection. The ratios of conversion to securement are given in various combinations where CRI-S is the ratio of conversion to securement (GAP 1-3) and CRI-P is the ratio of conversion to protection (GAP 1-2).

	Percentages					Subtotals		Rations: Acres converted for each acre secure				Total
Geology Class	**Agriculture**	**Developed**	**Gap 1 & 2**	**Gap 3**	**Not Secured**	**% Converted**	**% Secured**	**CRI-S**	**CRI-P**	**Developed to Secured**	**Developed to Protected**	**Acres**
Calcareous sed/metased	0.39	0.13	0.01	0.02	0.45	0.52	0.03	16.7	51.2	4.2	12.8	10,081,655
Coarse sediments	0.26	0.17	0.06	0.05	0.46	0.43	0.11	4.0	7.6	1.6	3.1	17,667,196
Fine sediments	0.25	0.13	0.03	0.04	0.55	0.38	0.08	4.9	11.4	1.7	3.9	9,228,436
Acidic shale	0.25	0.09	0.01	0.07	0.57	0.34	0.09	4.0	29.3	1.0	7.6	18,390,526
Mod calcareous sed/metased	0.21	0.09	0.02	0.08	0.61	0.29	0.10	3.1	19.2	0.9	5.7	15,640,399
Ultramafic	0.18	0.10	0.05	0.05	0.62	0.28	0.10	2.9	6.0	1.1	2.2	118,028
Mafic/intermediate granitic	0.11	0.08	0.12	0.11	0.57	0.19	0.24	0.8	1.6	0.4	0.7	7,212,394
Acidic sed/metased	0.12	0.07	0.04	0.14	0.63	0.19	0.18	1.1	4.7	0.4	1.7	55,967,531
Acidic granitic	0.11	0.07	0.13	0.12	0.58	0.18	0.25	0.7	1.4	0.3	0.6	21,622,929
Grand Total	0.18	0.09	0.05	0.10	0.57	0.28	0.15	1.9	5.6	0.6	1.9	155,929,095
Elevation Zone	**Agriculture**	**Developed**	**Gap 1 & 2**	**Gap 3**	**Not Secured**	**% Converted**	**% Secured**	**CRI-S**	**CRI-P**	**Developed to Secured**	**Developed to Protected**	**Acres**
< 20'	0.19	0.17	0.10	0.08	0.47	0.35	0.18	2.0	3.5	0.9	1.6	4,883,797
20-800'	0.24	0.14	0.02	0.04	0.55	0.38	0.07	5.9	18.6	2.2	6.9	64,881,752
800-1700'	0.16	0.06	0.04	0.11	0.64	0.22	0.14	1.6	6.1	0.4	1.7	56,816,806
1700-2500'	0.11	0.03	0.11	0.21	0.54	0.14	0.32	0.4	1.2	0.1	0.3	22,395,143
2500-3600'	0.09	0.03	0.17	0.22	0.49	0.12	0.39	0.3	0.7	0.1	0.2	6,241,805
> 3600'	0.01	0.02	0.24	0.44	0.29	0.03	0.68	0.0	0.1	0.0	0.1	709,792
Grand Total	0.18	0.09	0.05	0.10	0.57	0.28	0.15	1.9	5.6	0.6	1.9	155,929,095
Landform Type	**Agriculture**	**Developed**	**Gap 1 & 2**	**Gap 3**	**Not Secured**	**% Converted**	**% Secured**	**CRI-S**	**CRI-P**	**Developed to Secured**	**Developed to Protected**	**Acres**
Dry flats	0.35	0.15	0.02	0.06	0.42	0.49	0.08	6.1	22.9	1.8	6.8	14,575,122
Gentle hill/valley	0.26	0.13	0.03	0.08	0.50	0.39	0.11	3.6	13.7	1.2	4.5	57,915,942
Wet flats	0.15	0.11	0.07	0.09	0.58	0.26	0.16	1.6	3.7	0.7	1.6	22,277,873
Sideslope	0.10	0.05	0.06	0.13	0.66	0.15	0.19	0.8	2.3	0.2	0.8	45,715,477
Cove/footslope	0.06	0.07	0.08	0.16	0.63	0.13	0.25	0.5	1.5	0.3	0.8	4,327,868
Summit/ridgetop	0.04	0.01	0.11	0.17	0.66	0.06	0.28	0.2	0.5	0.0	0.1	3,068,775
Cliff/steep slope	0.00	0.02	0.12	0.18	0.67	0.02	0.30	0.1	0.2	0.1	0.2	4,048,329
Open water	0.01	0.01	0.03	0.04	0.90	0.03	0.07	0.4	0.9	0.2	0.4	3,999,710
Grand Total	0.18	0.09	0.05	0.10	0.57	0.28	0.15	1.9	5.6	0.6	1.9	155,929,095

Map 4. Conversion and geology type.



Map 5. Securement and geology type.

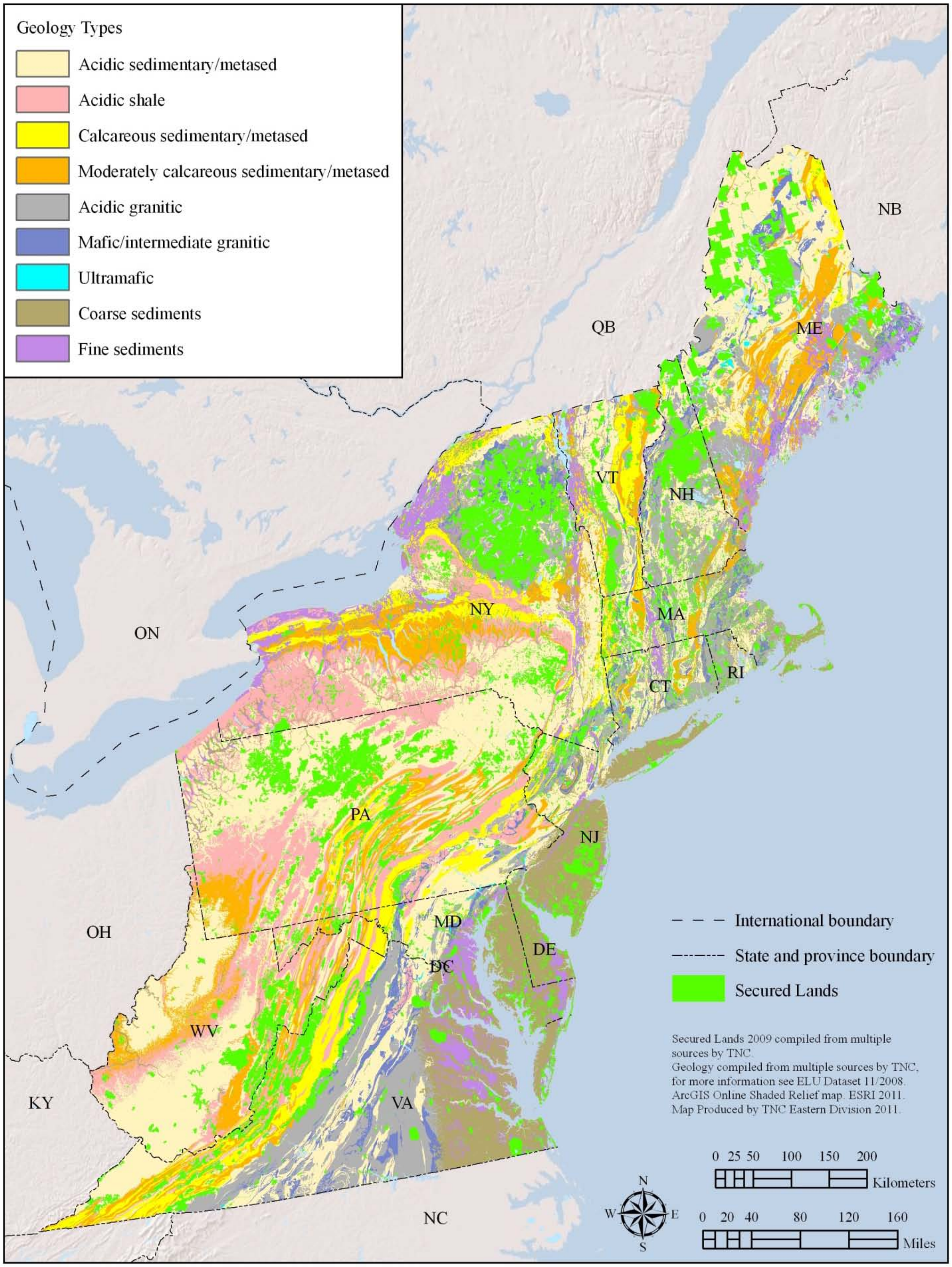
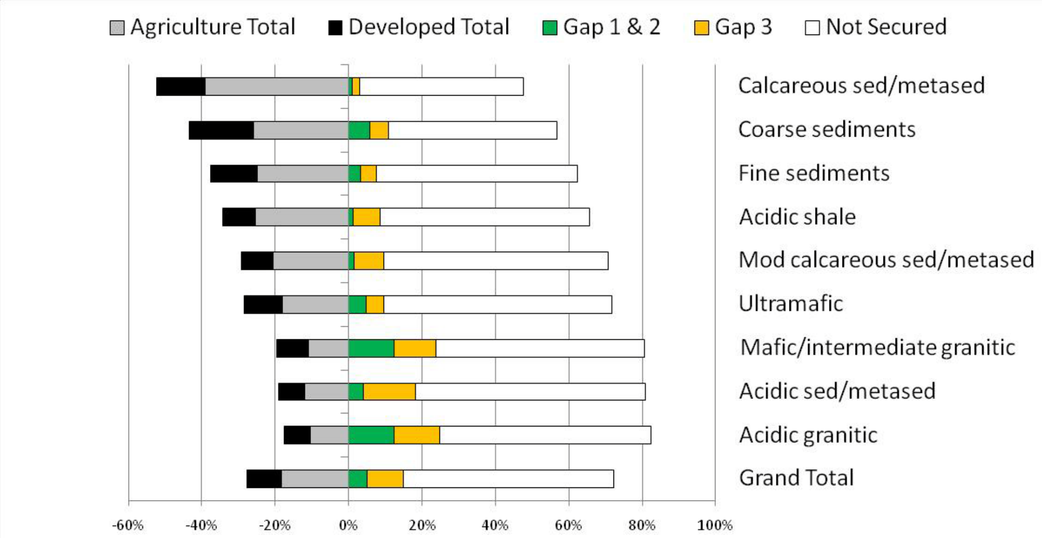
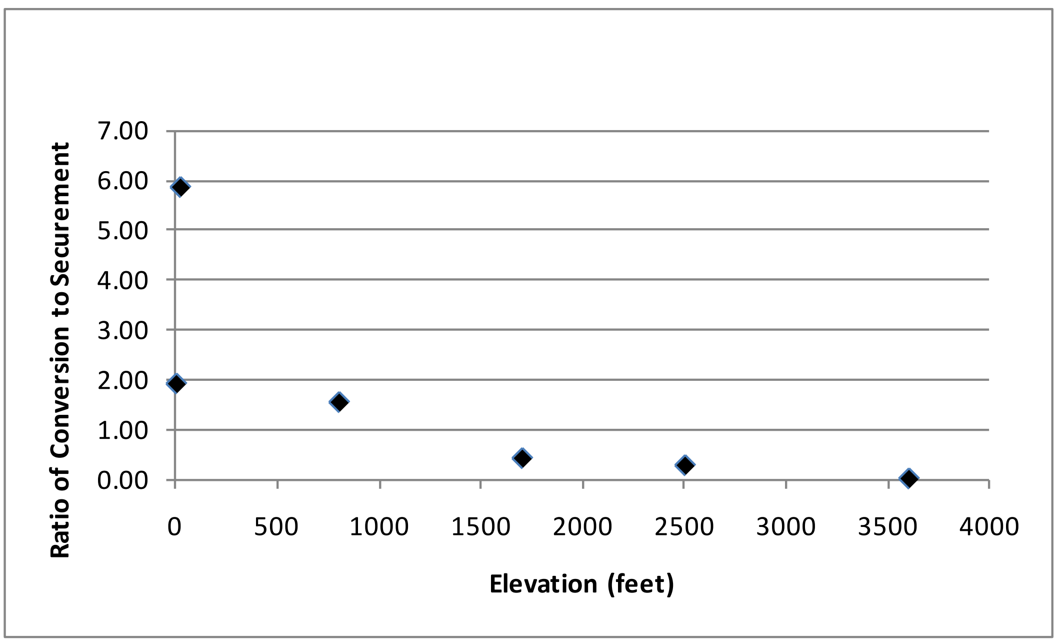


Figure 2. Geology Classes: Amount of conversion compared with the amount of securement. Each bar represents 100% of the historic area. Area to the left of the "0" axis indicates acreage converted, area to the right shows the remaining natural land by securement status (see also Maps 4 and 5).

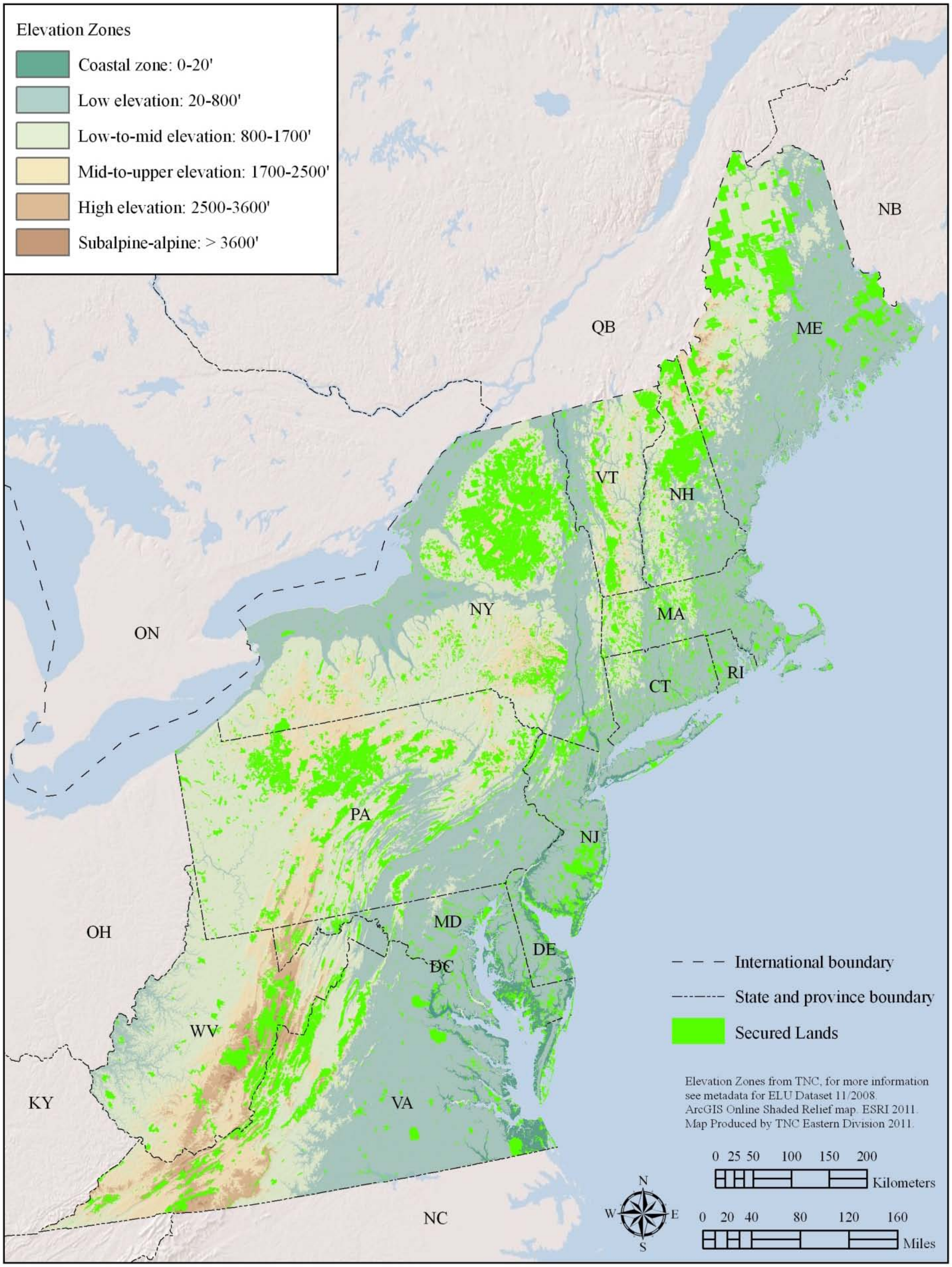


	Grand Total	Acidic granitic	Acidic sed/metased	Mafic/intermediate granitic	Ultramafic	Mod calcareous sed/metased	Acidic shale	Fine sediments	Coarse sediments	Calcareous sed/metased
Agriculture Total	-28,556,492	-2,283,753	-6,728,847	-793,354	-21,227	-3,222,082	-4,687,094	-2,287,296	-4,578,490	-3,954,349
Developed Total	-14,644,968	-1,513,030	-3,945,212	-612,371	-12,205	-1,365,181	-1,630,504	-1,184,910	-3,068,909	-1,312,647
Gap 1 & 2	7,726,069	2,704,205	2,260,050	891,617	5,575	238,712	215,721	305,576	1,001,712	102,901
Gap 3	15,541,033	2,679,990	7,868,414	819,021	5,791	1,264,275	1,373,246	400,960	917,493	211,844
Not Secured	89,460,532	12,441,951	35,165,008	4,096,031	73,229	9,550,149	10,483,961	5,049,694	8,100,593	4,499,914

Figure 3. The ratio of conversion to securement for each elevation zone.



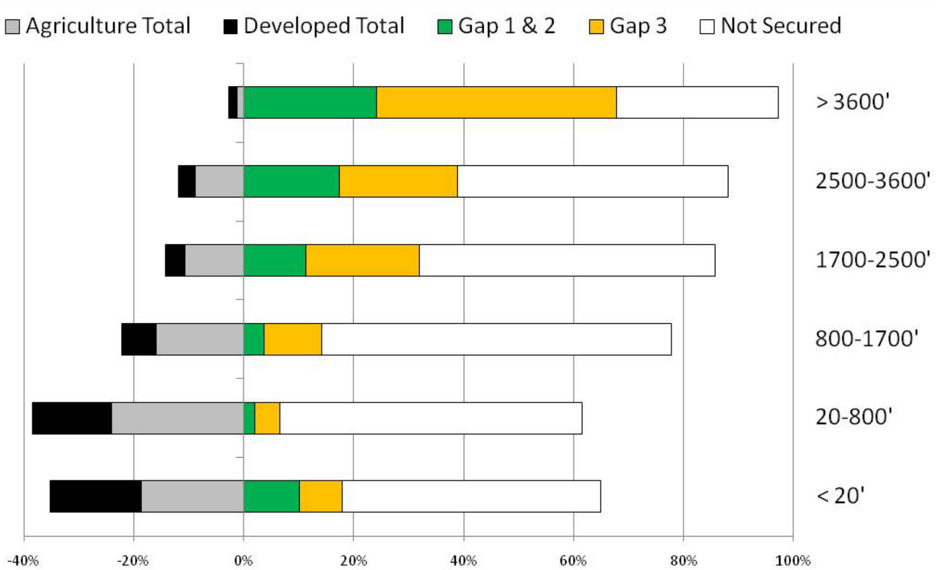
Map 6. Securement by elevation zone.



From a landform perspective, people have secured slopes and converted flats. All flat settings had more conversion than securement: dry flats (6:1), gentle hills and valleys (3:1) and wetflats (2:1). The heavily converted dry flats were particularly at risk with conversion outweighing protection 22:1 (Figure 4, Table 14). In contrast, every type of sloping landforms had more securement than conversion, and all except sidelopes and coves had more protection than conversion as well. (Figure 4, Table 14).

Finally, we tested whether the ratio of conversion to securement was simply a function of the acreage of the setting or feature, but found that they were unrelated (Figure 6). In summary, five settings were clearly at risk due to the large amount of conversion and small amount of securement: calcareous, fine-grained and coarse-grained sediment, dry flats, low elevation.

Figure 4. Elevation Zones. The amount of conversion compared with the amount of securement. Each bar represents 100% of the historic area. Area to the left of the "0" axis indicates acreage converted, area to the right shows the remaining natural land by securement status. See also Map 6.



	< 20'	20-800'	800-1700'	1700-2500'	2500-3600'	> 3600'
Agriculture Total	-905,824	-15,599,364	-9,086,278	-2,407,320	-549,727	-7,980
Developed Total	-810,027	-9,295,159	-3,556,004	-782,079	-190,027	-11,671
Gap 1 & 2	494,489	1,338,769	2,087,096	2,552,344	1,082,136	171,235
Gap 3	382,559	2,914,028	5,995,445	4,596,963	1,342,284	309,753
Not Secured	2,290,899	35,734,431	36,091,983	12,056,436	3,077,631	209,152

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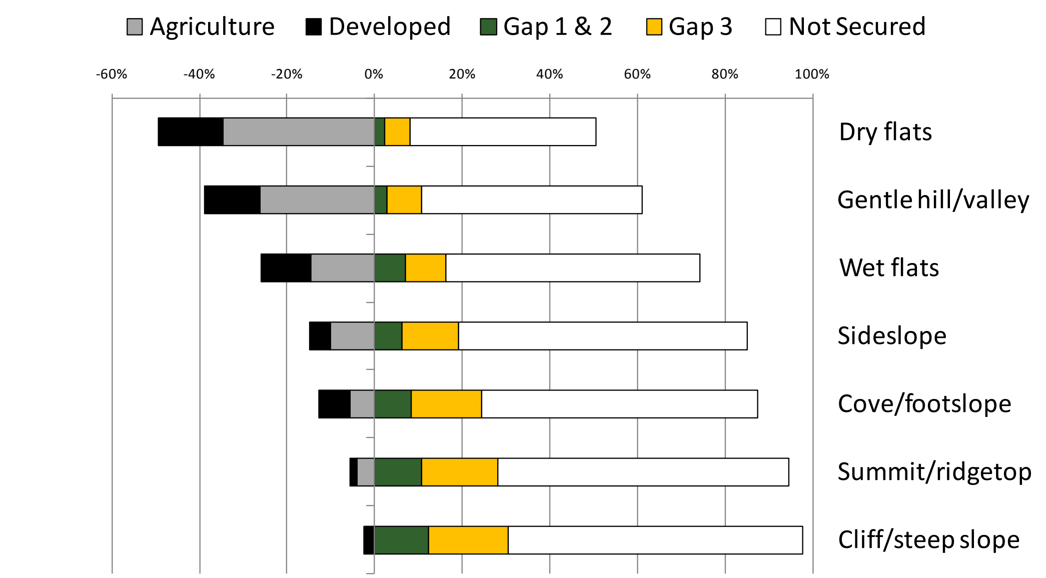
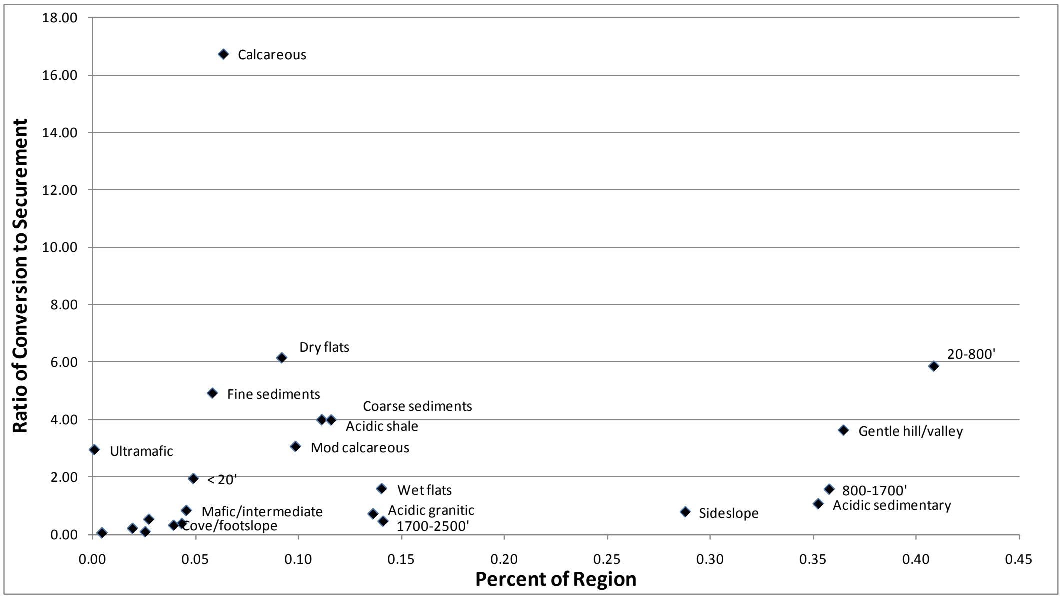
Figure 5. Landform Types. The amount of habitat conversion compared with the amount of habitat securement or protection. . Each bar represents 100% of the historic area. Area to the left of the "0" axis indicates acreage converted, area to the right shows the remaining natural land by securement status.



	Cliff/steep slope	Summit/ridgetop	Cove/footslope	Sideslope	Wet flats	Gentle hill/valley	Dry flats
Agriculture	-18,966	-127,494	-241,306	-4,613,600	-3,256,258	-15,188,450	-5,054,800
Developed	-77,465	-42,371	-304,190	-2,202,147	-2,487,359	-7,331,189	-2,153,577
Gap 1 & 2	500,441	328,364	360,483	2,904,966	1,554,605	1,643,378	315,254
Gap 3	732,334	530,479	702,276	5,910,948	2,076,172	4,570,415	858,075
Not Secured	2,719,122	2,040,068	2,719,656	30,083,876	12,907,850	29,182,823	6,194,172

Figure 6. The conservation risk index in relation to acreage. This chart shows the ratio of conversion to securement for each geological setting, elevation zone, and landform type in relation to the percent of the region covered by that feature.



Ecological Condition: Fragmentation and Connectivity

The region now contains 71 million people and 732,000 miles of permanent roads, but people and roads are not distributed randomly across the region. In this section we examine the spatial distribution of roads and other fragmenting features in relationship to the underlying geology and elevation, to objectively assess the degree of fragmentation present in each setting.

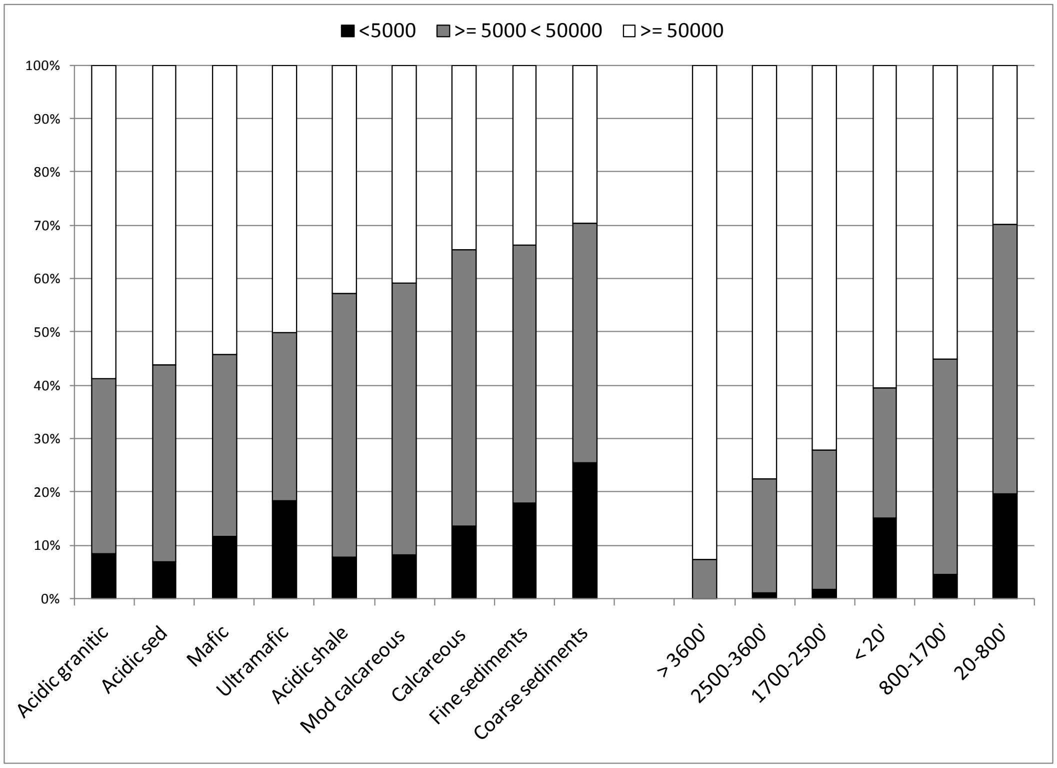
Fragmentation: Fragmentation occurs when a contiguous area of natural land is subdivided into smaller patches, resulting in each patch having more edge habitat and less interior. Because edge habitat contrasts strongly with interior the surrounding edge habitat tends to isolate the interior region and contribute to its degradation. Thus fragmentation can lead to an overall deterioration of ecological quality and a shift in associated species from interior specialists to edge generalists.

The region's permanent roads are the primary fragmenting features providing access into interior regions, and decreasing the amount of sheltered secluded habitat preferred by many species. Heavily-used paved roads create noisy disturbances that many species avoid, and the roads themselves may be barriers to the movement of small mammals, reptiles, and amphibians. To evaluate the extent and impact of roads, we examined the patterns created when major roads connect to encircle contiguous blocks of land. We defined a block as a distinct area of land surrounded on all sides by major roads (e.g. wide paved roads with significant traffic volume). The area of each block was calculated, the block was assigned to a size class, and the amount of each geophysical setting within each block was summarized to determine the size class distribution for blocks of each setting type (Map 3, Figure 4, Table 2). Our assumption was that the highest quality habitat is found in the central core of each block (the region greater than 100 meters from any major road, field or developed area), and that the effect of the fragmenting feature decreases with the size of the blocks.

The results of overlaying the blocks on the landscape features revealed progressively decreasing large blocks of natural land as the settings went from acidic bedrock to calcareous bedrock to surficial deposits, and from high elevation to low elevations (Figure 6). For instance, only 30 percent of the coarse-grained sediment areas, and low elevation areas were found in blocks over 50,000 acres compared to almost 60 percent for granitic settings, and 92 percent for alpine settings.

Connectivity: The opposite of fragmentation is connectivity, a measure of how easy it is for species and processes to freely move within a setting. The metric we used to measure connectivity - local connectedness - is related to, but more sensitive than, the forest block analysis of the previous section. Using more than just major roads, this metric takes into account the impacts of local roads, as well as the density of all nearby roads and the degree of nearby conversion. The assessment method treats the landscape as having a gradient of permeability where highly contrasting land cover types have reduced permeability between them, and highly similar ones have enhanced permeability. In applying the metric, we differentiated between developed lands, agricultural lands, and natural cover, but all forms of natural land cover were combined into one class for the analysis. The assessment of local connectivity was developed and run by Brad Compton at the University of Massachusetts, based on the 30 m National Land Cover dataset (Homer et al. 2004) land cover map supplemented with major and minor road information (Tele Atlas North America, Inc. 2009 –and see appendix B for detail on the methods).

Figure 6. Block sizes by geology and elevation. In this chart, the percent of land acres within each block size classes is shown by setting, and arranged in order of decreasing large blocks.



The region's different geologic settings differed markedly in their degree of connectivity. Calcareous areas had the lowest connectedness scores, averaging 14, and suggesting that they had lost about 84 percent of their natural connectivity (Figure 7 and 8). Both coarse-grained deposits and fine-grained deposits had scores averaging less than 20. The high scoring regions of granite and mafic materials, averaged only in the 40s, highlighting how pervasive fragmentation was across the region, although scores in the 40s can be fairly intact (Figure 7).

Figure 7: Aerial photo of areas with different connectedness scores. The image on the left has a mean score of "10" for the area under the circle, close to the mean score of "14" for limestone settings. The image on the right has a mean score of "43" for the area under the circle, similar to the mean score of "42" for granitic settings. A pristine area with no roads, power-lines, development or farms would score "100."

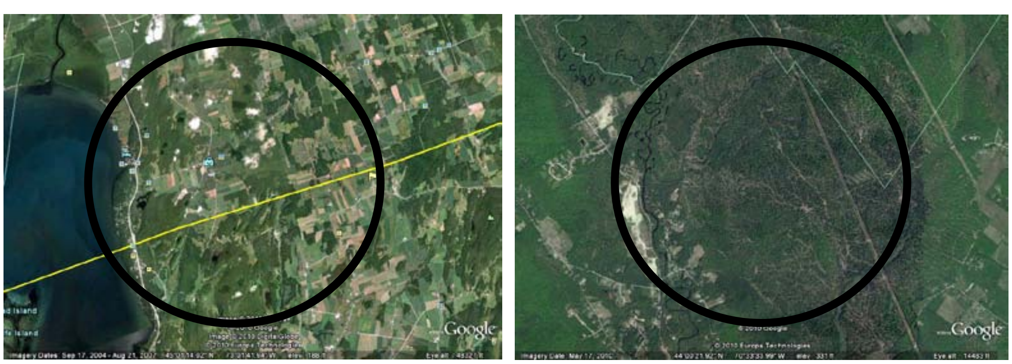
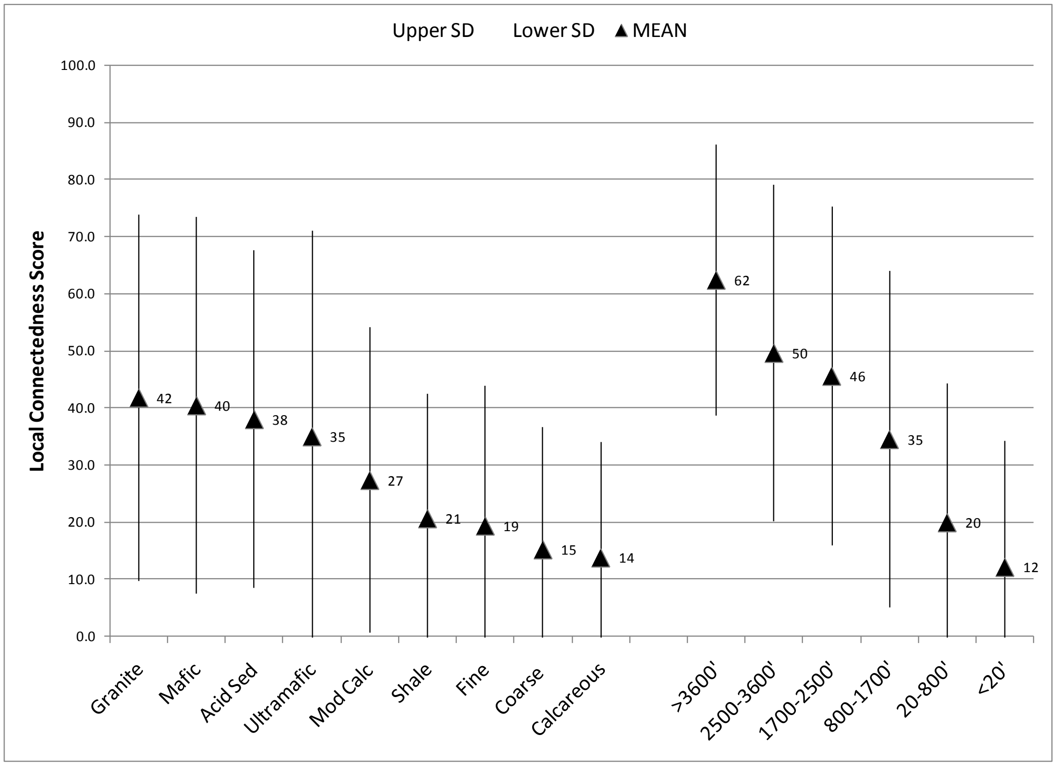


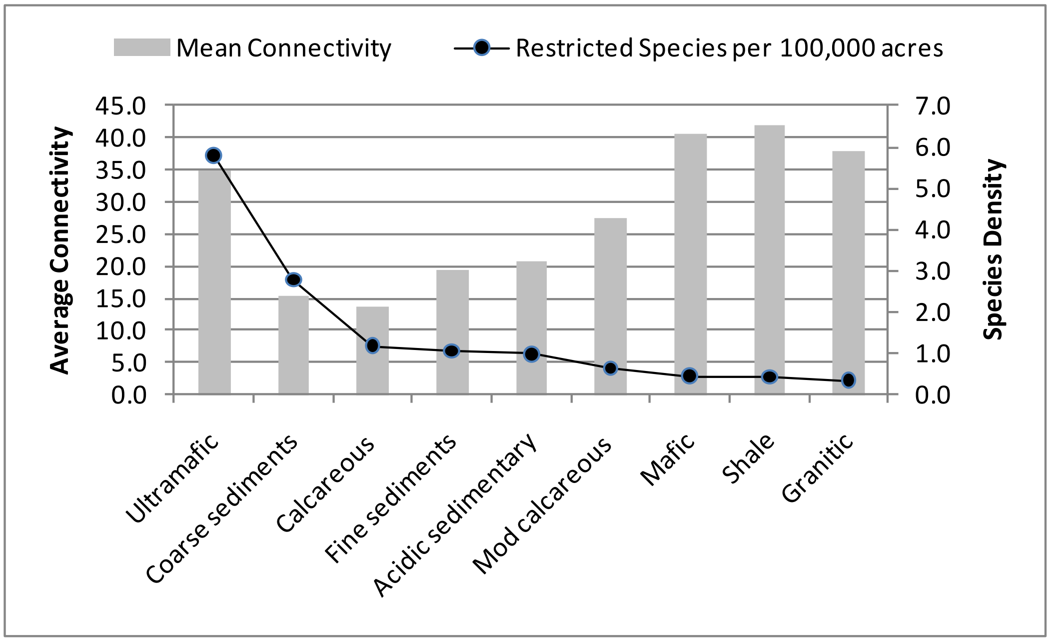
Figure 8. Average connectedness scores for the nine geology classes and six elevation zones. Error bars show one standard deviation above and below the mean.



Synthesis of Species Data with Habitat Condition

Lastly, we examined how the density of restricted species, described in the initial sections of this chapter, related to the conversion, fragmentation, and connectivity scores. Using simple correlations and visual inspection we found that the more fragmented and less connected environments were the ones with the higher densities of restricted species, with the exception of the very rare ultramafic settings (Figure 9). Coarse-grained sediment, calcareous bedrock, and fine-grained sediment emerged as the three habitats of the highest concern, paralleling the results of the conversion to securement ratios.

Figure 9. Relationship between the average connectivity score (left axis) and the density of restricted species (right axis). In general the settings with higher numbers of restricted species are more fragmented, the exception being ultramafic environments that account for only 0.002 percent of the region.



References

Please see the data sources (appendix A) and detailed methods (appendix B) sections of the main report for more information on the data sources and analysis methods used in this chapter.

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Homer, C., C. Huang, L. Yang, B. Wylie and M. Coan, 2004. Development of a 2001 national land cover database for the United States. Photogrammetric Engineering and Remote Sensing.

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Tele Atlas North America, Inc. 2009. U.S. and Canada Railroads. 1:100,000. ESRI® Data & Maps: StreetMap. 2009 Data Update: North America. Redlands, California, USA. U.S. and Canada Railroads represent the railroads of the United States and Canada.

The Nature Conservancy (TNC). 2009. Eastern U.S. Secured Lands. Various scales. Compiled from multiple sources.

Species names used in the text

Common Name	**Standard name**
Allegheny Woodrat	*Neotoma magister*
Alpine Azalea	*Loiseleuria procumbens*
Anarta Noctuid Moth	*Anarta melanopa*
Annual Fimbry	*Fimbristylis annua*
Appalachian Azure	*Celastrina neglectamajor*
Appalachian Firmoss	*Huperzia appressa*
Appalachian grizzled skipper	*Pyrgus Wyandot*
Appalachian Trail Lichen	*Ramalina petrina*
Appalachian Woodsia	*Woodsia appalachiana*
Black Rail	*Laterallus jamaicensis*
Black-stem Spleenwort	*Asplenium resiliens*
Bog Copper	*Lycaena epixanthe*
Bog Fern	*Thelypteris simulate*
Bryohaplocladium microphyllum	*Bryohaplocladium microphyllum*
Cambarus crayfish	*Cambarus veteranus*
Carolina sphagnum	*Sphagnum carolinianum*
Cave Salamander	*Eurycea lucifuga*
Cheat Mountain Salamander	*Plethodon netting*
Chowanoke Crayfish	*Orconectes virginiensis*
Coastal Barrens Buckmoth	*Hemileuca maia maia*
Common Loon	*Gavia immer*
Copperbelly Water Snake	*Nerodia erythrogaster neglecta*
Copperhead	*Agkistrodon contortrix*
Creek Heelsplitter	*Lasmigona compressa*
Crested Coralroot	*Hexalectris spicata var. spicata*
Currant Spanworm	*Itame ribearia*
Deer's Hair Sedge	*Trichophorum caespitosum*
Depressed Glyph	*Glyphyalinia virginica*
Eastern Spadefoot	*Scaphiopus holbrookii*
Elongated Lobelia	*Lobelia elongate*
Fence Lizard	*Sceloporus undulates*
Roundleaf fameflower	*Talinum teretifolium*
Golden Darter	*Etheostoma denoncourti*
Gray Myotis	*Myotis grisescens*
Green Mountain maidenhair-fern	*Adiantum viridimontanum*
Ground Skink	*Scincella lateralis*
Hart's-tongue Fern	*Asplenium scolopendrium var.americanum*
Holsinger's Cave Isopod	*Caecidotea holsingeri*
Indian Milk-vetch	*Astragalus australis*
Indian's dream	*Aspidotis densa*
Inland Silverside	*Menidia beryllina*
James Spinymussel	*Pleurobema collina*
Joyful Holomelina moth	*Holomelina laeta*
Kanawha Minnow	*Phenacobius teretulus*
Lake Erie Water Snake	*Nerodia sipedon insularum*
Largeleaf Sphagnum	*Sphagnum macrophyllum*
Lilypad Clubtail	*Arigomphus furcifer*
Lined Topminnow	*Fundulus lineolatus*
Loggerhead	*Caretta caretta*

Maritime Shrew	*Sorex maritimensis?*
Mountain Spleenwort	*Asplenium montanum*
Mud Salamander	*Pseudotriton montanus*
Narrowleaf Peatmoss	*Sphagnum angustifolium*
NE beach tiger beetle	*Cicindela patruela consentanea*
New England Siltsnail	*Cincinnatia winkleyi*
Northern Appressed Clubmoss	*Lycopodiella subappressa*
Northern Clearwater Crayfish	*Orconectes propinquus*
Northern flying squirrel	*Glaucomys sabrinus*
Northern Lance	*Elliptio fisheriana*
Northern Monk's-hood	*Aconitum noveboracense*
Northern Red-bellied Cooter	*Pseudemys rubriventris pop 1*
Northern Redbelly Dace	*Phoxinus eos*
Organ Cavesnail	*Fontigens tartarea*
Pennsylvania ostrich fern	*Matteuccia struthiopteris var. pens*
Peregrine Falcon	*Falco peregrines*
Philadelphia Vireo	*Vireo philadelphicus*
Pine Barren Gentian	*Gentiana autumnalis*
Pink Papershell	*Potamilus ohiensis*
Piping Plover	*Charadrius melodus*
Plains Clubtail	*Gomphus externus*
Prairie Vole	*Microtus ochrogaster*
Price's Cave Isopod	*Caecidotea pricei*
Pseudanophthalmus Cave beetles	*Pseudanophthalmus spp.*
Pseudanophthalmus delicatus	*Pseudanophthalmus delicates*
Purple Sedge	*Carex purpurifera*
Rafinesque's Big-eared Bat	*Corynorhinus rafinesquii*
Red Peatmoss	*Sphagnum rubellum*
Red-breasted Nuthatch	*Sitta Canadensis*
Red-cockaded Woodpecker	*Picoides borealis*
Roughhead shiner	*Notropis semperasper*
Seabeach knotweed	*Polygonum glaucum*
Serpentine aster	*Symphyotrichum depauperatum*
Shalebarren Pussytoes	*Antennaria virginica*
Shenandoah Salamander	*Plethodon Shenandoah*
Silverling	*Paronychia argyrocoma var. albimontana*
Slenderhead Darter	*Percina phoxocephala*
Slimy Salamander	*Plethodon glutinosus*
Slimy Sculpin	*Cottus cognatus*
Small Yellow Lady's-slipper	*Cypripedium calceolus var. parviflo*
Small's ragwort	*Packera anonyma*
Smooth Cliff Brake	*Pellaea glabella ssp. Glabella*
Smooth Softshell	*Apalone mutica*
Southern Leopard Frog	*Rana sphenocephala*
Spiny Riversnail	*Io fluvialis*
Swamp Fly-honeysuckle	*Lonicera oblongifolia*
Tidewater interstitial amphipod	*Stygobromus araeus*
Timber Rattlesnake	*Crotalus horridus*
Virginia Big-eared Bat	*Corynorhinus townsendii virginianus*
Virginia Northern Flying Squirrel	*Glaucomys sabrinus fuscus*
Virginia Pigtoe	*Lexingtonia subplana*
White Mountain Fritillary	*Boloria chariclea montinus*

Wood Turtle *Glyptemys insculpta*

Appendix 6-1. Acres of each habitat conversion/securement by elevation zone, geology, and landform. The ratios of conversion to securement are given in combinations where CRI-S is the ratio of conversion to securement (GAP 1-3) and CRI-P is the ratio of conversion to protection (GAP 1-2).

Connecticut

	Acres Agriculture	Percent Agriculture	Acres Developed	Percent Developed	Acres Gap 1 & 2	Percent Gap 1 & 2	Acres Gap 3	Percent Gap 3	Acres Not Secured	Percent Not Secured	Total Acres	Percent Converted	Percent Secured	CRI-S	CRI-P
Elevation															
< 20'	2,003	2.55%	31,006	39.50%	4,392	5.60%	6,706	8.54%	34,391	43.81%	78,497	42.05%	14.14%	2.97	7.52
20-800'	227,683	8.74%	669,751	25.70%	77,854	2.99%	208,400	8.00%	1,421,901	54.57%	2,605,589	34.44%	10.99%	3.14	11.53
800-1700'	48,760	9.99%	33,582	6.88%	25,898	5.30%	66,841	13.69%	313,190	64.14%	488,271	16.86%	18.99%	0.89	3.18
1700-2500'	30	0.58%	88	1.71%	538	10.48%	627	12.20%	3,855	75.04%	5,137	2.29%	22.68%	0.10	0.22
Geology															
Fine sediments	20,265	13.18%	72,011	46.83%	2,413	1.57%	8,575	5.58%	50,522	32.85%	153,787	60.00%	7.15%	8.40	38.24
Coarse sediments	34,890	12.62%	96,851	35.02%	8,461	3.06%	17,366	6.28%	118,962	43.02%	276,531	47.64%	9.34%	5.10	15.57
Calcareous sed/metased	13,862	20.00%	12,091	17.44%	2,907	4.19%	2,012	2.90%	38,444	55.46%	69,316	37.44%	7.10%	5.28	8.93
Acidic sed/metased	87,405	8.14%	272,891	25.41%	30,946	2.88%	91,111	8.48%	591,550	55.08%	1,073,904	33.55%	11.37%	2.95	11.64
Mafic/intermediate granitic	30,002	7.20%	79,129	18.99%	17,507	4.20%	36,985	8.87%	253,166	60.74%	416,788	26.18%	13.07%	2.00	6.23
Acidic granitic	53,086	6.04%	165,366	18.82%	36,052	4.10%	100,944	11.49%	523,085	59.54%	878,533	24.87%	15.59%	1.59	6.06
Mod calcareous sed/metased	38,959	12.63%	36,067	11.69%	10,395	3.37%	25,554	8.28%	197,525	64.03%	308,500	24.32%	11.65%	2.09	7.22
Ultramafic	6	4.79%	19	14.36%	1	0.66%	26	19.14%	82	61.06%	135	19.14%	19.80%	0.97	28.99
Landform															
Dry flats	22,165	11.54%	75,423	39.26%	3,454	1.80%	10,649	5.54%	80,413	41.86%	192,105	50.80%	7.34%	6.92	28.25
Hill/valley: gentle slope	162,448	10.58%	414,309	27.00%	37,457	2.44%	115,522	7.53%	805,001	52.45%	1,534,737	37.58%	9.97%	3.77	15.40
Wet flats	62,009	8.95%	165,548	23.89%	25,558	3.69%	63,611	9.18%	376,109	54.29%	692,835	32.84%	12.87%	2.55	8.90
Cove/footslope	409	3.30%	1,735	14.00%	1,226	9.89%	1,954	15.76%	7,071	57.05%	12,394	17.30%	25.66%	0.67	1.75
Sideslope	30,440	4.70%	75,148	11.61%	35,961	5.55%	78,978	12.20%	426,939	65.94%	647,466	16.31%	17.75%	0.92	2.94
Summit/ridgetop	179	1.20%	385	2.59%	1,809	12.14%	2,734	18.35%	9,793	65.73%	14,899	3.79%	30.49%	0.12	0.31
Cliff/steep slope	17	0.31%	181	3.28%	781	14.12%	1,276	23.06%	3,277	59.23%	5,532	3.59%	37.18%	0.10	0.25
Open water	808	1.04%	1,697	2.19%	2,437	3.14%	7,850	10.13%	64,736	83.50%	77,526	3.23%	13.27%	0.24	1.03
Total	**278,475**	**8.76%**	**734,426**	**23.11%**	**108,683**	**3.42%**	**282,573**	**8.89%**	**1,773,337**	**55.81%**	**3,177,495**	**31.88%**	**12.31%**	**2.59**	**9.32**

Delaware

	Acres Agriculture	Percent Agriculture	Acres Developed	Percent Developed	Acres Gap 1 & 2	Percent Gap 1 & 2	Acres Gap 3	Percent Gap 3	Acres Not Secured	Percent Not Secured	Total Acres	Percent Converted	Percent Secured	CRI-S	CRI-P
Elevation															
< 20'	116,522	29.36%	28,397	7.16%	21,222	5.35%	42,850	10.80%	187,851	47.34%	396,842	36.52%	16.15%	2.26	6.83
20-800'	533,888	56.51%	98,143	10.39%	13,515	1.43%	47,287	5.01%	251,937	26.67%	944,770	66.90%	6.44%	10.39	46.77
Geology															
Ultramafic	21	28.47%	0	0.30%	0	0.00%	39	53.04%	13	18.19%	73	28.77%	53.04%	0.54	0.00
Mafic/intermediate granitic	1,431	23.27%	2,117	34.42%	431	7.00%	414	6.74%	1,758	28.58%	6,151	57.68%	13.74%	4.20	8.24
Fine sediments	82,784	54.08%	6,602	4.31%	866	0.57%	12,346	8.07%	50,488	32.98%	153,086	58.39%	8.63%	6.77	103.24
Acidic sed/metased	11,046	36.91%	6,672	22.30%	224	0.75%	4,301	14.37%	7,683	25.67%	29,926	59.21%	15.12%	3.92	78.97
Coarse sediments	550,051	52.67%	85,616	8.20%	33,013	3.16%	70,536	6.75%	305,161		1,044,377	60.87%	9.91%	6.14	19.25
Acidic granitic	4,568	11.91%	24,975	65.12%	202	0.53%	2,349	6.12%	6,259	16.32%	38,352	77.03%	6.65%	11.58	146.13
Calcareous sed/metased	487	41.24%	462	39.18%	0	0.00%	36	3.07%	195	16.51%	1,180	80.42%	3.07%	26.18	0.00
Landform															
Wet flats	40,262	15.03%	10,587	3.95%	22,725	8.48%	49,799	18.59%	144,537	53.95%	267,909	18.98%	27.07%	0.70	2.24
Cliff/steep slope	2	18.50%	0	1.83%	2	13.00%	4	31.50%	4	35.17%	12	20.33%	44.50%	0.46	1.56
Open water	9,141	18.06%	1,587	3.14%	2,295	4.53%	4,411	8.71%	33,182	65.56%	50,616	21.20%	13.25%	1.60	4.67
Cove/footslope	266	12.54%	292	13.78%	84	3.96%	470	22.22%	1,005	47.49%	2,117	26.33%	26.18%	1.01	6.65
Summit/ridgetop	49	29.56%	4	2.26%	2	1.46%	33	19.71%	79	47.01%	167	31.82%	21.17%	1.50	21.78
Sideslope	3,103	25.73%	1,470	12.20%	198	1.64%	2,737	22.70%	4,549	37.73%	12,057	37.93%	24.34%	1.56	23.08
Dry flats	549,262	65.17%	84,675	10.05%	8,638	1.02%	28,367	3.37%	171,872	20.39%	842,815	75.22%	4.39%	17.13	73.39
Hill/valley: gentle slope	48,302	49.56%	27,829	28.56%	792	0.81%	4,201	4.31%	16,329	16.76%	97,453	78.12%	5.12%	15.25	96.11
Total	**650,387**	**51.09%**	**126,445**	**9.93%**	**34,736**	**2.73%**	**90,021**	**7.07%**	**371,557**	**29.18%**	**1,273,146**	**61.02%**	**9.80%**	**6.23**	**22.36**

Maine

	Acres Agriculture	Percent Agriculture	Acres Developed	Percent Developed	Acres Gap 1 & 2	Percent Gap 1 & 2	Acres Gap 3	Percent Gap 3	Acres Not Secured	Percent Not Secured	Total Acres	Percent Converted	Percent Secured	CRI-S	CRI-P
Elevation															
< 20'	5,136	2.48%	20,997	10.12%	10,444	5.04%	10,276	4.96%	160,528	77.41%	207,382	12.60%	9.99%	1.26	2.50
20-800'	771,687	6.29%	653,951	5.33%	239,045	1.95%	846,213	6.89%	9,762,814	79.54%	12,273,711	11.62%	8.84%	1.31	5.96
800-1700'	45,114	0.64%	40,918	0.58%	322,208	4.57%	1,521,229	21.58%	5,120,096	72.63%	7,049,566	1.22%	26.15%	0.05	0.27
1700-2500'	153	0.01%	4,303	0.42%	84,218	8.14%	218,610	21.14%	726,860	70.29%	1,034,144	0.43%	29.28%	0.01	0.05
2500-3600'	0	0.00%	123	0.06%	39,825	18.87%	49,602	23.50%	121,502	57.57%	211,052	0.06%	42.37%	0.00	0.00
> 3600'	0	0.00%	13	0.15%	5,986	68.81%	842	9.68%	1,858	21.36%	8,700	0.15%	78.49%	0.00	0.00
Geology															
Calcareous sed/metased	164,257	22.99%	44,944	6.29%	5,377	0.75%	11,069	1.55%	488,891	68.42%	714,537	29.28%	2.30%	12.72	38.91
Fine sediments	152,721	8.09%	197,191	10.45%	45,925	2.43%	59,563	3.16%	1,431,495	75.87%	1,886,895	18.54%	5.59%	3.32	7.62
Coarse sediments	50,385	6.40%	46,214	5.87%	22,814	2.90%	63,838	8.11%	604,171	76.73%	787,422	12.27%	11.00%	1.11	4.23
Mod calcareous sed/metased	165,227	5.11%	150,829	4.66%	43,222	1.34%	289,809	8.96%	2,586,148	79.94%	3,235,235	9.77%	10.29%	0.95	7.31
Acidic granitic	66,612	1.78%	97,538	2.61%	313,216	8.37%	474,719	12.69%	2,789,327	74.55%	3,741,412	4.39%	21.06%	0.21	0.52
Acidic sed/metased	198,261	2.24%	152,780	1.73%	210,990	2.39%	1,469,070	16.63%	6,802,728	77.01%	8,833,830	3.97%	19.02%	0.21	1.66
Mafic/intermediate granitic	24,584	1.59%	30,263	1.96%	58,394	3.79%	276,220	17.91%	1,152,667	74.75%	1,542,128	3.56%	21.70%	0.16	0.94
Ultramafic	43	0.10%	546	1.27%	1,790	4.15%	2,485	5.77%	38,233	88.71%	43,097	1.37%	9.92%	0.14	0.33
Landform															
Hill/valley: gentle slope	565,609	5.99%	427,922	4.53%	227,362	2.41%	1,235,910	13.09%	6,981,502	73.97%	9,438,305	10.53%	15.50%	0.68	4.37
Dry flats	104,951	4.96%	94,824	4.48%	48,665	2.30%	298,897	14.13%	1,568,646	74.13%	2,115,983	9.44%	16.43%	0.57	4.11
Wet flats	105,160	2.40%	133,739	3.05%	149,965	3.42%	574,463	13.11%	3,419,960	78.02%	4,383,286	5.45%	16.53%	0.33	1.59
Sideslope	44,068	1.26%	58,668	1.67%	212,400	6.06%	474,154	13.52%	2,716,750	77.49%	3,506,039	2.93%	19.58%	0.15	0.48
Cove/footslope	194	0.22%	2,380	2.64%	14,372	15.96%	14,538	16.15%	58,546	65.03%	90,030	2.86%	32.11%	0.09	0.18
Cliff/steep slope	204	0.27%	225	0.30%	26,493	34.92%	12,109	15.96%	36,845	48.56%	75,875	0.56%	50.88%	0.01	0.02
Summit/ridgetop	282	0.24%	191	0.16%	15,487	12.99%	19,648	16.49%	83,577	70.12%	119,185	0.40%	29.48%	0.01	0.03
Open water	1,623	0.15%	2,357	0.22%	6,983	0.66%	17,055	1.62%	1,027,834	97.35%	1,055,851	0.38%	2.28%	0.17	0.57
Total	**822,090**	**3.96%**	**720,305**	**3.47%**	**701,727**	**3.38%**	**2,646,773**	**12.73%**	**15,893,660**	**76.47%**	**20,784,554**	**7.42%**	**16.11%**	**0.46**	**2.20**

New Hampshire

	Acres Agriculture	Percent Agriculture	Acres Developed	Percent Developed	Acres Gap 1 & 2	Percent Gap 1 & 2	Acres Gap 3	Percent Gap 3	Acres Not Secured	Percent Not Secured	Total Acres	Percent Converted	Percent Secured	CRI-S	CRI-P
Elevation															
< 20'	1,392	6.60%	5,163	24.48%	991	4.70%	2,256	10.70%	11,287	53.52%	21,089	31.08%	15.40%	2.02	6.61
20-800'	168,057	7.32%	333,999	14.55%	30,257	1.32%	216,662	9.44%	1,546,394	67.37%	2,295,370	21.87%	10.76%	2.03	16.59
800-1700'	92,115	3.70%	100,159	4.02%	113,947	4.57%	467,692	18.76%	1,718,559	68.95%	2,492,473	7.71%	23.34%	0.33	1.69
1700-2500'	3,721	0.46%	6,022	0.75%	176,633	22.04%	352,197	43.94%	262,952	32.81%	801,525	1.22%	65.98%	0.02	0.06
2500-3600'	15	0.01%	337	0.12%	205,093	73.83%	42,822	15.42%	29,516	10.63%	277,783	0.13%	89.25%	0.00	0.00
> 3600'	0	0.00%	136	0.32%	40,664	95.54%	1,180	2.77%	582	1.37%	42,561	0.32%	98.31%	0.00	0.00
Geology															
Fine sediments	21,725	18.04%	26,786	22.25%	2,608	2.17%	8,586	7.13%	60,694	50.41%	120,400	40.29%	9.30%	4.33	18.60
Coarse sediments	43,692	9.47%	88,947	19.28%	7,582	1.64%	53,222	11.54%	267,857	58.07%	461,299	28.75%	13.18%	2.18	17.49
Mod calcareous sed/metased	19,139	9.62%	30,917	15.54%	7,388	3.71%	19,262	9.68%	122,197	61.44%	198,903	25.17%	13.40%	1.88	6.78
Calcareous sed/metased	3,863	16.24%	1,220	5.13%	290	1.22%	1,128	4.74%	17,279	72.67%	23,779	21.37%	5.96%	3.59	17.53
Acidic sed/metased	86,058	4.11%	130,351	6.22%	179,053	8.55%	405,191	19.34%	1,294,159	61.78%	2,094,812	10.33%	27.89%	0.37	1.21
Mafic/intermediate granitic	14,486	4.06%	18,233	5.11%	28,435	7.97%	54,698	15.33%	240,855	67.52%	356,707	9.17%	23.31%	0.39	1.15
Acidic granitic	76,338	2.85%	149,362	5.58%	342,231	12.79%	540,723	20.21%	1,566,246	58.55%	2,674,901	8.44%	33.01%	0.26	0.66
Landform															
Dry flats	26,901	9.22%	53,281	18.26%	7,655	2.62%	33,685	11.54%	170,340	58.36%	291,862	27.47%	14.16%	1.94	10.47
Hill/valley: gentle slope	148,777	7.16%	236,939	11.40%	61,962	2.98%	302,885	14.57%	1,327,570	63.88%	2,078,133	18.56%	17.56%	1.06	6.23
Wet flats	50,317	5.87%	92,728	10.82%	35,161	4.10%	138,357	16.15%	540,242	63.05%	856,807	16.70%	20.25%	0.82	4.07
Sideslope	37,179	1.67%	57,635	2.60%	301,629	13.59%	543,842	24.49%	1,280,016	57.65%	2,220,301	4.27%	38.08%	0.11	0.31
Cove/footslope	323	0.34%	2,994	3.15%	40,636	42.71%	24,378	25.62%	26,823	28.19%	95,153	3.49%	68.33%	0.05	0.08
Open water	1,389	0.74%	1,779	0.94%	2,137	1.13%	9,821	5.21%	173,555	91.98%	188,681	1.68%	6.34%	0.26	1.48
Summit/ridgetop	286	0.30%	219	0.23%	44,604	47.21%	16,216	17.16%	33,150	35.09%	94,476	0.53%	64.38%	0.01	0.01
Cliff/steep slope	129	0.12%	241	0.23%	73,802	70.03%	13,624	12.93%	17,591	16.69%	105,387	0.35%	82.96%	0.00	0.01
Total	**265,301**	**4.47%**	**445,816**	**7.52%**	**567,586**	**9.57%**	**1,082,809**	**18.26%**	**3,569,288**	**60.18%**	**5,930,800**	**11.99%**	**27.83%**	**0.43**	**1.25**

New Jersey

	Acres Agriculture	Percent Agriculture	Acres Developed	Percent Developed	Acres Gap 1 & 2	Percent Gap 1 & 2	Acres Gap 3	Percent Gap 3	Acres Not Secured	Percent Not Secured	Total Acres	Percent Converted	Percent Secured	CRI-S	CRI-P
Elevation															
< 20'	78,809	10.58%	171,561	23.04%	197,042	26.46%	10,013	1.34%	287,338	38.58%	744,762	33.62%	27.80%	1.21	1.27
20-800'	828,940	22.28%	957,797	25.74%	516,848	13.89%	56,195	1.51%	1,361,463	36.59%	3,721,243	48.01%	15.40%	3.12	3.46
800-1700'	26,315	7.33%	35,132	9.79%	138,204	38.51%	9,790	2.73%	149,398	41.63%	358,839	17.12%	41.24%	0.42	0.44
1700-2500'	3	6.03%	4	7.31%	45	86.66%	0	0.00%	0	0.00%	52	13.34%	86.66%	0.15	0.15
Geology															
Ultramafic	0	0.00%	213	98.97%	0	0.00%	0	0.00%	2	1.03%	215	98.97%	0.00%		
Acidic sed/metased	168,181	20.88%	307,231	38.14%	94,242	11.70%	6,765	0.84%	229,085	28.44%	805,504	59.02%	12.54%	4.71	5.04
Calcareous sed/metased	68,088	38.55%	29,101	16.48%	20,497	11.61%	986	0.56%	57,941	32.81%	176,614	55.03%	12.16%	4.52	4.74
Mod calcareous sed/metased	30,350	24.30%	35,028	28.04%	10,261	8.22%	2,267	1.81%	46,999	37.63%	124,905	52.34%	10.03%	5.22	6.37
Acidic shale	15,700	34.66%	5,735	12.66%	4,583	10.12%	92	0.20%	19,192	42.36%	45,301	47.32%	10.32%	4.59	4.68
Fine sediments	27,682	11.63%	84,419	35.48%	41,850	17.59%	4,702	1.98%	79,301	33.33%	237,954	47.11%	19.56%	2.41	2.68
Coarse sediments	567,337	20.11%	576,375	20.43%	563,136	19.96%	34,705	1.23%	1,079,086	38.26%	2,820,639	40.55%	21.20%	1.91	2.03
Mafic/intermediate granitic	17,645	6.71%	77,511	29.48%	45,773	17.41%	10,734	4.08%	111,291	42.32%	262,954	36.19%	21.49%	1.68	2.08
Acidic granitic	39,083	11.14%	48,879	13.93%	71,797	20.47%	15,746	4.49%	175,302	49.97%	350,808	25.07%	24.95%	1.00	1.23
Landform															
Dry flats	148,359	25.30%	195,554	33.35%	69,194	11.80%	4,856	0.83%	168,404	28.72%	586,367	58.65%	12.63%	4.64	4.97
Hill/valley: gentle slope	490,049	27.10%	562,571	31.11%	197,545	10.92%	21,381	1.18%	536,764	29.68%	1,808,311	58.21%	12.11%	4.81	5.33
Wet flats	252,281	13.24%	353,767	18.56%	446,057	23.40%	31,328	1.64%	822,554	43.16%	1,905,987	31.80%	25.05%	1.27	1.36
Sideslope	41,080	10.50%	45,033	11.51%	97,706	24.97%	14,724	3.76%	192,719	49.26%	391,262	22.01%	28.74%	0.77	0.88
Cove/footslope	410	2.91%	1,500	10.66%	5,682	40.38%	498	3.54%	5,981	42.51%	14,071	13.58%	43.92%	0.31	0.34
Cliff/steep slope	157	2.27%	447	6.48%	4,092	59.40%	225	3.26%	1,969	28.59%	6,889	8.75%	62.66%	0.14	0.15
Summit/ridgetop	444	2.61%	866	5.08%	8,079	47.42%	606	3.56%	7,042	41.33%	17,037	7.69%	50.98%	0.15	0.16
Open water	1,286	1.35%	4,755	5.01%	23,785	25.04%	2,380	2.51%	62,764	66.09%	94,971	6.36%	27.55%	0.23	0.25
Total	**934,067**	**19.36%**	**1,164,493**	**24.14%**	**852,139**	**17.66%**	**75,997**	**1.58%**	**1,798,199**	**37.27%**	**4,824,895**	**43.49%**	**19.24%**	**2.26**	**2.46**

New York

	Acres Agriculture	Percent Agriculture	Acres Developed	Percent Developed	Acres Gap 1 & 2	Percent Gap 1 & 2	Acres Gap 3	Percent Gap 3	Acres Not Secured	Percent Not Secured	Total Acres	Percent Converted	Percent Secured	CRI-S	CRI-P
Elevation															
< 20'	11,180	3.12%	157,586	43.92%	18,010	5.02%	14,702	4.10%	157,334	43.85%	358,812	47.03%	9.12%	5.16	9.37
20-800'	3,191,088	28.13%	1,929,070	17.00%	131,400	1.16%	338,443	2.98%	5,755,934	50.73%	11,345,936	45.13%	4.14%	10.90	38.97
800-1700'	3,164,141	23.51%	620,730	4.61%	936,722	6.96%	1,145,112	8.51%	7,589,799	56.40%	13,456,505	28.13%	15.47%	1.82	4.04
1700-2500'	590,588	10.60%	75,373	1.35%	1,550,834	27.83%	817,038	14.66%	2,538,487	45.56%	5,572,320	11.95%	42.49%	0.28	0.43
2500-3600'	164	0.04%	370	0.08%	355,492	78.69%	37,292	8.25%	58,464	12.94%	451,781	0.12%	86.94%	0.00	0.00
> 3600'	6	0.02%	36	0.13%	25,805	91.13%	648	2.29%	1,822	6.44%	28,318	0.15%	93.41%	0.00	0.00
Geology															
Mod calcareous sed/metased	1,253,046	41.42%	244,064	8.07%	22,635	0.75%	165,396	5.47%	1,340,060	44.30%	3,025,200	49.49%	6.22%	7.96	66.14
Fine sediments	1,071,523	35.23%	384,159	12.63%	21,782	0.72%	83,258	2.74%	1,480,594	48.68%	3,041,316	47.86%	3.45%	13.86	66.83
Coarse sediments	584,906	19.10%	810,147	26.46%	145,556	4.75%	142,778	4.66%	1,378,937	45.03%	3,062,324	45.56%	9.42%	4.84	9.58
Calcareous sed/metased	1,011,030	33.90%	312,592	10.48%	36,862	1.24%	85,128	2.85%	1,536,740	51.53%	2,982,352	44.38%	4.09%	10.85	35.91
Acidic shale	1,691,567	29.88%	282,086	4.98%	23,382	0.41%	329,411	5.82%	3,334,261	58.90%	5,660,707	34.87%	6.23%	5.59	84.41
Acidic sed/metased	1,276,618	16.42%	562,335	7.23%	511,248	6.58%	593,519	7.64%	4,829,436	62.13%	7,773,156	23.66%	14.21%	1.66	3.60
Ultramafic	274	6.65%	586	14.21%	66	1.59%	415	10.06%	2,781	67.48%	4,121	20.86%	11.66%	1.79	13.11
Mafic/intermediate granitic	17,537	1.22%	50,156	3.50%	614,947	42.89%	259,545	18.10%	491,668	34.29%	1,433,854	4.72%	60.99%	0.08	0.11
Acidic granitic	50,668	1.20%	137,041	3.24%	1,641,787	38.81%	693,785	16.40%	1,707,362	40.36%	4,230,642	4.44%	55.21%	0.08	0.11
Landform															
Dry flats	904,567	37.08%	394,474	16.17%	95,144	3.90%	119,358	4.89%	926,147	37.96%	2,439,690	53.25%	8.79%	6.06	13.65
Hill/valley: gentle slope	4,119,080	32.68%	1,452,788	11.53%	707,408	5.61%	787,780	6.25%	5,536,872	43.93%	12,603,930	44.21%	11.86%	3.73	7.88
Wet flats	982,725	17.35%	606,247	10.70%	502,537	8.87%	441,882	7.80%	3,130,665	55.27%	5,664,057	28.05%	16.67%	1.68	3.16
Sideslope	866,098	10.94%	278,398	3.52%	1,292,351	16.33%	791,688	10.00%	4,686,583	59.21%	7,915,118	14.46%	26.33%	0.55	0.89
Cove/footslope	35,293	4.98%	34,988	4.94%	123,749	17.46%	70,039	9.88%	444,688	62.74%	708,755	9.92%	27.34%	0.36	0.57
Summit/ridgetop	42,255	7.61%	5,958	1.07%	136,615	24.60%	65,294	11.76%	305,330	54.97%	555,452	8.68%	36.35%	0.24	0.35
Cliff/steep slope	2,154	0.61%	2,511	0.72%	141,568	40.34%	41,169	11.73%	163,517	46.60%	350,918	1.33%	52.07%	0.03	0.03
Open water	4,996	0.51%	7,801	0.80%	18,892	1.94%	36,026	3.69%	908,037	93.06%	975,752	1.31%	5.63%	0.23	0.68
Total	**6,957,167**	**22.29%**	**2,783,165**	**8.92%**	**3,018,264**	**9.67%**	**2,353,235**	**7.54%**	**16,101,840**	**51.59%**	**31,213,672**	**31.21%**	**17.21%**	**1.81**	**3.23**

New Jersey

	Acres Agriculture	Percent Agriculture	Acres Developed	Percent Developed	Acres Gap 1 & 2	Percent Gap 1 & 2	Acres Gap 3	Percent Gap 3	Acres Not Secured	Percent Not Secured	Total Acres	Percent Converted	Percent Secured	CRI-S	CRI-P
Elevation															
< 20'	78,809	10.58%	171,561	23.04%	197,042	26.46%	10,013	1.34%	287,338	38.58%	744,762	33.62%	27.80%	1.21	1.27
20-800'	828,940	22.28%	957,797	25.74%	516,848	13.89%	56,195	1.51%	1,361,463	36.59%	3,721,243	48.01%	15.40%	3.12	3.46
800-1700'	26,315	7.33%	35,132	9.79%	138,204	38.51%	9,790	2.73%	149,398	41.63%	358,839	17.12%	41.24%	0.42	0.44
1700-2500'	3	6.03%	4	7.31%	45	86.66%	0	0.00%	0	0.00%	52	13.34%	86.66%	0.15	0.15
Geology															
Ultramafic	0	0.00%	213	98.97%	0	0.00%	0	0.00%	2	1.03%	215	98.97%	0.00%		
Acidic sed/metased	168,181	20.88%	307,231	38.14%	94,242	11.70%	6,765	0.84%	229,085	28.44%	805,504	59.02%	12.54%	4.71	5.04
Calcareous sed/metased	68,088	38.55%	29,101	16.48%	20,497	11.61%	986	0.56%	57,941	32.81%	176,614	55.03%	12.16%	4.52	4.74
Mod calcareous sed/metased	30,350	24.30%	35,028	28.04%	10,261	8.22%	2,267	1.81%	46,999	37.63%	124,905	52.34%	10.03%	5.22	6.37
Acidic shale	15,700	34.66%	5,735	12.66%	4,583	10.12%	92	0.20%	19,192	42.36%	45,301	47.32%	10.32%	4.59	4.68
Fine sediments	27,682	11.63%	84,419	35.48%	41,850	17.59%	4,702	1.98%	79,301	33.33%	237,954	47.11%	19.56%	2.41	2.68
Coarse sediments	567,337	20.11%	576,375	20.43%	563,136	19.96%	34,705	1.23%	1,079,086	38.26%	2,820,639	40.55%	21.20%	1.91	2.03
Mafic/intermediate granitic	17,645	6.71%	77,511	29.48%	45,773	17.41%	10,734	4.08%	111,291	42.32%	262,954	36.19%	21.49%	1.68	2.08
Acidic granitic	39,083	11.14%	48,879	13.93%	71,797	20.47%	15,746	4.49%	175,302	49.97%	350,808	25.07%	24.95%	1.00	1.23
Landform															
Dry flats	148,359	25.30%	195,554	33.35%	69,194	11.80%	4,856	0.83%	168,404	28.72%	586,367	58.65%	12.63%	4.64	4.97
Hill/valley: gentle slope	490,049	27.10%	562,571	31.11%	197,545	10.92%	21,381	1.18%	536,764	29.68%	1,808,311	58.21%	12.11%	4.81	5.33
Wet flats	252,281	13.24%	353,767	18.56%	446,057	23.40%	31,328	1.64%	822,554	43.16%	1,905,987	31.80%	25.05%	1.27	1.36
Sideslope	41,080	10.50%	45,033	11.51%	97,706	24.97%	14,724	3.76%	192,719	49.26%	391,262	22.01%	28.74%	0.77	0.88
Cove/footslope	410	2.91%	1,500	10.66%	5,682	40.38%	498	3.54%	5,981	42.51%	14,071	13.58%	43.92%	0.31	0.34
Cliff/steep slope	157	2.27%	447	6.48%	4,092	59.40%	225	3.26%	1,969	28.59%	6,889	8.75%	62.66%	0.14	0.15
Summit/ridgetop	444	2.61%	866	5.08%	8,079	47.42%	606	3.56%	7,042	41.33%	17,037	7.69%	50.98%	0.15	0.16
Open water	1,286	1.35%	4,755	5.01%	23,785	25.04%	2,380	2.51%	62,764	66.09%	94,971	6.36%	27.55%	0.23	0.25
Total	934,067	19.36%	1,164,493	24.14%	852,139	17.66%	75,997	1.58%	1,798,199	37.27%	4,824,895	43.49%	19.24%	2.26	2.46

New York

	Acres Agriculture	Percent Agriculture	Acres Developed	Percent Developed	Acres Gap 1 & 2	Percent Gap 1 & 2	Acres Gap 3	Percent Gap 3	Acres Not Secured	Percent Not Secured	Total Acres	Percent Converted	Percent Secured	CRI-S	CRI-P
Elevation															
< 20'	11,180	3.12%	157,586	43.92%	18,010	5.02%	14,702	4.10%	157,334	43.85%	358,812	47.03%	9.12%	5.16	9.37
20-800'	3,191,088	28.13%	1,929,070	17.00%	131,400	1.16%	338,443	2.98%	5,755,934	50.73%	11,345,936	45.13%	4.14%	10.90	38.97
800-1700'	3,164,141	23.51%	620,730	4.61%	936,722	6.96%	1,145,112	8.51%	7,589,799	56.40%	13,456,505	28.13%	15.47%	1.82	4.04
1700-2500'	590,588	10.60%	75,373	1.35%	1,550,834	27.83%	817,038	14.66%	2,538,487	45.56%	5,572,320	11.95%	42.49%	0.28	0.43
2500-3600'	164	0.04%	370	0.08%	355,492	78.69%	37,292	8.25%	58,464	12.94%	451,781	0.12%	86.94%	0.00	0.00
> 3600'	6	0.02%	36	0.13%	25,805	91.13%	648	2.29%	1,822	6.44%	28,318	0.15%	93.41%	0.00	0.00
Geology															
Mod calcareous sed/metased	1,253,046	41.42%	244,064	8.07%	22,635	0.75%	165,396	5.47%	1,340,060	44.30%	3,025,200	49.49%	6.22%	7.96	66.14
Fine sediments	1,071,523	35.23%	384,159	12.63%	21,782	0.72%	83,258	2.74%	1,480,594	48.68%	3,041,316	47.86%	3.45%	13.86	66.83
Coarse sediments	584,906	19.10%	810,147	26.46%	145,556	4.75%	142,778	4.66%	1,378,937	45.03%	3,062,324	45.56%	9.42%	4.84	9.58
Calcareous sed/metased	1,011,030	33.90%	312,592	10.48%	36,862	1.24%	85,128	2.85%	1,536,740	51.53%	2,982,352	44.38%	4.09%	10.85	35.91
Acidic shale	1,691,567	29.88%	282,086	4.98%	23,382	0.41%	329,411	5.82%	3,334,261	58.90%	5,660,707	34.87%	6.23%	5.59	84.41
Acidic sed/metased	1,276,618	16.42%	562,335	7.23%	511,248	6.58%	593,519	7.64%	4,829,436	62.13%	7,773,156	23.66%	14.21%	1.66	3.60
Ultramafic	274	6.65%	586	14.21%	66	1.59%	415	10.06%	2,781	67.48%	4,121	20.86%	11.66%	1.79	13.11
Mafic/intermediate granitic	17,537	1.22%	50,156	3.50%	614,947	42.89%	259,545	18.10%	491,668	34.29%	1,433,854	4.72%	60.99%	0.08	0.11
Acidic granitic	50,668	1.20%	137,041	3.24%	1,641,787	38.81%	693,785	16.40%	1,707,362	40.36%	4,230,642	4.44%	55.21%	0.08	0.11
Landform															
Dry flats	904,567	37.08%	394,474	16.17%	95,144	3.90%	119,358	4.89%	926,147	37.96%	2,439,690	53.25%	8.79%	6.06	13.65
Hill/valley: gentle slope	4,119,080	32.68%	1,452,788	11.53%	707,408	5.61%	787,780	6.25%	5,536,872	43.93%	12,603,930	44.21%	11.86%	3.73	7.88
Wet flats	982,725	17.35%	606,247	10.70%	502,537	8.87%	441,882	7.80%	3,130,665	55.27%	5,664,057	28.05%	16.67%	1.68	3.16
Sideslope	866,098	10.94%	278,398	3.52%	1,292,351	16.33%	791,688	10.00%	4,686,583	59.21%	7,915,118	14.46%	26.33%	0.55	0.89
Cove/footslope	35,293	4.98%	34,988	4.94%	123,749	17.46%	70,039	9.88%	444,688	62.74%	708,755	9.92%	27.34%	0.36	0.57
Summit/ridgetop	42,255	7.61%	5,958	1.07%	136,615	24.60%	65,294	11.76%	305,330	54.97%	555,452	8.68%	36.35%	0.24	0.35
Cliff/steep slope	2,154	0.61%	2,511	0.72%	141,568	40.34%	41,169	11.73%	163,517	46.60%	350,918	1.33%	52.07%	0.03	0.03
Open water	4,996	0.51%	7,801	0.80%	18,892	1.94%	36,026	3.69%	908,037	93.06%	975,752	1.31%	5.63%	0.23	0.68
Total	6,957,167	22.29%	2,783,165	8.92%	3,018,264	9.67%	2,353,235	7.54%	16,101,840	51.59%	31,213,672	31.21%	17.21%	1.81	3.23

Pennsylvania

	Acres Agriculture	Percent Agriculture	Acres Developed	Percent Developed	Acres Gap 1 & 2	Percent Gap 1 & 2	Acres Gap 3	Percent Gap 3	Acres Not Secured	Percent Not Secured	Total Acres	Percent Converted	Percent Secured	CRI-S	CRI-P
Elevation															
< 20'	3,143	7.07%	25,481	57.32%	1,532	3.45%	22	0.05%	14,280	32.12%	44,458	64.39%	3.50%	18.42	18.69
20-800'	3,086,388	46.84%	1,312,491	19.92%	63,592	0.97%	89,693	1.36%	2,036,571	30.91%	6,588,735	66.76%	2.33%	28.70	69.17
800-1700'	3,444,453	21.21%	1,569,161	9.66%	316,243	1.95%	1,679,142	10.34%	9,230,925	56.84%	16,239,924	30.87%	12.29%	2.51	15.85
1700-2500'	608,161	10.31%	210,983	3.58%	236,426	4.01%	1,937,037	32.82%	2,908,589	49.29%	5,901,197	13.88%	36.83%	0.38	3.46
2500-3600'	15,714	7.39%	6,539	3.08%	17,372	8.17%	35,868	16.87%	137,097	64.49%	212,591	10.47%	25.04%	0.42	1.28
> 3600'	0	0.00%	1	20.83%	0	0.00%	0	0.00%	4	79.17%	5	20.83%	0.00%		
Geology															
Calcareous sed/metased	1,032,770	58.06%	419,911	23.61%	3,147	0.18%	11,300	0.64%	311,609	17.52%	1,778,737	81.67%	0.81%	100.55	461.57
Coarse sediments	133,125	26.13%	151,164	29.67%	11,686	2.29%	14,713	2.89%	198,794	39.02%	509,482	55.80%	5.18%	10.77	24.33
Ultramafic	6,021	38.81%	2,567	16.55%	682	4.40%	567	3.66%	5,677	36.59%	15,514	55.35%	8.05%	6.87	12.59
Acidic granitic	165,312	35.84%	56,610	12.27%	10,957	2.38%	43,647	9.46%	184,662	40.04%	461,188	48.12%	11.84%	4.06	20.25
Acidic shale	2,161,285	30.58%	920,511	13.03%	75,301	1.07%	250,464	3.54%	3,659,050	51.78%	7,066,611	43.61%	4.61%	9.46	40.93
Mod calcareous sed/metased	898,952	27.81%	458,814	14.20%	38,007	1.18%	249,701	7.73%	1,586,481	49.09%	3,231,955	42.01%	8.90%	4.72	35.72
Fine sediments	48,290	27.97%	22,557	13.06%	13,614	7.89%	13,133	7.61%	75,057	43.47%	172,651	41.03%	15.49%	2.65	5.20
Mafic/intermediate granitic	79,317	31.01%	24,740	9.67%	6,413	2.51%	11,317	4.42%	133,975	52.38%	255,762	40.68%	6.93%	5.87	16.23
Acidic sed/metased	2,632,788	16.99%	1,067,783	6.89%	475,357	3.07%	3,146,920	20.31%	8,172,163	52.74%	15,495,011	23.88%	23.38%	1.02	7.78
Landform															
Dry flats	590,435	39.95%	290,222	19.63%	18,246	1.23%	88,762	6.01%	490,449	33.18%	1,478,114	59.58%	7.24%	8.23	48.27
Hill/valley: gentle slope	4,156,546	35.34%	1,643,453	13.97%	182,939	1.56%	1,139,532	9.69%	4,639,184	39.44%	11,761,653	49.31%	11.24%	4.39	31.70
Wet flats	724,440	28.56%	406,763	16.04%	57,308	2.26%	183,741	7.24%	1,164,349	45.90%	2,536,601	44.60%	9.50%	4.69	19.74
Sideslope	1,592,092	14.77%	689,132	6.39%	231,279	2.15%	1,645,056	15.26%	6,623,540	61.44%	10,781,099	21.16%	17.40%	1.22	9.86
Cove/footslope	68,279	6.80%	72,129	7.19%	40,363	4.02%	263,741	26.29%	558,877	55.70%	1,003,388	13.99%	30.31%	0.46	3.48
Summit/ridgetop	20,233	3.69%	5,658	1.03%	23,800	4.34%	176,873	32.27%	321,538	58.66%	548,104	4.72%	36.61%	0.13	1.09
Open water	2,936	0.99%	7,329	2.47%	32,849	11.06%	10,398	3.50%	243,600	81.99%	297,111	3.45%	14.56%	0.24	0.31
Cliff/steep slope	2,901	0.50%	9,971	1.72%	48,381	8.33%	233,659	40.23%	285,930	49.23%	580,842	2.22%	48.56%	0.05	0.27
Total	7,157,860	24.69%	3,124,656	10.78%	635,164	2.19%	3,741,762	12.91%	14,327,467	49.43%	28,986,910	35.47%	15.10%	2.35	16.19

Rhode Island

	Acres Agriculture	Percent Agriculture	Acres Developed	Percent Developed	Acres Gap 1 & 2	Percent Gap 1 & 2	Acres Gap 3	Percent Gap 3	Acres Not Secured	Percent Not Secured	Total Acres	Percent Converted	Percent Secured	CRI-S	CRI-P
Elevation															
< 20'	1,516	3.54%	15,020	35.04%	2,464	5.75%	2,172	5.07%	21,690	50.60%	42,861	38.58%	10.82%	3.57	6.71
20-800'	42,037	6.43%	184,348	28.19%	25,260	3.86%	77,294	11.82%	324,976	49.70%	653,915	34.62%	15.68%	2.21	8.96
800-1700'	9	3.27%	24	8.70%	0	0.00%	5	1.68%	241	86.36%	279	11.97%	1.68%	7.14	0.00
Geology															
Acidic sed/metased	7,390	6.81%	64,656	59.58%	2,628	2.42%	5,874	5.41%	27,973	25.78%	108,520	66.39%	7.83%	8.47	27.42
Mod calcareous sed/metased	1,807	11.61%	7,361	47.30%	391	2.51%	913	5.87%	5,091	32.71%	15,563	58.91%	8.38%	7.03	23.48
Ultramafic	27	27.53%	30	30.50%	0	0.00%	0	0.00%	41	41.98%	97	58.02%	0.00%		
Coarse sediments	9,117	6.42%	50,364	35.46%	6,319	4.45%	14,493	10.20%	61,753	43.47%	142,046	41.87%	14.65%	2.86	9.41
Mafic/intermediate granitic	1,535	5.56%	7,674	27.79%	1,022	3.70%	1,855	6.72%	15,530	56.24%	27,616	33.35%	10.42%	3.20	9.01
Fine sediments	1	0.07%	223	23.05%	62	6.42%	9	0.92%	671	69.53%	966	23.12%	7.34%	3.15	3.60
Acidic granitic	23,687	5.89%	69,084	17.17%	17,302	4.30%	56,327	14.00%	235,847	58.63%	402,247	23.06%	18.30%	1.26	5.36
Landform															
Dry flats	5,564	8.07%	27,040	39.22%	1,942	2.82%	5,690	8.25%	28,700	41.63%	68,936	47.30%	11.07%	4.27	16.79
Hill/valley: gentle slope	25,261	6.88%	118,426	32.26%	12,244	3.34%	38,809	10.57%	172,376	46.95%	367,115	39.14%	13.91%	2.81	11.74
Wet flats	10,760	5.63%	44,256	23.16%	11,354	5.94%	25,425	13.30%	99,328	51.97%	191,124	28.79%	19.24%	1.50	4.85
Sideslope	1,729	4.04%	8,818	20.60%	1,838	4.29%	7,303	17.06%	23,113	54.00%	42,800	24.64%	21.36%	1.15	5.74
Cove/footslope	10	3.96%	51	20.56%	15	5.94%	20	8.20%	151	61.34%	247	24.52%	14.14%	1.73	4.13
Summit/ridgetop	8	3.65%	42	18.67%	7	2.96%	16	7.11%	152	67.60%	225	22.32%	10.08%	2.22	7.53
Open water	230	0.86%	758	2.85%	325	1.22%	2,207	8.30%	23,086	86.77%	26,606	3.71%	9.52%	0.39	3.04
Cliff/steep slope	0	0.00%	0	0.00%	0	0.00%	1	44.50%	1	55.50%	2	0.00%	44.50%	0.00	0.00
Total	43,563	6.25%	199,391	28.60%	27,724	3.98%	79,471	11.40%	346,906	49.77%	697,055	34.85%	15.38%	2.27	8.76

Virginia

	Acres Agriculture	Percent Agriculture	Acres Developed	Percent Developed	Acres Gap 1 & 2	Percent Gap 1 & 2	Acres Gap 3	Percent Gap 3	Acres Not Secured	Percent Not Secured	Total Acres	Percent Converted	Percent Secured	CRI-S	CRI-P
Elevation															
< 20'	319,951	21.51%	180,605	12.14%	139,284	9.36%	99,300	6.68%	748,320	50.31%	1,487,460	33.65%	16.04%	2.10	3.59
20-800'	3,524,512	26.76%	966,984	7.34%	50,409	0.38%	350,461	2.66%	8,278,110	62.85%	13,170,476	34.10%	3.04%	11.20	89.10
800-1700'	1,212,699	26.14%	471,589	10.17%	87,742	1.89%	239,475	5.16%	2,627,658	56.64%	4,639,163	36.31%	7.05%	5.15	19.20
1700-2500'	789,636	20.22%	240,960	6.17%	337,141	8.63%	494,246	12.66%	2,042,911	52.32%	3,904,892	26.39%	21.29%	1.24	3.06
2500-3600'	360,677	15.67%	80,229	3.49%	315,148	13.69%	505,018	21.94%	1,040,237	45.20%	2,301,308	19.16%	35.64%	0.54	1.40
> 3600'	7,069	3.71%	3,645	1.91%	41,195	21.64%	77,900	40.92%	60,567	31.81%	190,375	5.63%	62.56%	0.09	0.26
Geology															
Fine sediments	248,069	17.32%	29,466	2.06%	121,377	8.48%	115,512	8.07%	917,662	64.08%	1,432,086	19.38%	16.54%	1.17	2.29
Acidic sed/metased	845,600	13.82%	394,380	6.45%	450,166	7.36%	752,597	12.30%	3,675,174	60.07%	6,117,917	20.27%	19.66%	1.03	2.75
Acidic shale	322,229	21.48%	113,010	7.53%	79,826	5.32%	304,085	20.27%	681,135	45.40%	1,500,285	29.01%	25.59%	1.13	5.45
Mod calcareous sed/metased	363,684	22.61%	121,631	7.56%	50,200	3.12%	166,892	10.38%	905,974	56.33%	1,608,382	30.17%	13.50%	2.24	9.67
Mafic/intermediate granitic	453,949	23.93%	124,777	6.58%	88,688	4.68%	31,926	1.68%	1,197,683	63.13%	1,897,023	30.51%	6.36%	4.80	6.53
Acidic granitic	1,549,333	24.24%	400,798	6.27%	106,222	1.66%	228,405	3.57%	4,106,387	64.25%	6,391,144	30.51%	5.24%	5.83	18.36
Coarse sediments	1,306,711	29.99%	458,296	10.52%	62,412	1.43%	129,783	2.98%	2,400,109	55.08%	4,357,311	40.51%	4.41%	9.18	28.28
Ultramafic	5,239	28.65%	3,477	19.02%	61	0.33%	63	0.34%	9,446	51.66%	18,285	47.67%	0.68%	70.62	144.07
Calcareous sed/metased	1,119,727	47.22%	298,176	12.57%	11,966	0.50%	37,138	1.57%	904,234	38.13%	2,371,242	59.80%	2.07%	28.88	118.49
Landform															
Cliff/steep slope	6,358	0.67%	18,956	1.99%	164,138	17.27%	189,702	19.96%	571,095	60.10%	950,249	2.66%	37.24%	0.07	0.15
Open water	15,165	3.24%	6,379	1.36%	11,499	2.45%	16,883	3.60%	418,684	89.35%	468,609	4.60%	6.06%	0.76	1.87
Summit/ridgetop	34,069	5.69%	12,096	2.02%	68,650	11.46%	99,358	16.59%	384,652	64.23%	598,825	7.71%	28.06%	0.27	0.67
Cove/footslope	64,731	7.04%	63,550	6.91%	101,457	11.03%	138,790	15.10%	550,884	59.92%	919,412	13.95%	26.13%	0.53	1.26
Sideslope	1,041,427	15.63%	310,634	4.66%	401,782	6.03%	829,100	12.45%	4,078,346	61.22%	6,661,289	20.30%	18.48%	1.10	3.37
Wet flats	438,897	19.39%	148,311	6.55%	143,154	6.32%	122,025	5.39%	1,411,677	62.35%	2,264,063	25.94%	11.71%	2.21	4.10
Hill/valley: gentle slope	3,331,664	32.30%	997,946	9.67%	56,453	0.55%	287,087	2.78%	5,642,193	54.70%	10,315,344	41.97%	3.33%	12.60	76.69
Dry flats	1,282,232	36.47%	386,140	10.98%	23,784	0.68%	83,456	2.37%	1,740,272	49.50%	3,515,883	47.45%	3.05%	15.56	70.15
Total	**6,214,543**	**24.19%**	**1,944,012**	**7.57%**	**970,918**	**3.78%**	**1,766,400**	**6.87%**	**14,797,803**	**57.59%**	**25,693,675**	**31.75%**	**10.65%**	**2.98**	**8.40**

Vermont

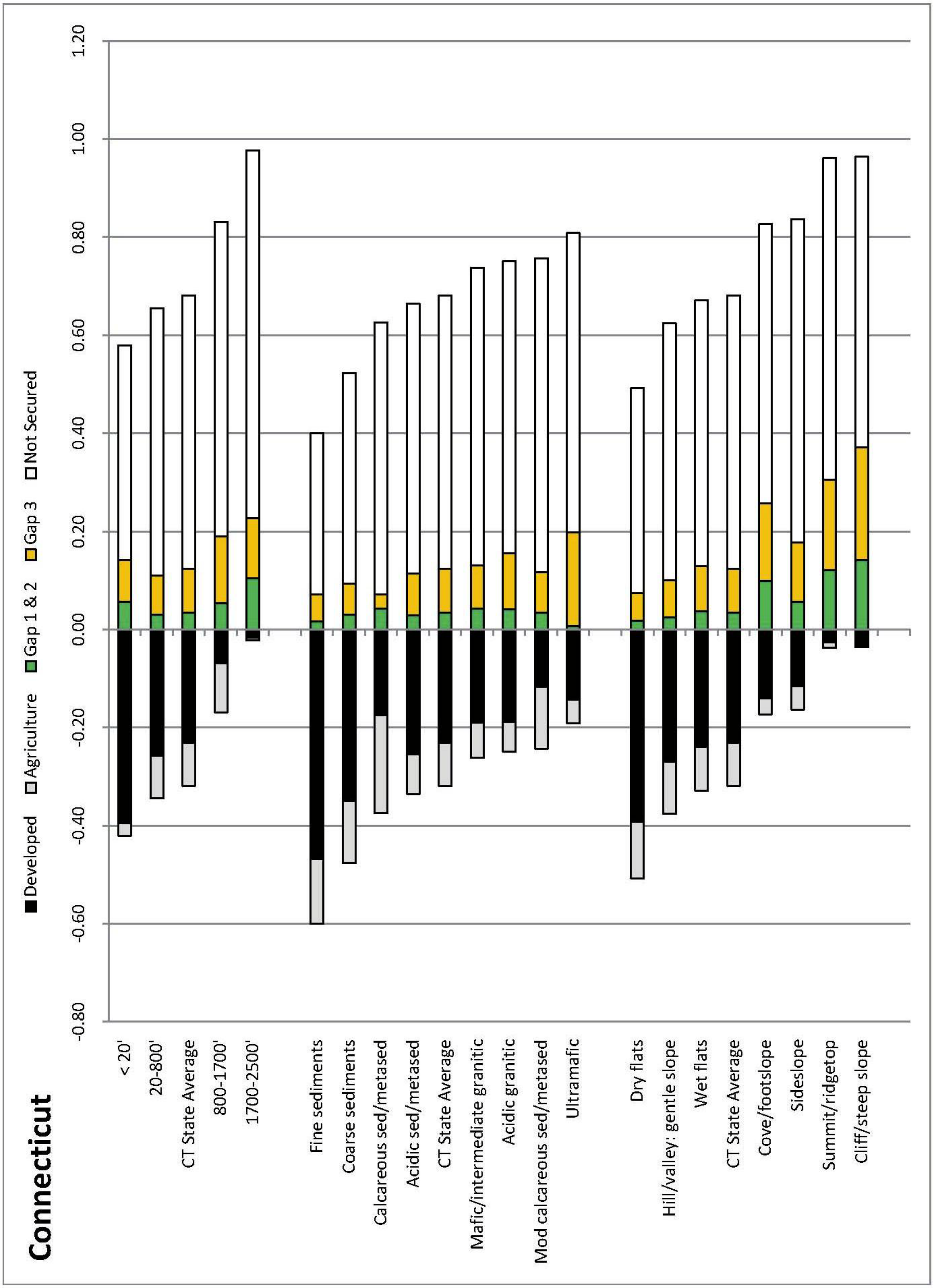
	Acres Agriculture	Percent Agriculture	Acres Developed	Percent Developed	Acres Gap 1 & 2	Percent Gap 1 & 2	Acres Gap 3	Percent Gap 3	Acres Not Secured	Percent Not Secured	Total Acres	Percent Converted	Percent Secured	CRI-S	CRI-P
Elevation															
< 20'	10	7.84%	2	1.19%	2	1.54%	2	1.70%	114	87.73%	130	9.03%	3.24%	2.79	5.88
20-800'	532,674	31.28%	177,739	10.44%	22,010	1.29%	39,351	2.31%	931,065	54.68%	1,702,839	41.72%	3.60%	11.58	32.28
800-1700'	321,704	10.30%	132,768	4.25%	56,789	1.82%	266,985	8.55%	2,346,104	75.09%	3,124,350	14.55%	10.36%	1.40	8.00
1700-2500'	16,589	1.47%	14,704	1.30%	107,536	9.53%	360,932	31.97%	629,137	55.73%	1,128,898	2.77%	41.50%	0.07	0.29
2500-3600'	106	0.06%	200	0.11%	74,486	39.38%	77,820	41.15%	36,514	19.31%	189,127	0.16%	80.53%	0.00	0.00
> 3600'	5	0.16%	38	1.16%	1,604	49.12%	872	26.71%	746	22.85%	3,266	1.32%	75.83%	0.02	0.03
Geology															
Fine sediments	269,313	43.06%	44,446	7.11%	7,880	1.26%	9,516	1.52%	294,306	47.05%	625,461	50.16%	2.78%	18.04	39.82
Coarse sediments	82,170	30.54%	48,781	18.13%	4,722	1.75%	9,138	3.40%	124,288	46.19%	269,099	48.66%	5.15%	9.45	27.73
Calcareous sed/metased	193,746	16.69%	79,805	6.88%	7,822	0.67%	36,260	3.12%	843,022	72.63%	1,160,657	23.57%	3.80%	6.21	34.97
Mafic/intermediate granitic	24,165	12.48%	9,681	5.00%	3,012	1.56%	15,739	8.13%	141,055	72.84%	193,653	17.48%	9.68%	1.80	11.24
Mod calcareous sed/metased	84,728	10.39%	39,903	4.89%	22,860	2.80%	121,325	14.87%	546,942	67.05%	815,757	15.28%	17.67%	0.86	5.45
Ultramafic	721	10.70%	163	2.41%	379	5.62%	22	0.33%	5,452	80.93%	6,737	13.11%	5.96%	2.20	2.33
Acidic sed/metased	179,177	8.44%	75,995	3.58%	95,497	4.50%	255,169	12.02%	1,517,490	71.47%	2,123,328	12.02%	16.51%	0.73	2.67
Acidic granitic	37,069	3.89%	26,676	2.80%	120,256	12.61%	298,793	31.32%	471,126	49.39%	953,920	6.68%	43.93%	0.15	0.53
Landform															
Dry flats	93,208	42.75%	26,955	12.36%	4,626	2.12%	13,603	6.24%	79,628	36.52%	218,020	55.12%	8.36%	6.59	25.97
Hill/valley: gentle slope	441,521	25.25%	138,950	7.95%	45,397	2.60%	162,047	9.27%	960,826	54.94%	1,748,740	33.19%	11.86%	2.80	12.79
Wet flats	154,257	24.66%	50,829	8.13%	27,885	4.46%	63,195	10.10%	329,354	52.65%	625,520	32.79%	14.56%	2.25	7.35
Cove/footslope	13,076	6.14%	18,288	8.58%	11,535	5.41%	30,516	14.32%	139,665	65.55%	213,080	14.72%	19.74%	0.75	2.72
Sideslope	163,304	5.75%	88,032	3.10%	138,317	4.87%	418,292	14.72%	2,034,494	71.58%	2,842,439	8.84%	19.58%	0.45	1.82
Cliff/steep slope	1,175	1.12%	1,201	1.15%	17,480	16.70%	21,826	20.85%	63,007	60.19%	104,689	2.27%	37.55%	0.06	0.14
Summit/ridgetop	2,319	1.42%	450	0.28%	15,681	9.64%	29,402	18.07%	114,891	70.60%	162,743	1.70%	27.70%	0.06	0.18
Open water	2,229	0.96%	747	0.32%	1,507	0.65%	7,080	3.03%	221,816	95.05%	233,379	1.27%	3.68%	0.35	1.97
Total	**871,089**	**14.17%**	**325,450**	**5.29%**	**262,428**	**4.27%**	**745,962**	**12.13%**	**3,943,681**	**64.14%**	**6,148,610**	**19.46%**	**16.40%**	**1.19**	**4.56**

Washington D.C.

	Acres Agriculture	Percent Agriculture	Acres Developed	Percent Developed	Acres Gap 1 & 2	Percent Gap 1 & 2	Acres Gap 3	Percent Gap 3	Acres Not Secured	Percent Not Secured	Total Acres	Percent Converted	Percent Secured	CRI-S	CRI-P
Elevation															
< 20'	175	2.66%	4,328	65.80%	1	0.01%	455	6.91%	1,619	24.62%	6,578	68.46%	6.92%	9.89	6,823.27
20-800'	775	2.25%	28,597	83.12%	0	0.00%	3,050	8.86%	1,981	5.76%	34,404	85.38%	8.87%	9.63	133,512.18
Geology															
Acidic sed/metased	109	4.14%	1,397	52.94%	0	0.00%	818	31.01%	314	11.91%	2,639	57.08%	31.01%	1.84	0.00
Acidic granitic	299	6.88%	2,361	54.28%	0	0.01%	884	20.33%	805	18.51%	4,350	61.16%	20.33%	3.01	12,092.86
Mafic/intermediate granitic	76	3.45%	1,660	75.62%	0	0.00%	260	11.83%	200	9.10%	2,195	79.07%	11.83%	6.68	0.00
Coarse sediments	132	1.94%	5,300	77.72%	1	0.01%	539	7.91%	847	12.42%	6,819	79.66%	7.92%	10.06	8,230.71
Fine sediments	334	1.34%	22,207	88.91%	0	0.00%	1,003	4.01%	1,434	5.74%	24,978	90.24%	4.01%	22.48	0.00
Landform															
Dry flats	12	0.70%	185	10.46%	0	0.02%	106	6.00%	1,467	82.82%	1,772	11.16%	6.03%	1.85	449.30
Hill/valley: gentle slope		0.00%	0	28.57%	0	0.00%	0	14.29%	1	57.14%	2	28.57%	14.29%	2.00	0.00
Cove/footslope	2	8.61%	6	26.93%	0	0.00%	13	57.75%	2	6.71%	23	35.54%	57.75%	0.62	0.00
Wet flats	214	4.31%	2,449	49.26%	0	0.00%	1,559	31.36%	749	15.07%	4,972	53.57%	31.36%	1.71	0.00
Sideslope	94	5.11%	907	49.45%	0	0.02%	439	23.92%	394	21.49%	1,835	54.57%	23.94%	2.28	2,275.41
Summit/ridgetop	42	3.53%	737	61.23%	0	0.00%	308	25.56%	117	9.68%	1,203	64.76%	25.56%	2.53	0.00
Cliff/steep slope	418	2.51%	14,616	87.74%	0	0.00%	886	5.32%	739	4.43%	16,658	90.25%	5.32%	16.98	0.00
Open water	167	1.15%	14,025	96.61%		0.00%	193	1.33%	132	0.91%	14,517	97.76%	1.33%	73.43	0.00
Total	**950**	**2.32%**	**32,926**	**80.34%**	**1**	**0.00%**	**3,504**	**8.55%**	**3,601**	**8.79%**	**40,982**	**82.66%**	**8.55%**	**9.66**	**38,495.50**

West Virginia

	Acres Agriculture	Percent Agriculture	Acres Developed	Percent Developed	Acres Gap 1 & 2	Percent Gap 1 & 2	Acres Gap 3	Percent Gap 3	Acres Not Secured	Percent Not Secured	Total Acres	Percent Converted	Percent Secured	CRI-S	CRI-P
Elevation															
20-800'	386,036	21.49%	319,050	17.76%	284	0.02%	32,241	1.79%	1,058,754	58.94%	1,796,365	39.25%	1.81%	21.68	2,479.12
800-1700'	560,944	7.70%	432,627	5.94%	2,036	0.03%	267,641	3.67%	6,025,895	82.67%	7,289,143	13.63%	3.70%	3.68	488.00
1700-2500'	360,798	9.95%	210,795	5.81%	8,645	0.24%	318,936	8.79%	2,728,710	75.21%	3,627,885	15.76%	9.03%	1.74	66.12
2500-3600'	132,995	5.64%	88,838	3.77%	63,355	2.69%	557,085	23.64%	1,513,989	64.25%	2,356,262	9.41%	26.33%	0.36	3.50
> 3600'	900	0.21%	7,802	1.79%	55,981	12.82%	228,311	52.30%	143,573	32.89%	436,567	1.99%	65.12%	0.03	0.16
Geology															
Coarse sediments	104,788	31.64%	106,213	32.07%	922	0.28%	8,150	2.46%	111,093	33.55%	331,166	63.71%	2.74%	23.26	228.79
Calcareous sed/metased	145,597	40.33%	37,262	10.32%	914	0.25%	14,609	4.05%	162,593	45.04%	360,974	50.66%	4.30%	11.78	200.11
Acidic shale	402,982	10.80%	281,554	7.54%	20,810	0.56%	429,613	11.51%	2,597,173	69.59%	3,732,132	18.34%	12.07%	1.52	32.89
Mod calcareous sed/metased	293,776	12.12%	142,480	5.88%	9,375	0.39%	158,790	6.55%	1,818,968	75.06%	2,423,389	18.00%	6.94%	2.59	46.53
Acidic sed/metased	494,526	5.71%	491,535	5.68%	98,279	1.14%	793,020	9.16%	6,780,223	78.32%	8,657,583	11.39%	10.30%	1.11	10.03
Mafic/intermediate granitic	4	2.12%	15	7.38%	0	0.00%	3	1.34%	177	89.16%	199	9.50%	1.34%	7.10	0.00
Fine sediments	0	0.06%	54	7.00%	0	0.00%	30	3.86%	693	89.09%	778	7.05%	3.86%	1.83	0.00
Landform															
Dry flats	78,371	41.69%	48,167	25.62%	605	0.32%	5,098	2.71%	55,733	29.65%	187,973	67.32%	3.03%	22.19	209.11
Wet flats	166,720	26.15%	135,491	21.25%	4,015	0.63%	38,652	6.06%	292,708	45.91%	637,586	47.40%	6.69%	7.08	75.27
Hill/valley: gentle slope	544,379	28.35%	273,597	14.25%	19,235	1.00%	106,847	5.56%	976,006	50.83%	1,920,065	42.60%	6.57%	6.49	42.52
Cove/footslope	47,322	4.27%	91,231	8.23%	11,318	1.02%	132,283	11.93%	826,994	74.56%	1,109,147	12.49%	12.95%	0.96	12.24
Sideslope	572,207	6.47%	450,355	5.10%	73,193	0.83%	796,748	9.02%	6,945,480	78.59%	8,837,984	11.57%	9.84%	1.18	13.97
Summit/ridgetop	25,600	2.85%	14,757	1.64%	6,839	0.76%	104,669	11.63%	747,944	83.12%	899,808	4.49%	12.39%	0.36	5.90
Open water	1,333	1.48%	2,636	2.92%	49	0.05%	14,383	15.94%	71,816	79.60%	90,218	4.40%	16.00%	0.27	80.41
Cliff/steep slope	5,742	0.31%	42,878	2.35%	15,045	0.83%	205,534	11.27%	1,554,242	85.24%	1,823,440	2.67%	12.10%	0.22	3.23
Total	**1,441,673**	**9.30%**	**1,059,112**	**6.83%**	**130,301**	**0.84%**	**1,404,214**	**9.06%**	**11,470,921**	**73.98%**	**15,506,221**	**16.13%**	**9.90%**	**1.63**	**19.19**


Connecticut
■ Developed □ Agriculture ■ Gap 1 & 2 ■ Gap 3 □ Not Secured
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-0.20
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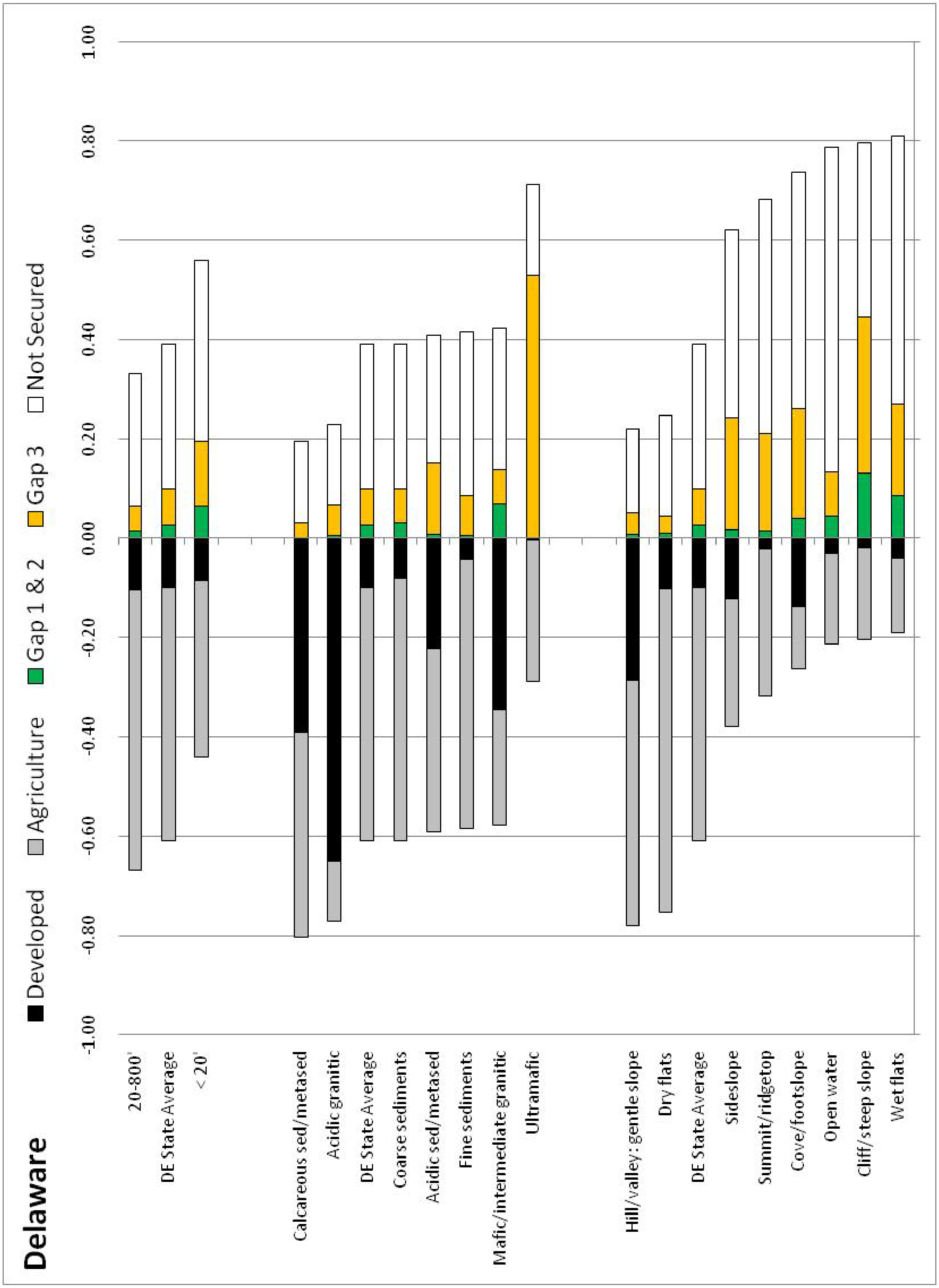
0.20
0.40
0.60
0.80
1.00
1.20
< 20'
20-800'
CT State Average
800-1700'
1700-2500'
Fine sediments
Coarse sediments
Calcareous sed/metased
Acidic sed/metased
CT State Average
Mafic/intermediate granitic
Acidic granitic
Mod calcareous sed/metased
Ultramafic
Dry flats
Hill/valley: gentle slope
Wet flats
CT State Average
Cove/footslope
Sideslope
Summit/ridgetop
Cliff/steep slope


Delaware
Developed
Agriculture
Gap 1 & 2
Gap 3
Not Secured
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0.00
0.20
0.40
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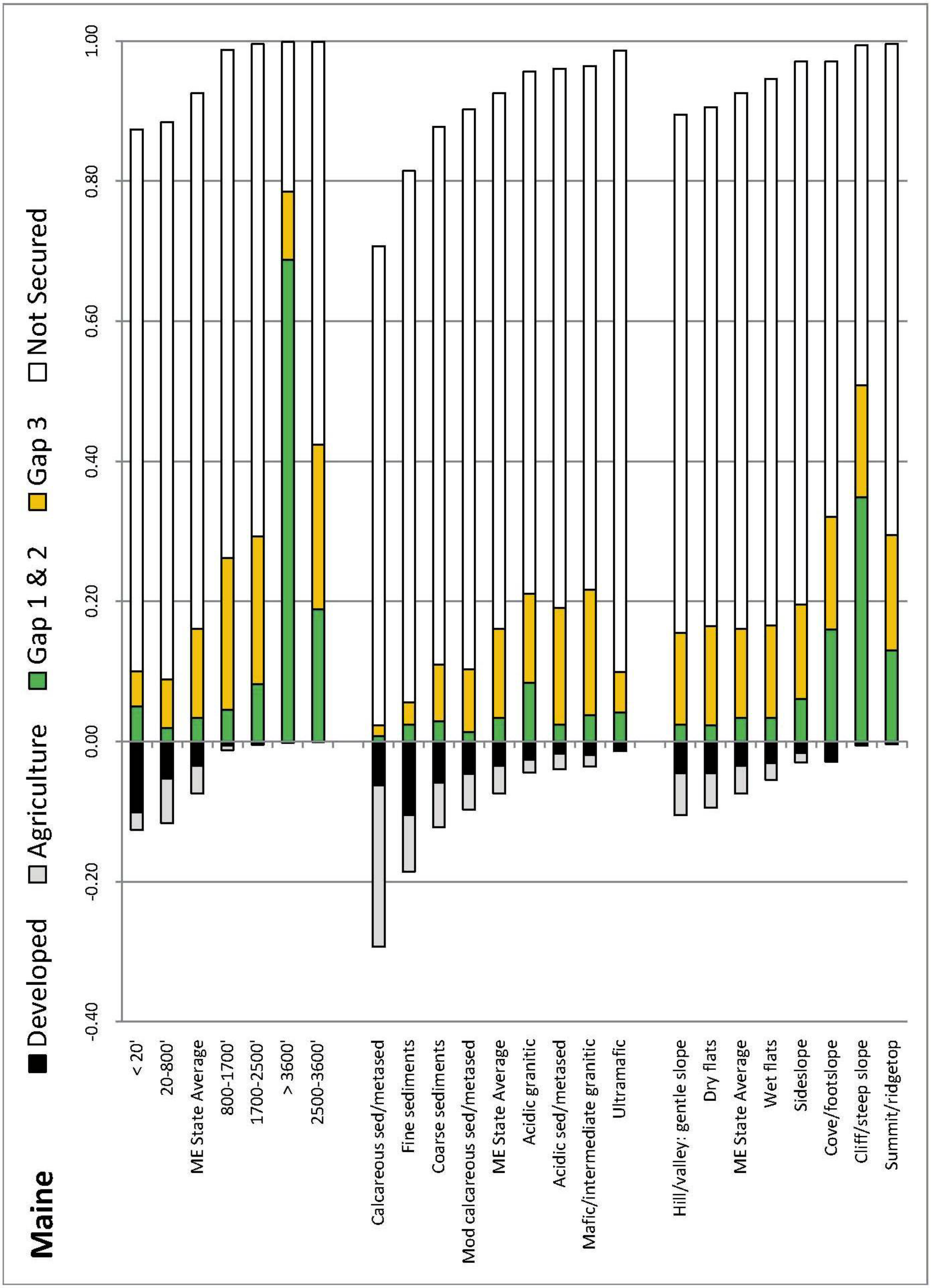
0.80
1.00
20-800'
DE State Average
< 20'
Calcareous sed/metased
Acidic granitic
DE State Average
Coarse sediments
Acidic sed/metased
Fine sediments
Mafic/intermediate granitic
Ultramafic
Hill/valley: gentle slope
Dry flats
DE State Average
Sideslope
Summit/ridgetop
Cove/footslope
Open water
Cliff/steep slope
Wet flats


Maine
Developed
Agriculture
Gap 1 & 2
Gap 3
Not Secured
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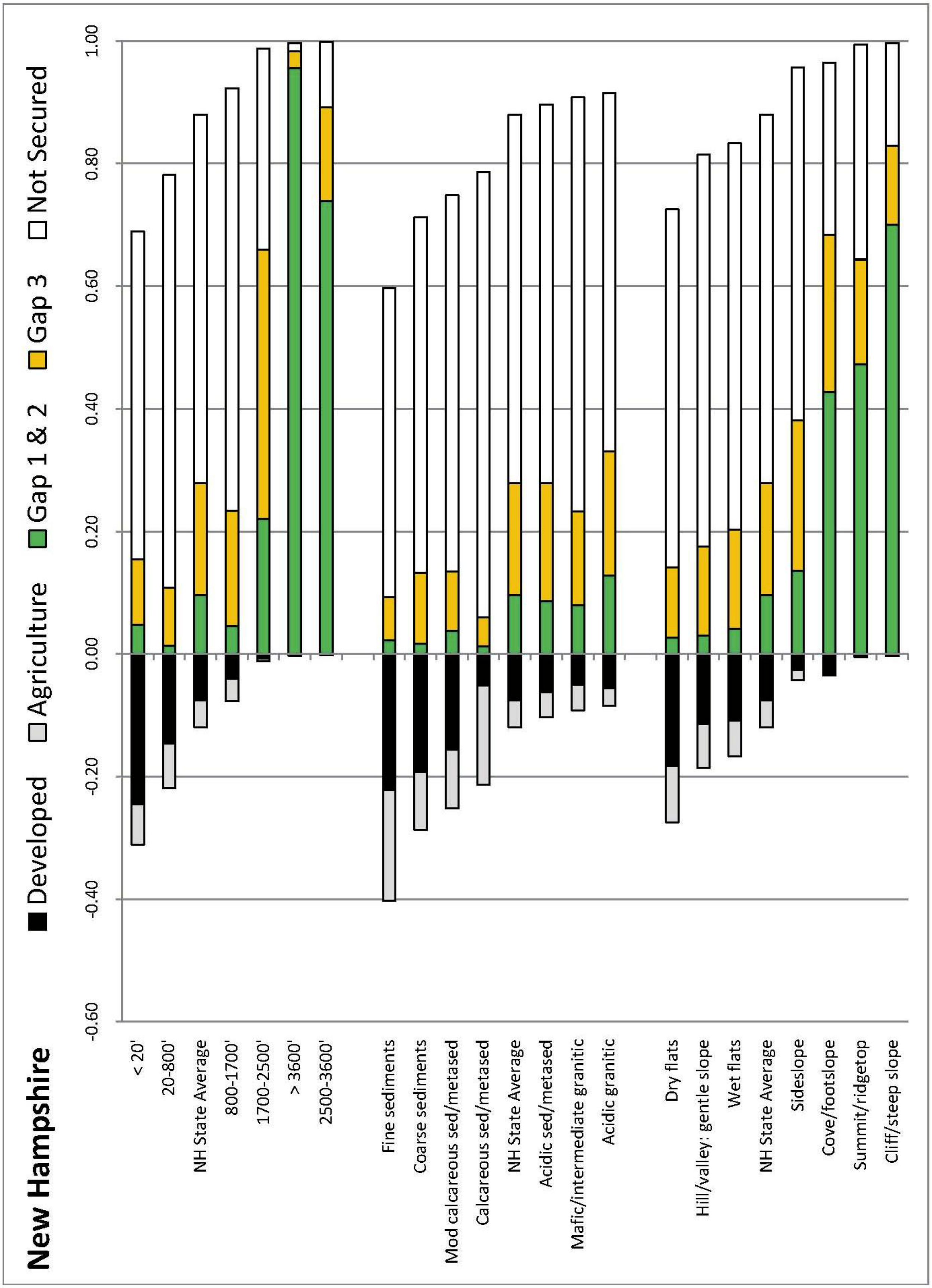
-0.20
0.00
0.20
0.40
0.60
0.80
1.00
< 20'
20-800'
ME State Average
800-1700'
1700-2500'
> 3600'
2500-3600'
Calcareous sed/metased
Fine sediments
Coarse sediments
Mod calcareous sed/metased
ME State Average
Acidic granitic
Acidic sed/metased
Mafic/intermediate granitic
Ultramafic
Hill/valley: gentle slope
Dry flats
ME State Average
Wet flats
Sideslope
Cove/footslope
Cliff/steep slope
Summit/ridgetop


New Hampshire
Developed
Agriculture
Gap 1 & 2
Gap 3
Not Secured
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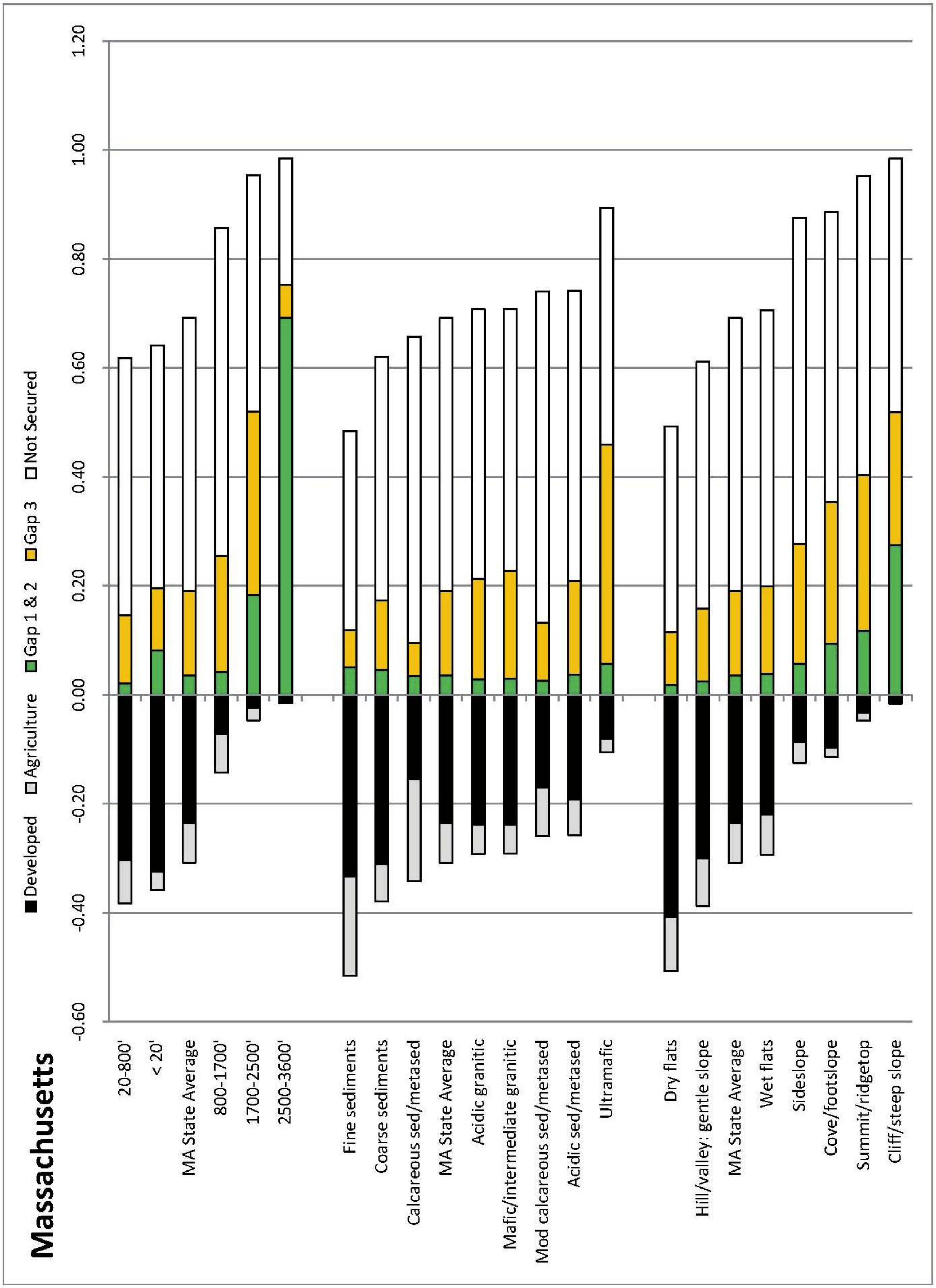

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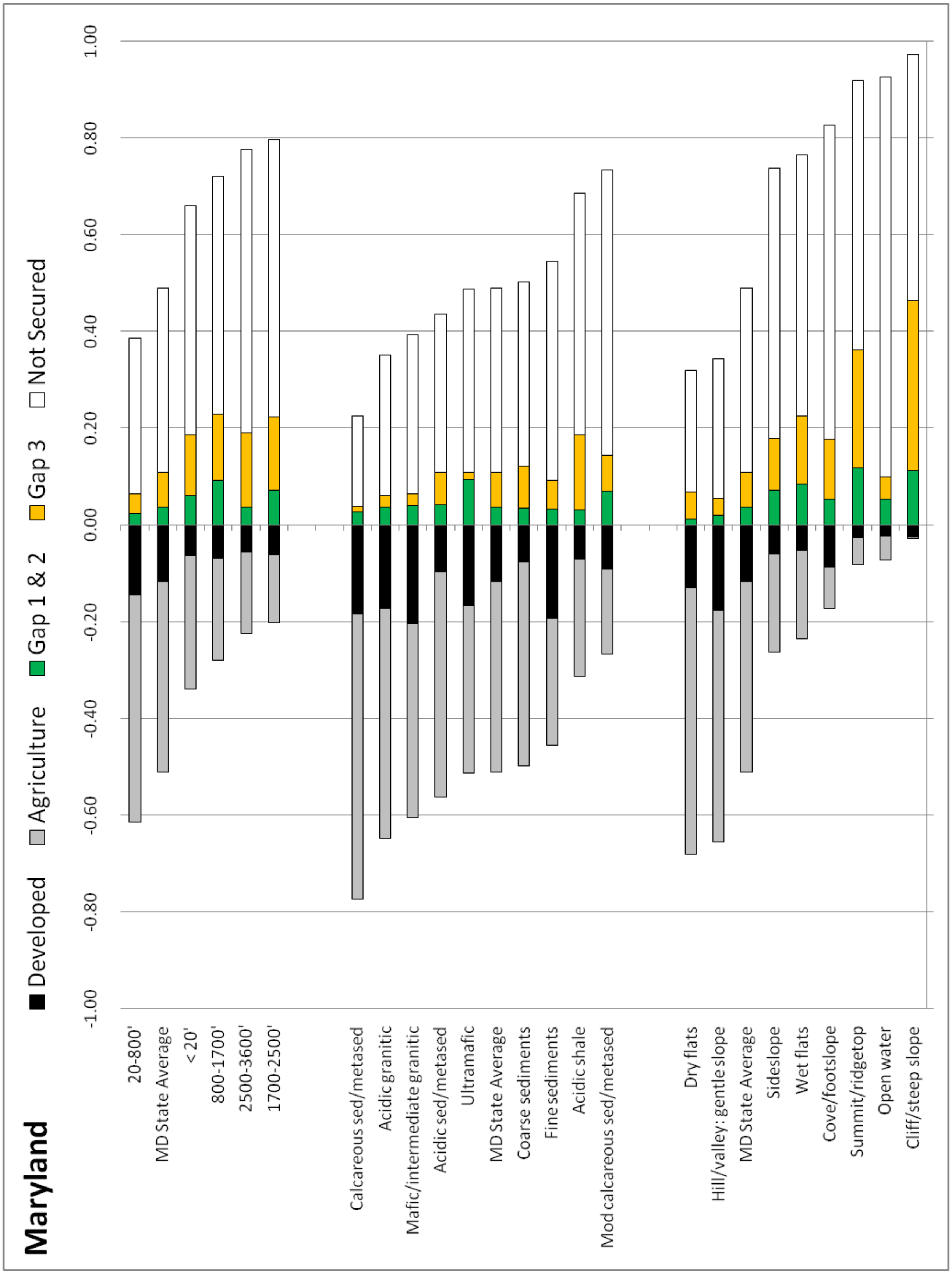
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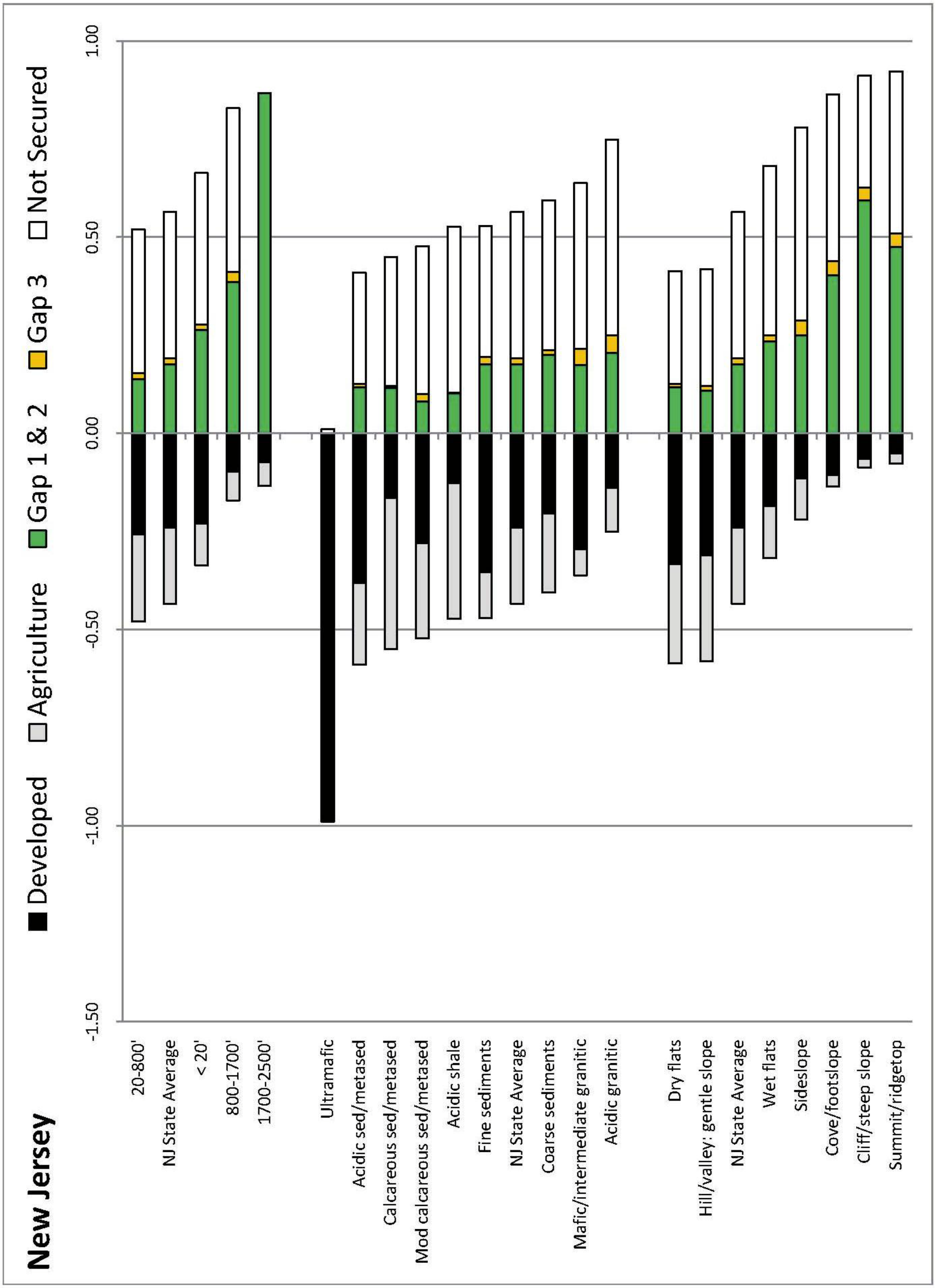
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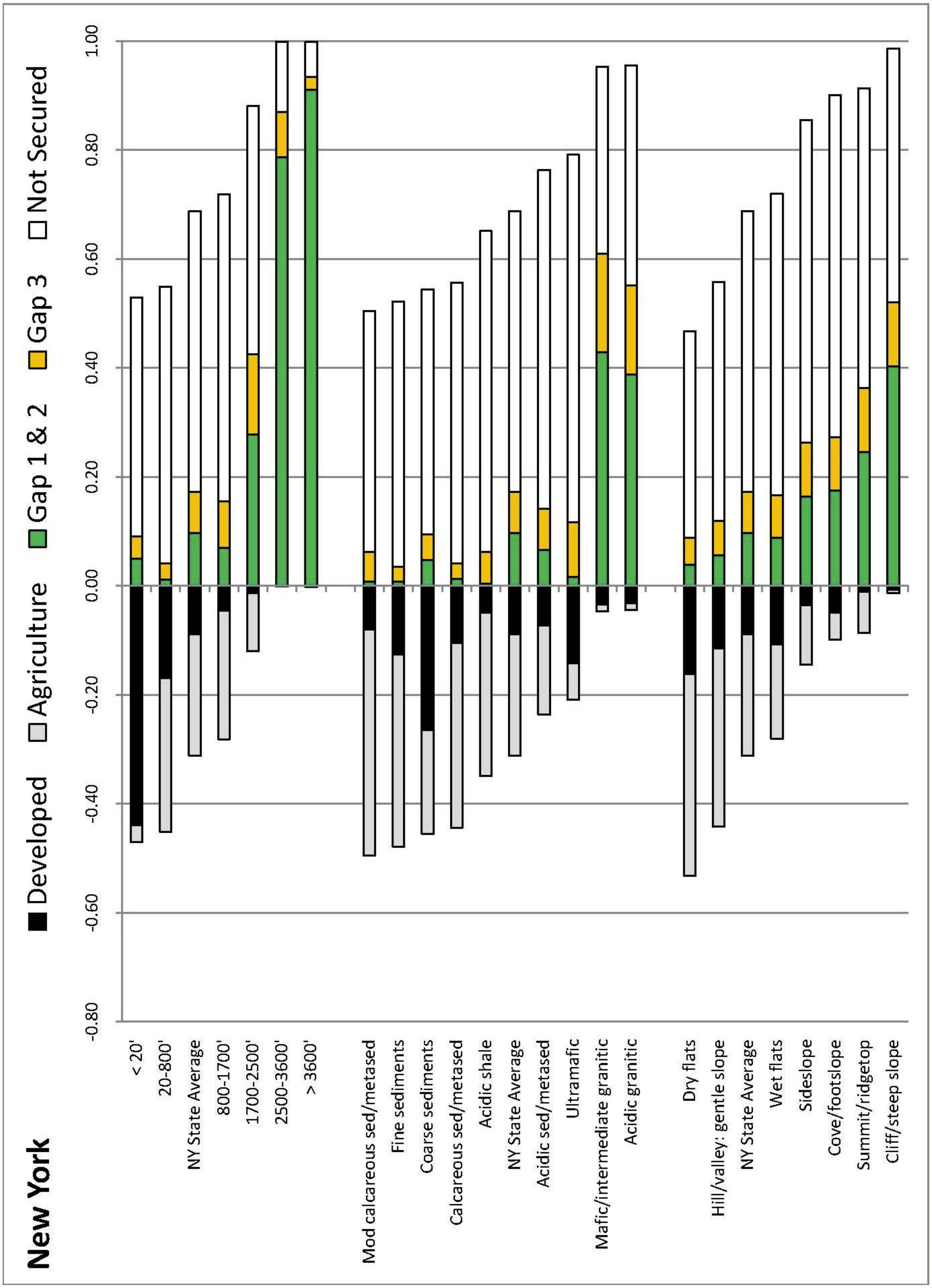
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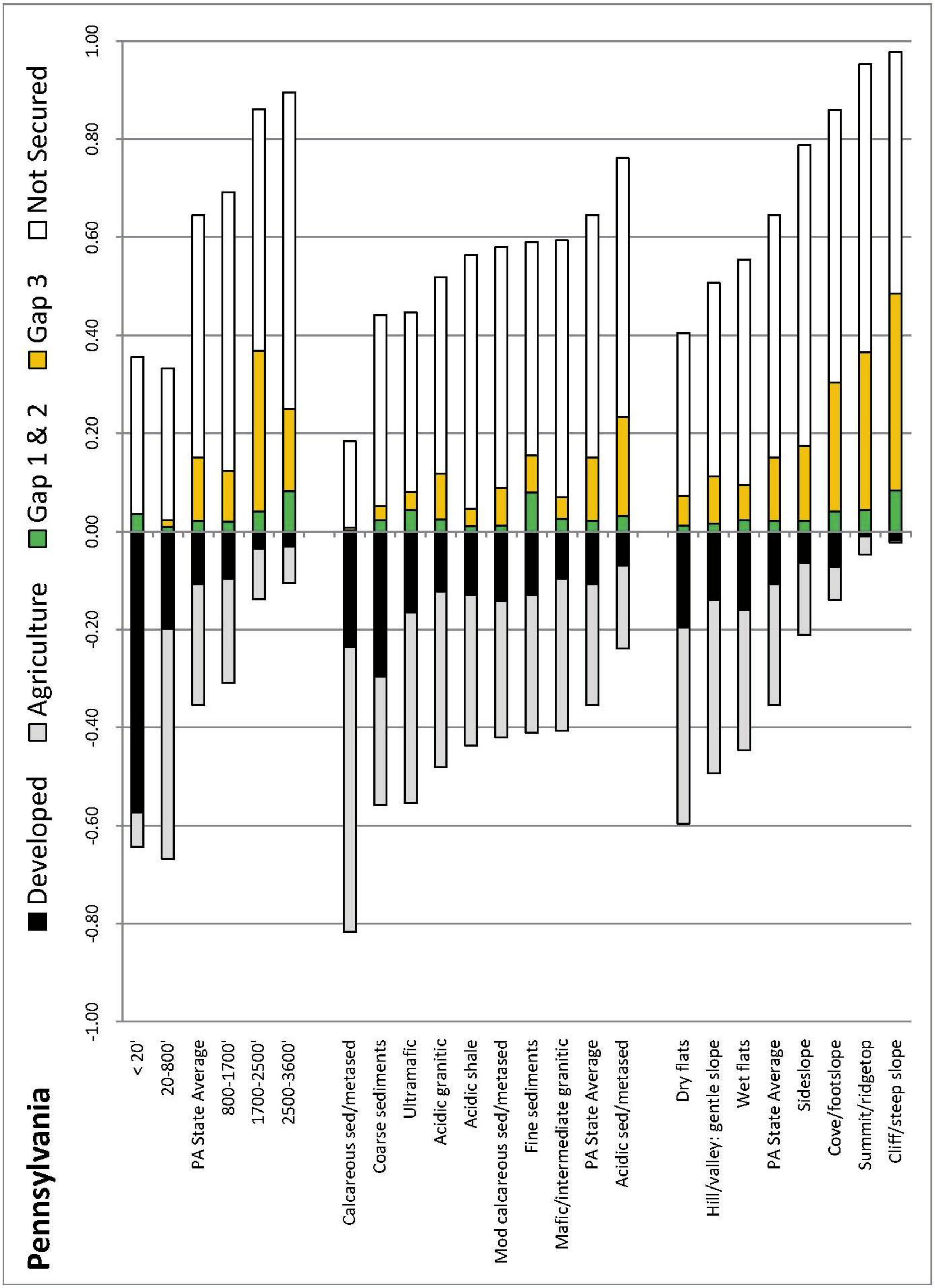
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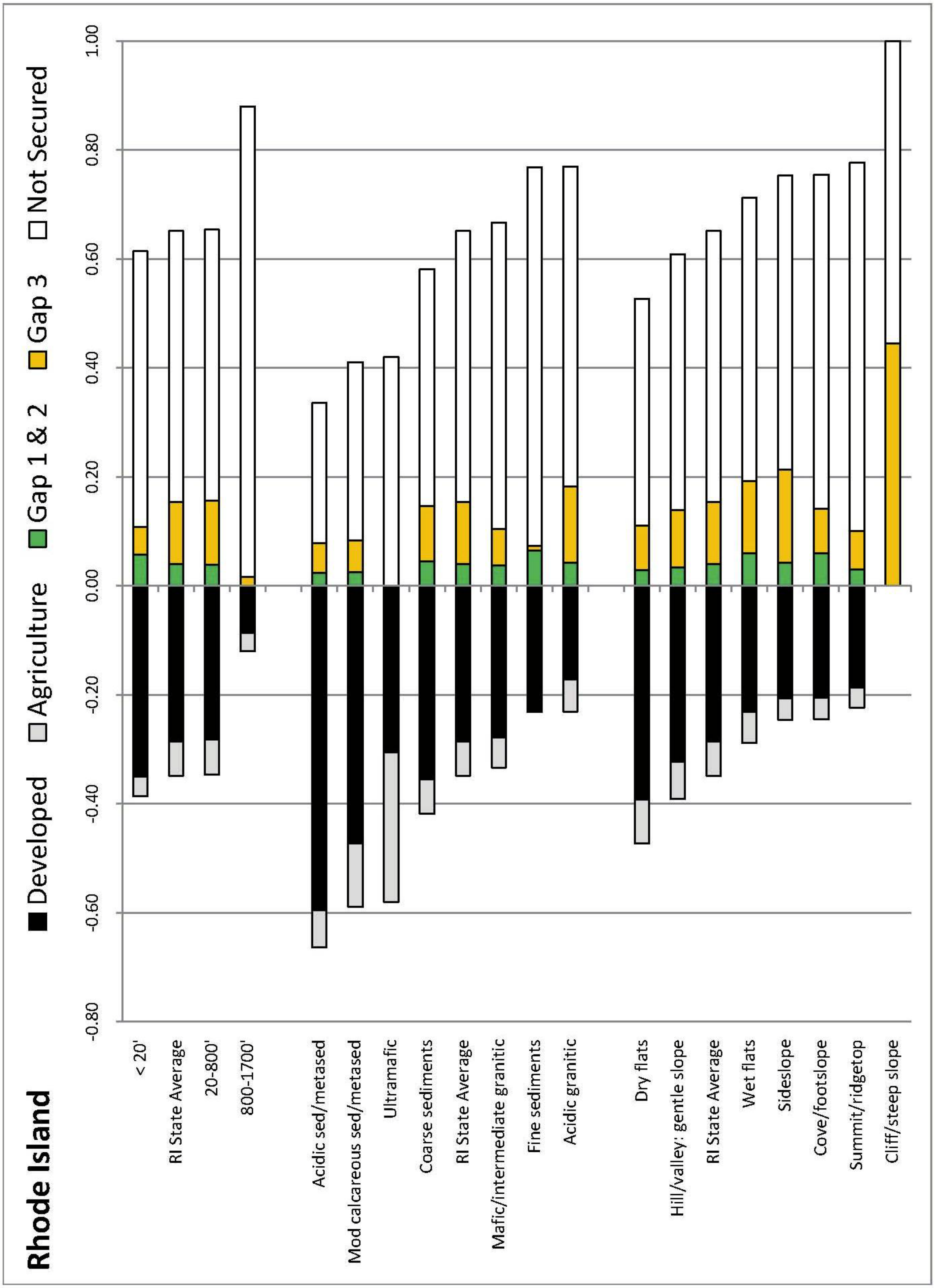
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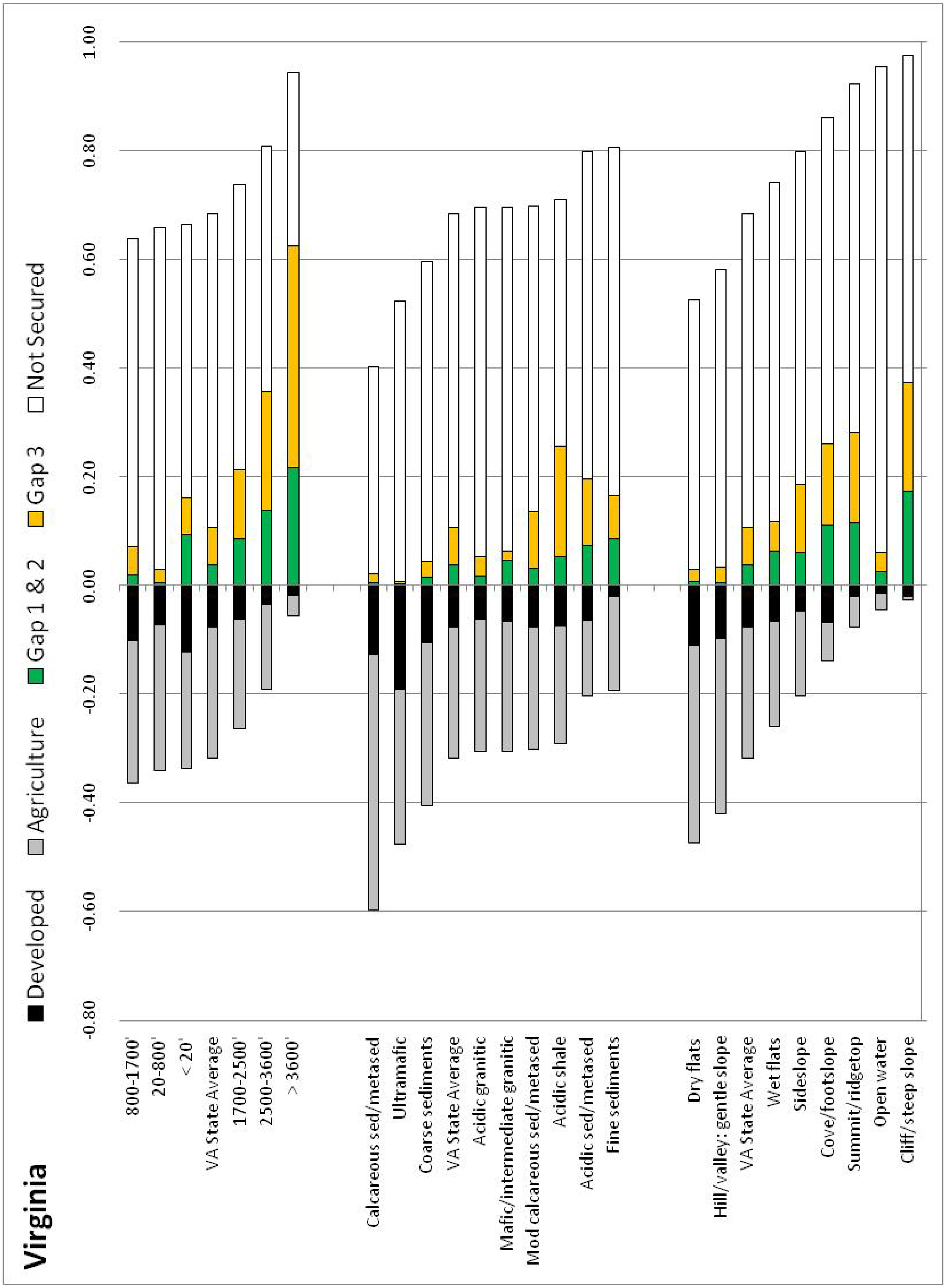
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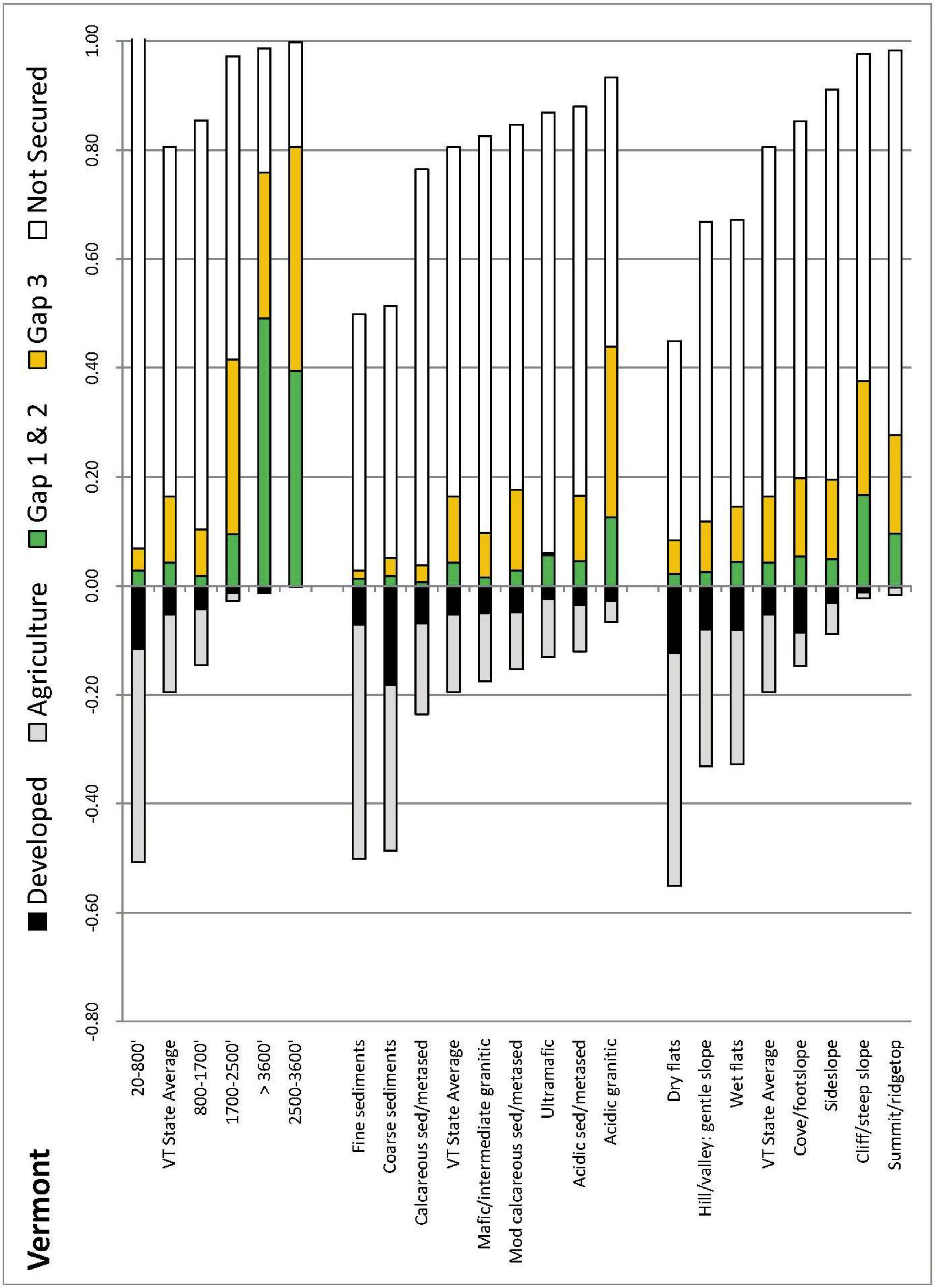
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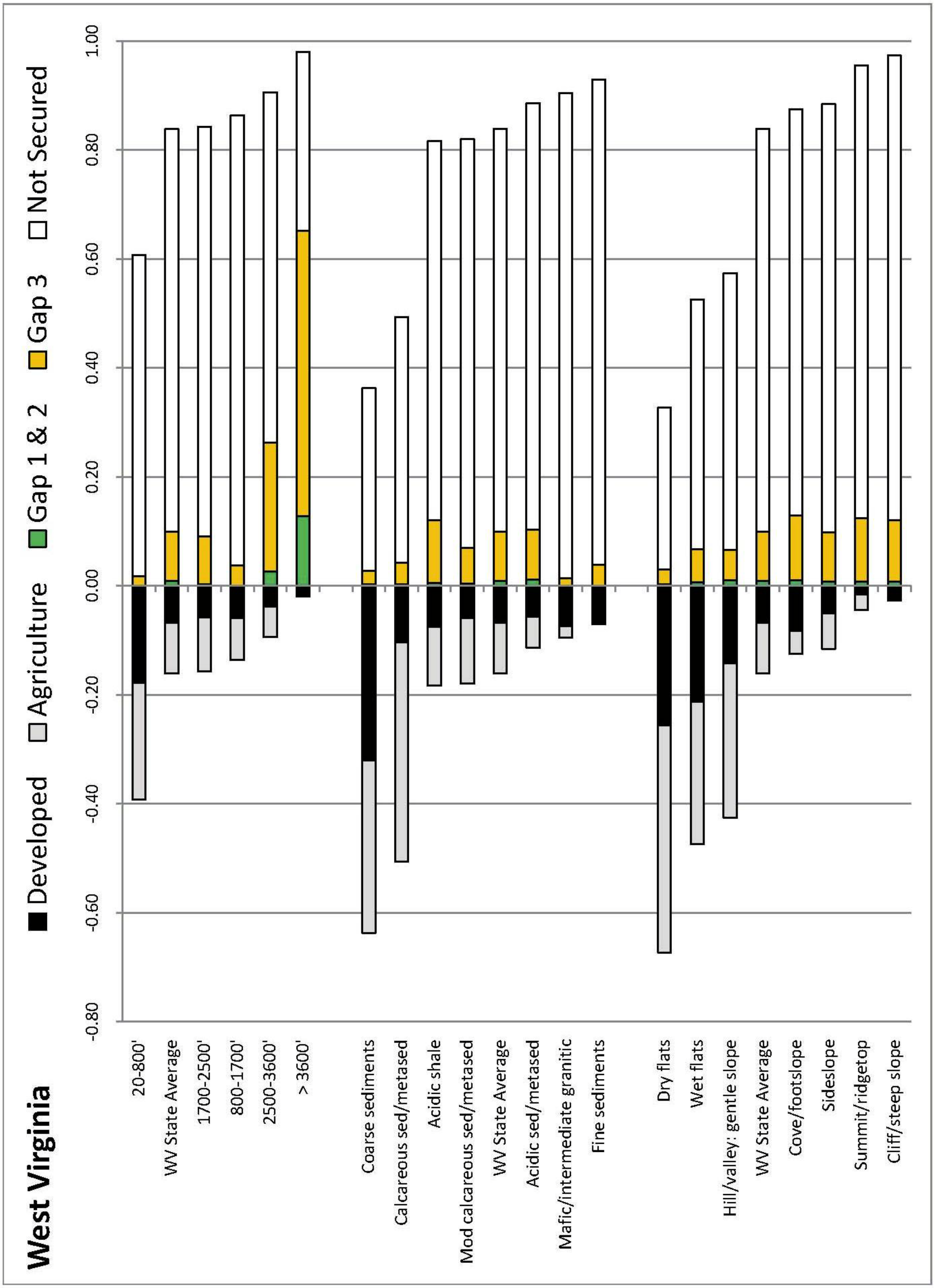
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CHAPTER

7

Stream and Rivers

Condition and Conservation Status

April 2011

M. Anderson and A. Olivero Sheldon

Streams and rivers are flowing water ecosystems. From a tiny trickle in a headwater stream to the vast volume of water flowing in our mighty rivers, these systems provide habitat for a tremendous diversity of life. For centuries, people have depended on streams and rivers for drinking water, food, transportation, recreation, hydropower, and waste disposal. As we struggle to balance human needs for water with the needs of stream biota, an assessment of the current condition of these ecosystems is imperative. Here we begin to examine their conditions and conservation status, with respect to development, damming, and non-indigenous aquatic species.

Summary of Findings

Biotic Integrity: The region contains over 200,000 miles of streams and rivers supporting over 1,000 aquatic species. The majority of the region's watersheds still retain 95-100 of their native fish species, but are also home to up to 37 non-indigenous species. The range of native brook trout, a species that prefers cold high-quality streams, has been reduced by 60 percent. Direct indicators of biological integrity (IBI scores) suggest that while 44 percent of the wadeable streams are undisturbed, another 30 percent are severely disturbed, and this correlates with the amount of impervious surfaces in the watershed.

Conversion and Securement in the Riparian Zone: Riparian areas, the narrow 100 m zone flanking all streams and rivers, are important for stream function and habitat. Currently, conversion of this natural habitat exceeds securement 2:1, as 27 percent of stream riparian area is converted to development or agriculture and 14 percent is secured for biodiversity or multiple uses.

Dams and Connected Networks: Historically, 41 percent of the region's streams were linked into huge interconnected networks, each over 5,000 miles long. Today none of those large networks remain, and even the smaller ones over 1,000 miles long have been reduced by half. There has been a corresponding increase in short 1-25 mile networks that now account for 23 percent of all stream miles, up from 3 percent historically. This highly fragmented pattern reflects the density of barriers, which currently averages 7 dams and 106 road-stream crossings per 100 miles of stream.

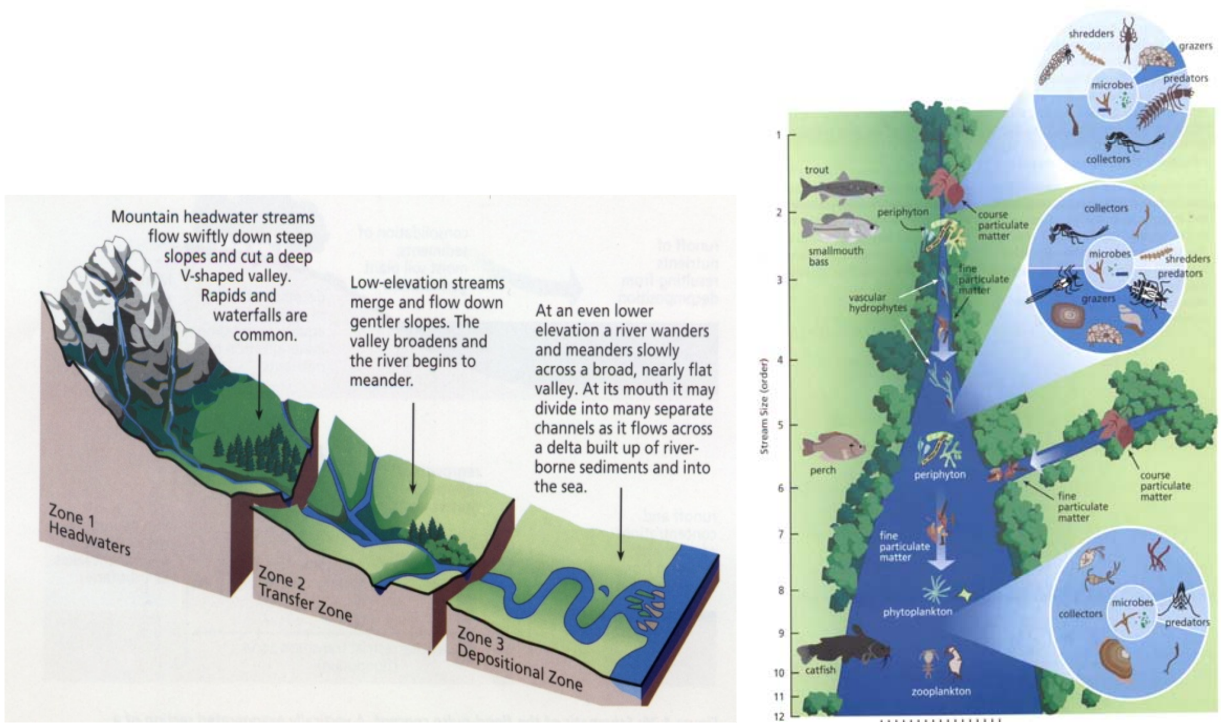
Water Flow: Flow is the essence of a stream ecosystem, but 61 percent of the region's streams have flow regimes that are altered enough to result in biotic impacts. One-third of all headwater streams have diminished minimum flow (they dry up), that translates into a reduction of habitat. Seventy percent of the large rivers have reduced maximum flow (smaller floods) that decreases the amount of nutrient laden water delivered to their floodplains.

Stream Types and Associated Species

Streams and rivers are dynamic features; they change temporally with seasonal changes in precipitation and temperature, and they change spatially from headwaters, to large river mouths. The well known "river continuum concept" provides a framework for how the physical size of the stream relates to major ecosystem processes, resulting in predictable changes in the species composition (Figure 1, Vannote et al. 1980). In narrow, shady, headwater streams, coarse particulate organic matter (e.g. leaves, twigs etc.) from the riparian zone provides the energy base for shredding insects. As a river broadens, more sunlight reaches the stream supporting significant algal growth and grazing insects. As the river further increases in size, reduced channel gradient and finer sediments form suitable conditions for the establishment of rooted plants. In larger rivers, turbidity, depth and fast current render it unsuitable for rooted plants or algal growth, and eventually, delta deposition increases until inputs from outside the stream channel again become a primary energy source.

Changes in physical habitat and energy source are correlated with predictable changes in riverine biological communities (Vannote et al. 1980). As streams increase in size they increase in fish diversity and their species composition changes (Box 1). In this region, fish of small, cold, clear streams with rocky substrates include brook trout and slimy sculpin. In larger streams, coolwater fish communities develop that include additional species such as blacknose dace, goldern shiner, and white sucker. As rivers broaden and flatten, warm water fish communities begin to develop until, in the lower coastal sections of large rivers the fish communities include a variety of anadromous and diadromous fish. In the very large rivers draining to the Ohio River there are additional species restricted to the Ohio-Mississippian basin.

Figure 1. River Continuium Concept (Vanotte et al., 1980).



Besides nearly 300 species of freshwater and anadromous fish, northeast rivers and streams also support a diversity of other biota including: 112 freshwater mussels species, 105 freshwater snail species, 36 crayfish species, 91 amphibian species, 523 caddisfly species, 228 mayfly species, 206 stonefly species, 243 dragonfly and damselfly species, and a myriad of aquatic plants, algae, sponges, worms, other invertebrates and microscopic life (NatureServe 2010). Freshwater dependent species are among the most threatened group of species in the region and are of great conservation concern. Globally rare or endangered species (G1 to G3 species) include: 47 species of freshwater and anadromous fish, 49 species of freshwater mussels, 26 species of freshwater snails, 8 species of crayfish, 13 species of amphibians, 91 species of caddisflies, 38 species of stoneflies, and 39 species of mayflies.

Box 1: Common Northeastern Stream and River Habitats, with examples of some associated fish species

Cold, rocky, swift streams: brook trout and slimy sculpin.

Cool streams and small rivers with moderate gradient: blacknose dace, white sucker, golden shiner, longnose dace, pearl dace, fathead minnow, common shiner, tessellated darter, mottled sculpin, fallfish.

Warm small to medium rivers with low gradients: river chub, longnose dace, central stoneroller, northern hogsucker, cutlips minnow, margined madtom, creek chub, rosyface shiner, fantail darter, and greenside darter, banded sunfish, redfin pickerel, swamp darter, creek chubsucker,

Warm large rivers with low gradients: redbreast sunfish, rock bass, spotfin shiner, smallmouth bass, spottail shiner, common shiner, tessellate darter, pumpkinseed, bluntnose minnow, bluegill, green sunfish, satinfin shiner, swallowtail shiner, yellow bullhead, shield darter, largemouth bass, river chub, rainbow darter, johnny darter, fantail darter, variegate darter, logperch, stonecat, silver shiner, blackside darter, striped shiner, golden redhorse, sand shiner, mimic shiner.

Large rivers near the Atlantic coast: blueback herring, striped bass, gizzard shad, American shad, Atlantic sturgeon, shortnose sturgeon, sea lamprey, banded killifish, white perch, eastern silvery minnow, and white catfish.

Very large rivers in the Ohio basin: channel catfish, sauger, common carp, gizzard shad, freshwater drum, walleye, white bass, shorthead redhorse, spotted bass, silver redhorse, quillback carpsucker, emerald shiner, flathead catfish, black crappie, smallmouth buffalo, river redhorse, and mooneye.

Adapted from Walsh et al, 2007; Stuart, 2003; Langdon et al 1998;

To encompass these diversity patterns, we classified and mapped the streams and rivers into seven size classes that roughly correspond to these major ecosystem changes. These size classes use upstream catchment area as a proxy for stream size because watershed area is mappable across the entire region and the width, depth, and volume of water in a stream channel on-the-ground increases in predictable ways with increasing watershed area. This classification follows the Northeast Aquatic Habitat Classification (Olivero and Anderson 2008), and to keep the terminology clear, we use the term "river" for rivers with catchments over 39 square miles and "stream" for those with smaller catchments (Table 1). We use "streams" when referring to all types collectively.

Table 1. River and Stream Size Classes used in this report (from Olivero and Anderson 2008).

Streams	
1a: Headwater:	1 to 3.9 sq.mi. (10 sq.km) catchment
1b: Creek:	3.9 to 39 sq.mi. (100 sq.km) catchment
Rivers	
2: Small River:	39 to 200 sq.mi. (518 sq.km) catchment
3a: Medium Tributary River	200 to 1,000 sq.mi. (2590 sq.km) catchment
3b: Medium Mainstem River	1,000 to 3,861 sq.mi. (10,000 sq.km) catchment
4: Large River	3,861 to 9,653 sq.mi. (25,000 sq.km) catchment
5: Great River:	greater than 9,653 sq.mi. (25,000 sq.km) catchment

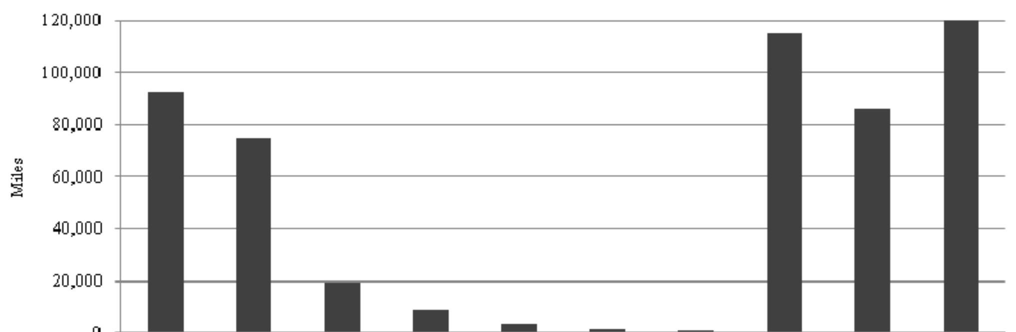
The region contains over 200,000 miles of streams and rivers that drain three major basins, the North Atlantic, Great Lakes, or Ohio-Mississippian (Map 1). Major river systems include the Penobscot, Kennebec, Merrimack, Connecticut, Hudson, Delaware, Susquehanna, Potomac, James, Roanoke, Allegheny, Monongahela, and New River.

In this document, we report on trends for perennial streams and rivers with catchments of one square mile or larger; smaller streams are too inconsistently mapped. The majority of streams and river miles are headwater and creeks with small catchment areas (83 percent). Small rivers account for another 10 percent and the larger river types collectively account for the remaining 7 percent (Figure 2). The percentage distribution of miles by size class is nearly identical between the New England and New York and the Mid-Atlantic, although, the Mid-Atlantic contains more stream and river miles given its larger geographic size.

Conversion and Securement of the Riparian Zone

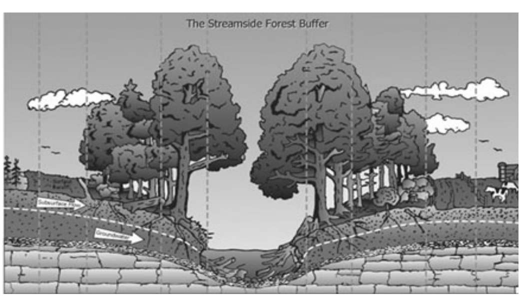
The riparian zone is the land area directly adjacent to a stream or river and subject to its influence. This dynamic zone is an ecologically rich environment, supporting many rare and common species, and numerous natural communities. Vegetated riparian zones provide bank stabilization, water temperature moderation, and sediment filtering, and they are important sources of dissolved particulate and coarse organic matter for adjacent waters (Figure 3). In this section, we assessed the riparian zone of each stream and river by creating (in GIS) a standard 100 m (~300 ft.) buffer on either side of each stream and river in the region. The 100 m distance was chosen to encompass the types of riparian functions noted for eastern riparian zones (Palone et al. 1997).

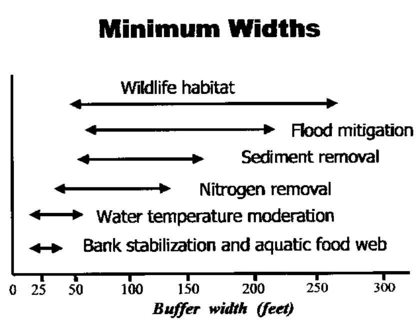
Figure 2. Miles of streams and rivers by size class.



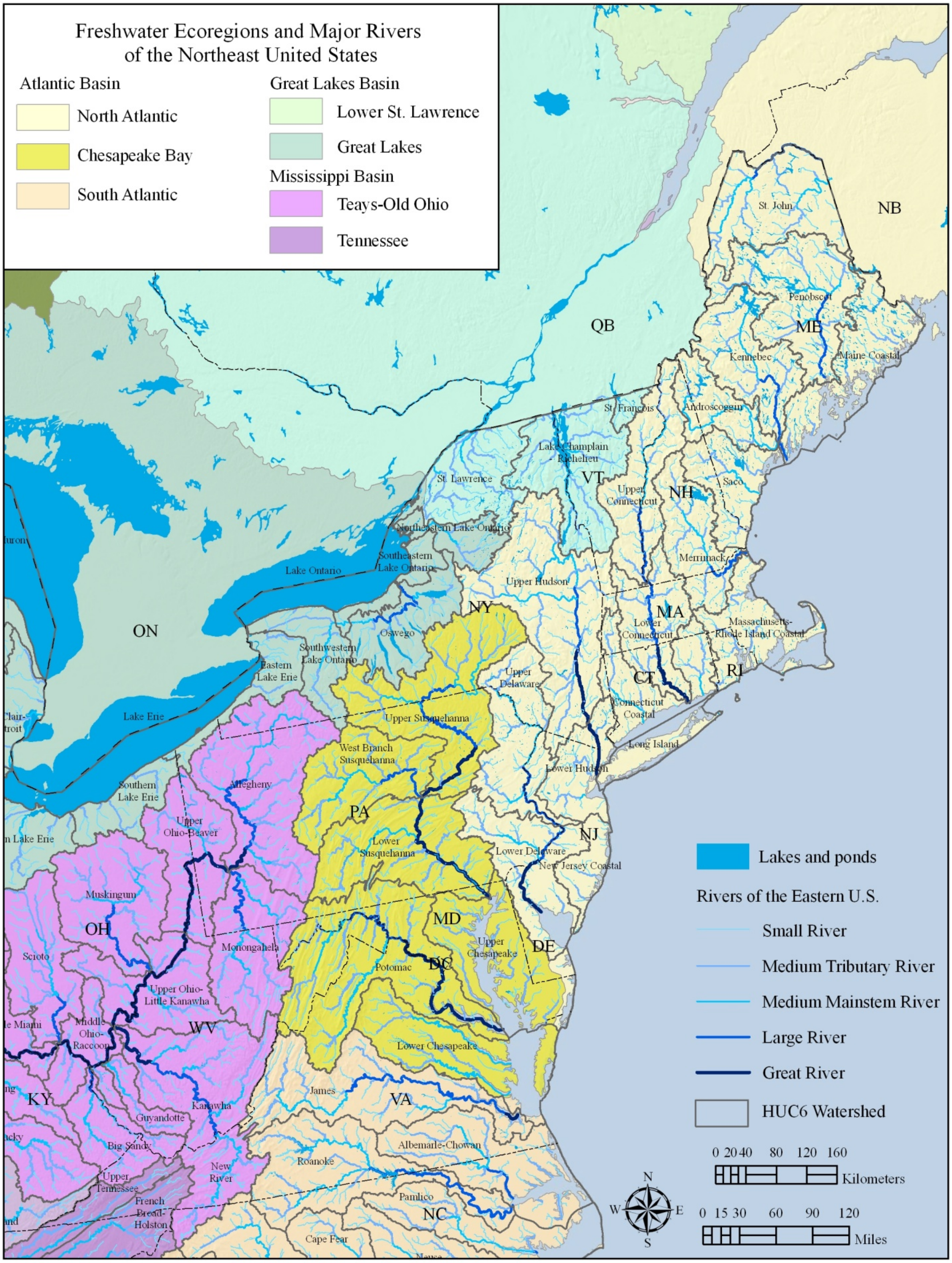
	Headwater	Creek	Small River	Medium Tributary River	Medium Mainstem River	Large River	Great River	Mid-Atl. Total	New Eng/NY Total	Region Total
Miles	92,573	75,228	19,421	8,975	3,441	1,596	973	115,609	86,598	202,207

Figure 3. A. Riparian Zone Conceptual Model (Welsch 1997, Palone et al. 1997).





Map 1. Freshwater ecoregions and major rivers of the northeast United States.

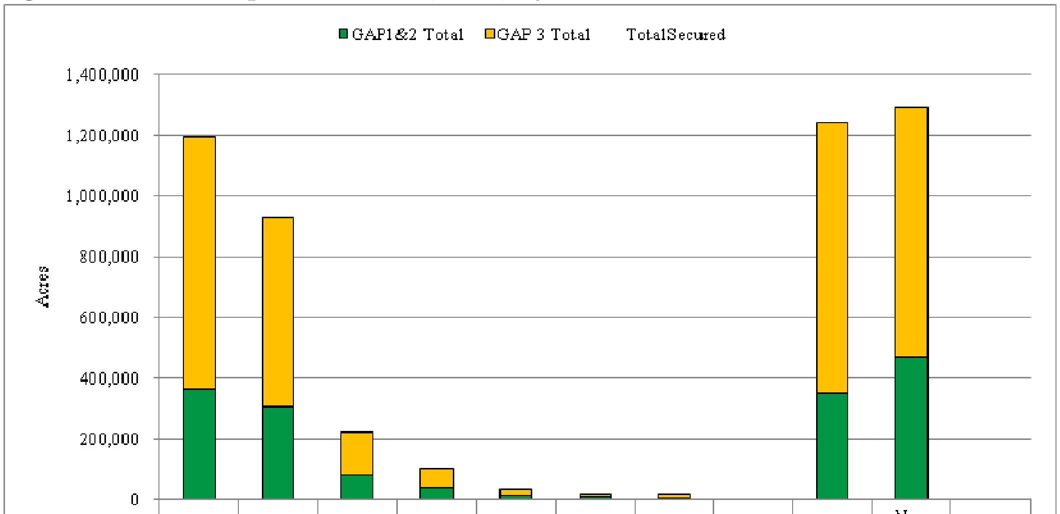


Secured Land in the Riparian Buffer: To evaluate the securement status of each stream's riparian zone we overlaid the TNC secured lands data set (see details in chapter 2) on the 100m (~300ft) riparian buffer zone and tabulated the amount of area protected for biodiversity or secured for multiple uses. The results of this overlay indicated that just over 2.5 million acres of riparian buffer was permanently secured against conversion to development; 14 percent of all the riparian area in the region (Figure 4). The vast majority of this secured acreage, 84 percent, was associated with small headwaters and creeks. This makes sense given that these small streams numerically dominate the miles of stream and river systems in the region.

We summarized the percent of secured riparian buffer in every small watershed (HUC12, e.g. 12 digit Hydrologic Cataloging Unit), and this revealed that few watersheds had 75-100 percent of their riparian buffers secured (Map 2). These watersheds were in northern and downeast Maine, northern New Hampshire, the Adirondack region of New York, the Allegheny mountains of Pennsylvania, the Central Appalachian mountains of West Virginia and Virginia, and in the Pinelands of New Jersey. In other areas of the region, although individual small sections of rivers may benefit from adjacent riparian secured lands, the larger network of streams and rivers of which they were a part had much less protection from conversion in their riparian zone.

Condition of the Riparian Buffer: Natural vegetated buffers along streams provide a suite of benefits to aquatic systems, but agricultural and urban development in the riparian zone is associated with elevated levels of nitrogen, phosphorus, pesticides, and bacteria in streams. We calculated the amount of agriculture and developed land within each riparian buffer zone by overlaying the 2001 National Land Cover dataset (Homer et al. 2004) on the 100 m riparian buffers and tabulating the acreage of each land use. Results show that the percent of riparian land in natural cover decreased with increasing stream size from a high of 73 percent for headwaters to a low of 60 percent for great rivers (Figure 5). Development showed the opposite pattern from natural cover, increasing from a low of 9 percent for headwaters to a high of 26 percent for great rivers. The percent of agricultural cover had a narrow range of variation across stream sizes, from a high of 18 percent for headwaters to a low of 14 percent for great rivers.

Figure 4. Acres of riparian buffer (100m) by secured land status.



	Headwater	Creek	Small River	Medium Tributary River	Medium Mainstem River	Large River	Great River		Mid-Atlantic Total	New England & New York Total	Region Total
Total Secured	1,198,760	931,137	224,982	104,196	38,110	21,023	16,929		1,240,674	1,294,461	2,535,136
GAP3 Total	831,837	624,552	144,648	64,187	24,700	12,664	10,153		889,463	823,277	1,712,740
GAP1&2 Total	366,924	306,585	80,334	40,009	13,410	8,359	6,776		351,212	471,184	822,396

Map 2. Amount of secured riparian buffer by small watersheds.

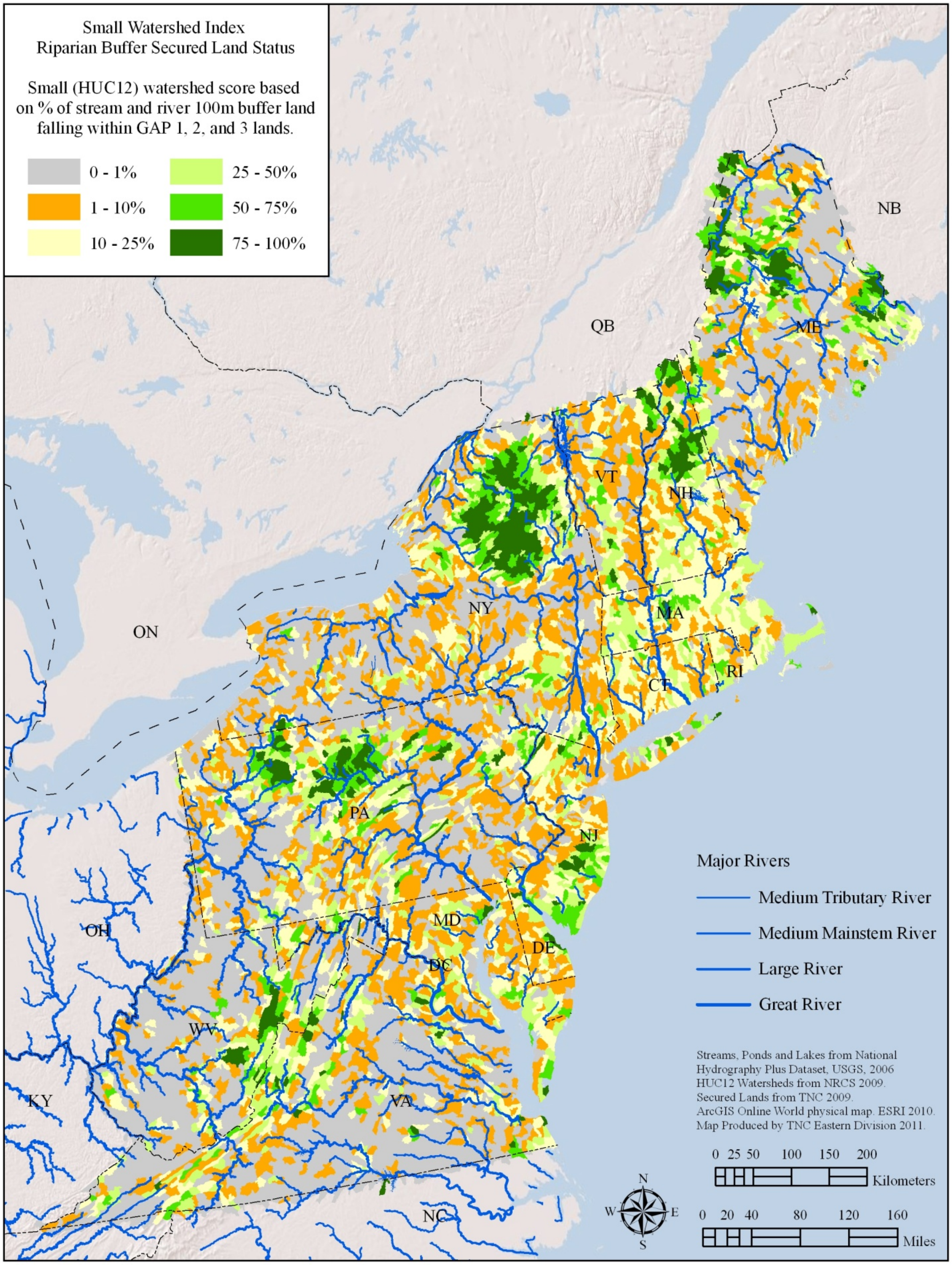
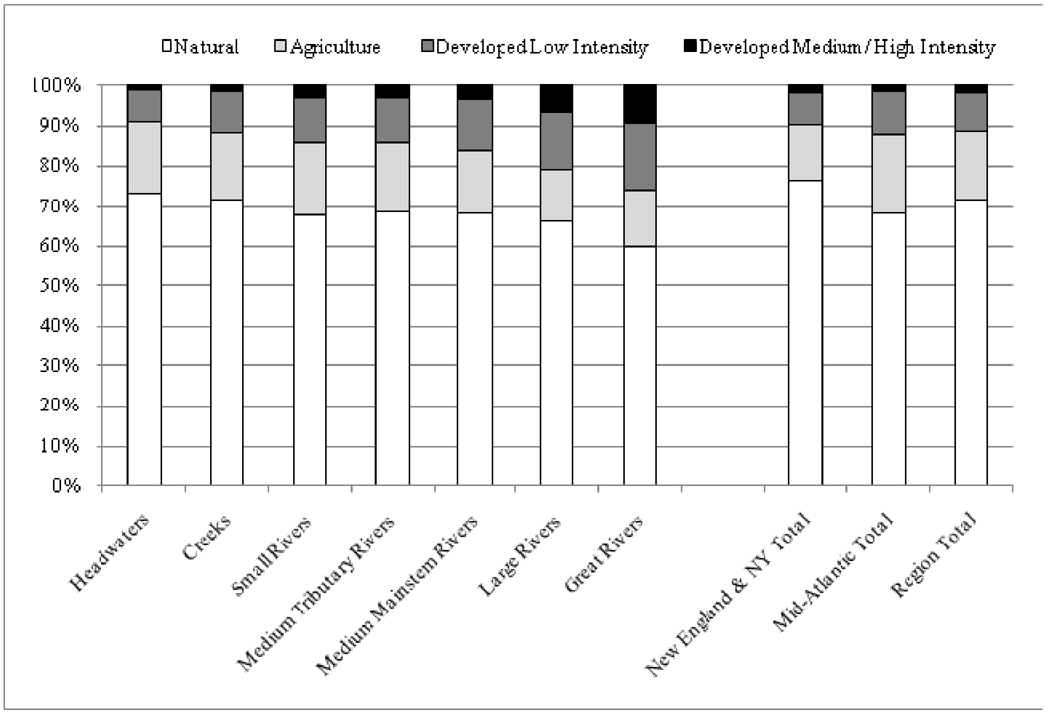


Figure 5. Percent of riparian buffer by land use type .



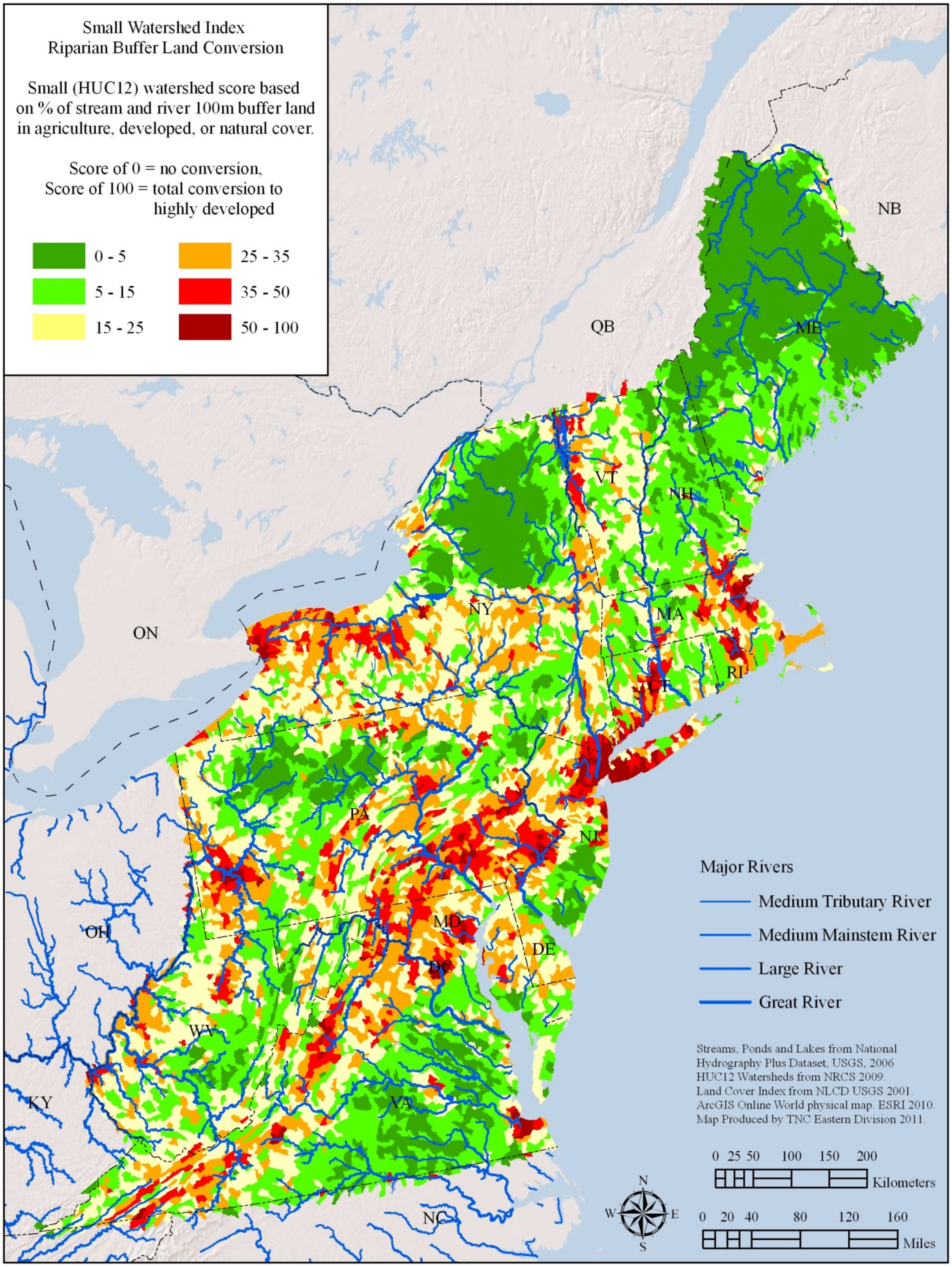
To see the spatial distribution of riparian buffer impacts, we developed a summary small watershed index. For each HUC12, we transformed the land cover information into a numeric impact index by summing the percent of development and agriculture in the buffer zone, and weighting the effect of high intensity development twice as much as of agriculture:

> *Impact = 0.5 * % agriculture + 0.75* % low intensity development+ 1.0* % high intensity development* (NLCD cover classes 81/82, 21/22, 23/24).

The impact index ranged from 100 for a watershed with its buffer zone totally developed to 0 where the buffer zone was completely within natural cover types. The results showed concentrations of highly impacted watersheds near the coast and in lower elevations where development and agriculture were more prevalent (Map 3).

<u>Conversion versus Securement:</u> To understand how the amount of conversion in the riparian buffer related to the amount of securement, we contrasted the amount of agriculture and developed land in this zone to the amount of land protected for nature or secured for multiple uses. Across all streams and rivers, conversion exceeded securement 2:1, with 28 percent of the area converted and 14 percent secured (Figure 6, Table 2). This pattern was similar across all stream and river size classes, conversion always exceeding securement, and ranging from 1.8 times higher in headwater streams, to 2.6 times higher in medium mainstem rivers. Great rivers had the smallest discrepancies, but also had both the highest percent conversion (37 percent) and the largest proportion of their riparian buffers secured (18 percent). Small rivers, medium tributary rivers, and large rivers, ranged from 30-32 percent converted, with conversion averaging 2.4 times the amount of securement (Figure 6).

Map 3. Spatial distribution of riparian buffer impacts.



Conversion outweighed securement in both subregions, with New England and New York having smaller discrepancies (Figure 6). These ranged from almost equal percentages in great rivers, to conversion being almost four times greater than securement in large rivers, with an overall total ratio of conversion to securement of 1.3. Mid-Atlantic discrepancies ranged from 2:1 for large rivers to 3:1 for small rivers, with a slightly higher overall total ratio of conversion to securement of 2.5. Given that the two subregions had similar amounts of conversion in large river riparian buffers (29-32 percent), the Mid-Atlantic had much smaller discrepancies in the amounts of conversion and securement (2:1 vs. 4:1) indicating a better balance of conversion with securement on large rivers. For the smaller river and stream sizes, the Mid-Atlantic has both more conversion than New England and New York, (30-33 percent vs. 21-30 percent) and less securement (11-12 percent vs. 15-18 percent).

In all rivers and streams with catchments smaller than 1000 sq mi., conversion to agriculture was more prevalent than conversion to development. This pattern reversed in rivers with catchments over 3,861 (large and great rivers) which had more development than agriculture in their riparian buffers (Figure 6, Table 2).

Figure 6. Percent conversion to agriculture or development compared with the current securement status of riparian buffer. Based on a 100 m buffer area around each stream or river, each bar represents 100 percent of area assessed. Area to the left of the "0" axis indicates acreage of non secured land converted to development or agriculture, to the right is remaining natural area and secured land.

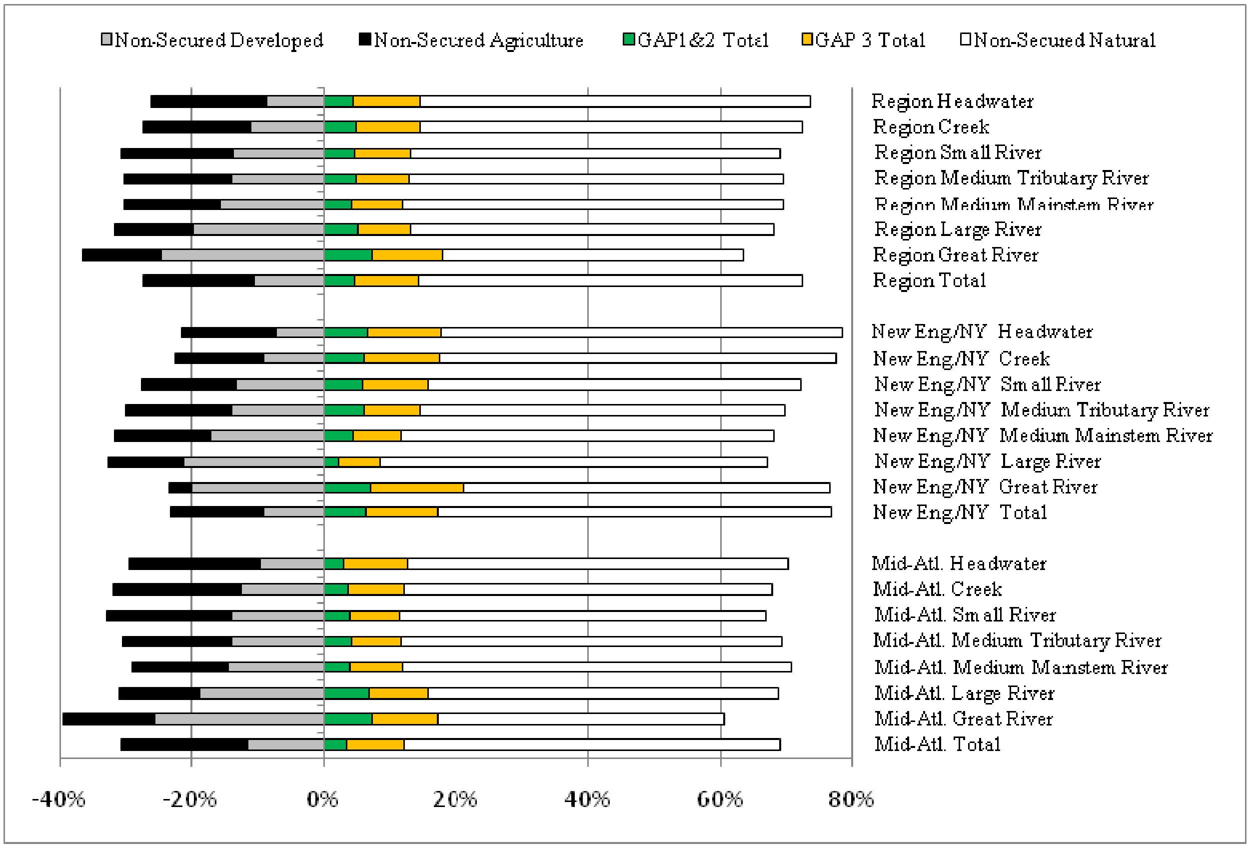


Table 2. Land use and conservation status of the riparian buffer area for all rivers and streams in the region. The units are acres in the 100 m riparian buffer. State by state details are in appendix 7-1.

		Acres Agriculture	%	Acres Developed	%	Acres GAP1&2	%	Acres GAP 3	%	Acres Non-Secured Natural	%	Total Acres	% converted	% secured	CRI-S ratio of converted / secured
Region	Headwater	1,458,379	18%	706,624	9%	366,924	4%	831,837	10%	4,881,868	59%	8,245,632	26%	15%	1.8
	Creek	1,052,323	16%	702,137	11%	306,585	5%	624,552	10%	3,699,379	58%	6,384,975	27%	15%	1.9
	Small River	295,925	17%	234,845	14%	80,334	5%	144,648	8%	968,222	56%	1,723,974	31%	13%	2.4
	Medium Tributary River	133,780	16%	112,794	14%	40,009	5%	64,187	8%	461,930	57%	812,701	30%	13%	2.4
	Medium Mainstem River	47,609	15%	50,104	15%	13,410	4%	24,700	8%	187,619	58%	323,443	30%	12%	2.6
	Large River	19,569	12%	31,801	20%	8,359	5%	12,664	8%	89,429	55%	161,822	32%	13%	2.4
	Great River	11,419	12%	23,132	24%	6,776	7%	10,153	11%	43,137	46%	94,616	37%	18%	2.0
Region Total		3,019,004	17%	1,861,437	10%	822,396	5%	1,712,740	10%	10,331,585	58%	17,747,162	27%	14%	1.9
Mid-Atlantic	Headwater	977,376	20%	465,611	10%	149,094	3%	458,919	9%	2,825,400	58%	4,876,401	30%	12%	2.4
	Creek	663,159	19%	429,377	13%	122,804	4%	288,053	8%	1,908,672	56%	3,412,064	32%	12%	2.7
	Small River	194,238	19%	141,008	14%	39,543	4%	75,392	7%	569,127	56%	1,019,308	33%	11%	2.9
	Medium Tributary River	79,424	17%	66,018	14%	19,641	4%	35,519	7%	276,583	58%	477,186	30%	12%	2.6
	Medium Mainstem River	28,168	15%	27,781	14%	7,655	4%	15,052	8%	113,171	59%	191,827	29%	12%	2.5
	Large River	12,401	12%	18,800	19%	6,921	7%	8,838	9%	53,420	53%	100,380	31%	16%	2.0
	Great River	10,804	14%	19,685	25%	5,554	7%	7,689	10%	33,524	43%	77,256	39%	17%	2.3
Mid-Atlantic Total		1,965,570	19%	1,168,279	12%	351,212	3%	889,463	9%	5,779,897	57%	10,154,421	31%	12%	2.5
New England & New York	Headwater	481,003	14%	241,014	7%	217,829	6%	372,917	11%	2,056,468	61%	3,369,231	21%	18%	1.2
	Creek	389,164	13%	272,760	9%	183,781	6%	336,499	11%	1,790,707	60%	2,972,911	22%	18%	1.3
	Small River	101,688	14%	93,837	13%	40,791	6%	69,255	10%	399,095	57%	704,666	28%	16%	1.8
	Medium Tributary River	54,356	16%	46,776	14%	20,368	6%	28,668	9%	185,348	55%	335,515	30%	15%	2.1
	Medium Mainstem River	19,442	15%	22,323	17%	5,755	4%	9,648	7%	74,448	57%	131,615	32%	12%	2.7
	Large River	7,168	12%	13,002	21%	1,438	2%	3,826	6%	36,009	59%	61,442	33%	9%	3.8
	Great River	615	4%	3,447	20%	1,222	7%	2,464	14%	9,613	55%	17,360	23%	21%	1.1
New England & New York Total		1,053,434	14%	693,158	9%	471,184	6%	823,277	11%	4,551,688	60%	7,592,741	23%	17%	1.3

Fragmentation and Flow

Impervious Surfaces: Impervious surfaces are substrates, like asphalt or concrete, incapable of being penetrated by water. Watersheds with reduced infiltration of rainwater tend to have more frequent and erosive flooding, and this contributes to increases in stream temperature, increases in sediment loads, and a reduction in structural habitat. Chemical pollution also tends to be higher in areas with an abundance of roads, parking lots, and houses.

All indicators of stream quality relative to biotic condition, hydrologic integrity, and water quality, decline with increasing watershed imperviousness. Current research suggests that aquatic systems become very seriously impacted when watershed impervious cover exceeds 10% (CWP 2003) and show significant declines in many stream taxa at much lower levels of impervious surface. For example, numerous declining species have been documented between 0.5 and 2% imperviousness, with 40-45% declines in regional stream biodiversity (invertebrates, fish, amphibians) at imperviousness greater than 2-3% (King and Baker 2010) based on the National Land Cover Impervious Dataset (Yang et al. 2002).

To examine impervious surface in the region, we summarized the amount of impervious cover for the upstream watershed of each stream reach using the National Land Cover Impervious Surface Dataset (Yang et al. 2002). We grouped each stream and river reach in the region into one of four impact categories guided by the thresholds found in King and Baker (2010). These categories match the categories used in the lake chapter:

- Class 1: Undisturbed: 0 < 0.5 percent impervious.
- Class 2: Low impacts: 0.5-2 percent impervious.
- Class 3: Moderately impacted: >=2-10 percent impervious.
- Class 4: Highly impacted: >=10 percent impervious.

The results revealed that 58 percent of stream and river miles in the region were undisturbed by impervious surface impacts, and 28 percent were in the low impact class. Conversely, 11 percent were in the moderately impacted class, and 4 percent were in the highly impacted class (Figure 7). The Mid-Atlantic and the New England and New York subregions both had 4 percent of their stream and river miles in the highly impacted class; however, the Mid-Atlantic had a lower percentage of streams and rivers in the undisturbed class.

The percent of undisturbed stream miles decreased with increasing stream size. This ranged from a high of 62 percent in headwater streams to a low of 0 percent in great rivers (Figure 7, Table 3). For rivers, the percent in the undisturbed class decreased with increasing river size: 45 percent for small rivers, 36 percent for medium rivers, 11 percent for large rivers, and 0 percent for great rivers. Conversely, the percent of streams in the highly impacted class was the same across headwaters, creeks, and small rivers (4 percent) and then decreased in larger rivers, probably due to the fact that their watersheds were so huge that the effects of impervious surfaces in one area may be offset by the presence of natural cover in another part of the huge drainage area.

Figure 7. Impervious surfaces classes by percent of stream miles.

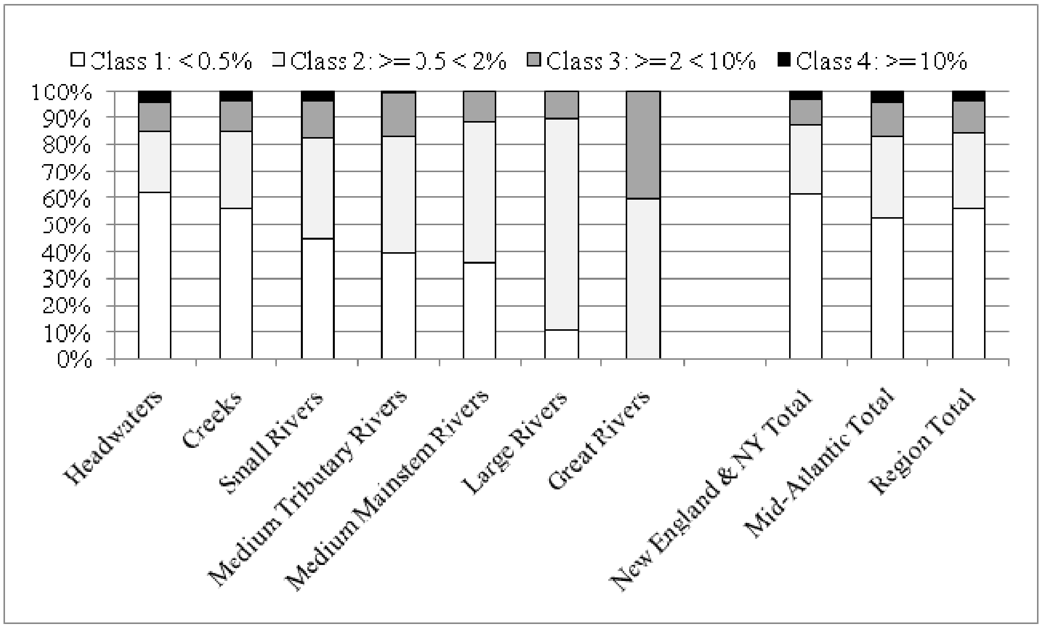


Table 3. Percent of stream miles by upstream impervious surface class.

Region	Size	Undisturbed: < 0.5%	Low: 0.5 < 2%	Moderate: 2 < 10%	High: >= 10%
	Headwaters	62%	23%	10%	4%
	Creeks	57%	28%	11%	4%
	Small Rivers	45%	37%	14%	4%
	Medium Tributary Rivers	40%	43%	16%	1%
	Medium Mainstem Rivers	36%	53%	11%	0%
	Large Rivers	11%	79%	10%	0%
	Great Rivers	0%	60%	40%	0%
Region Total		56%	28%	11%	4%
Mid-Atlantic	Headwaters	60%	24%	11%	5%
	Creeks	51%	31%	13%	5%
	Small Rivers	41%	38%	18%	3%
	Medium Tributary Rivers	36%	45%	18%	1%
	Medium Mainstem Rivers	24%	61%	15%	0%
	Large Rivers	1%	94%	5%	0%
	Great Rivers	0%	58%	42%	0%
M-A Total		53%	30%	13%	4%
NE & New York	Headwaters	65%	21%	9%	4%
	Creeks	63%	26%	9%	3%
	Small Rivers	51%	36%	10%	4%
	Medium Tributary Rivers	44%	41%	13%	2%
	Medium Mainstem Rivers	52%	41%	6%	0%
	Large Rivers	25%	57%	18%	0%
	Great Rivers	0%	70%	30%	0%
NE & NY Total		61%	26%	9%	4%
Grand Total		56%	28%	11%	4%

To see the spatial distribution of impervious impacts, we combined the impact classes into an index of impervious surfaces for watersheds. For each small watershed (HUC12), we calculated the miles of streams and rivers in each impact category and then summed them using the following weighting scheme:

Impact score = 1 (%Class 1) + 2* (%Class 2) + 3* (% Class 3) + 4* (%Class 4).*

This resulted in scores that ranged from 400 for a watershed where all stream and river miles were in the high impact class to a low of 100 where all streams and river miles were in the undisturbed class (Map 4). Results showed concentrations of highly impacted watersheds near the coast and within the urban and suburban fringe of existing cities.

<u>Stream Barriers:</u> Dams and improperly designed culverts alter the structure and function of a river as it is transformed from a continuous free-flowing system into segments separated by barriers and impoundments. In addition to creating migration barriers, dams cause a series of changes downstream and upstream from the impoundment. These include changes in: flow velocity and timing, oxygen levels, temperature, water clarity, and physical habitat.

The size, purpose, and operation of dams influence their impact on river systems. Hydroelectric dams store large quantities of water and replace a stream's natural hydrology with artificial flow regimes designed to meet daily and seasonal energy demands. Flood control dams collect and store water during floods and gradually release it after storm events. Water supply dams maintain large stores of water in a reservoir with a variety of release management practices. Recreational dams create impoundments within a river or maintain a constant high water level within a natural lake. Tailings dams hold the materials left over from the mining process. Low stature "run-of-the-river" dams are less disruptive of natural flow regimes because they release water at the same rate as it enters the impoundment. In general, the storage capacity of dams is highly correlated with measures of hydrologic alteration, and dams that retain larger amounts of water are thus agents of greater hydrologic alteration in the system.

To assess the extent and distribution of dams, we used a new regional dataset compiled by The Nature Conservancy for the Northeast Regional Aquatic Connectivity Assessment Project. This dataset combines the National Inventory of Dams barriers (dams over 6 ft high or storing 50 acre-feet) with state-based inventories of smaller dams. In all, this region (and this dataset) contains 28,103 dams, with 14,034 of those on streams with drainage areas greater than 1 square mile. Surprisingly, then, half the dams in the region were found on very small headwater creeks and pond systems, many of which are not perennial water bodies consistently mapped at the 1:100,000 scale.

We focused our analysis only on the 14,034 dams on streams with drainage areas over 1 square mile, and ignored the dams on smaller streams. The focal dams had a variety of primary purposes, the most common types being recreational dams followed by water supply, hydroelectric, and flood control dams. The northern subregion had a higher percentage of hydroelectric and fish and wildlife dams than the Mid-Atlantic, which had a higher percentage of tailings dams. Otherwise, the two subregions were relatively similar (Figure 8). The highest dams in the region were flood control, followed by water supply, hydroelectric, and recreational. Hydroelectric dams had the highest normal and maximum storage capacity and recreational dams the lowest, while flood control dams have a large difference between normal and maximum storage, with their maximum storage being almost three times their normal storage (Figure 9).

Map 4. Index of impervious surfaces for small watersheds.

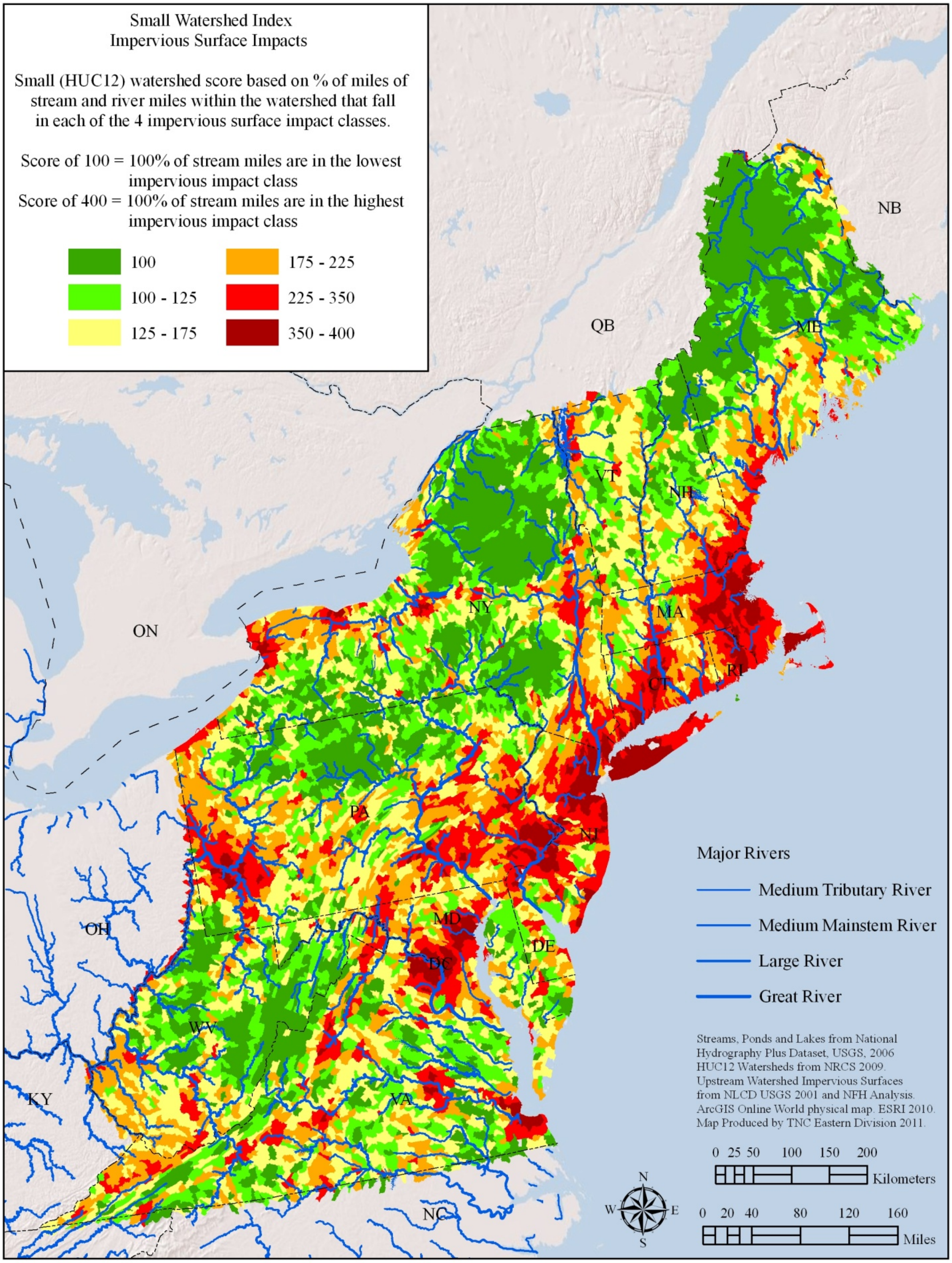
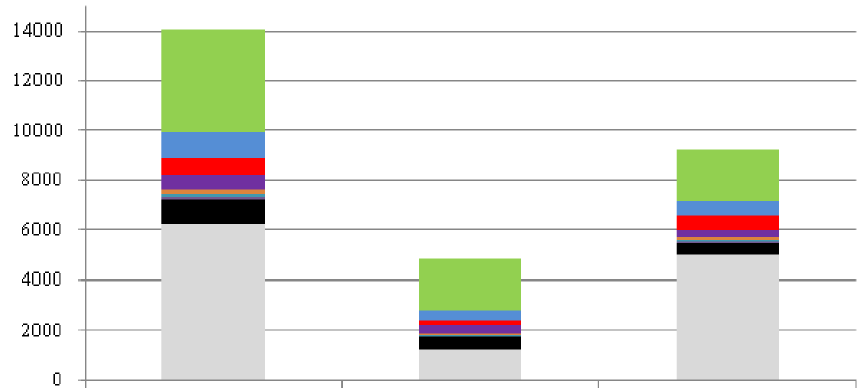
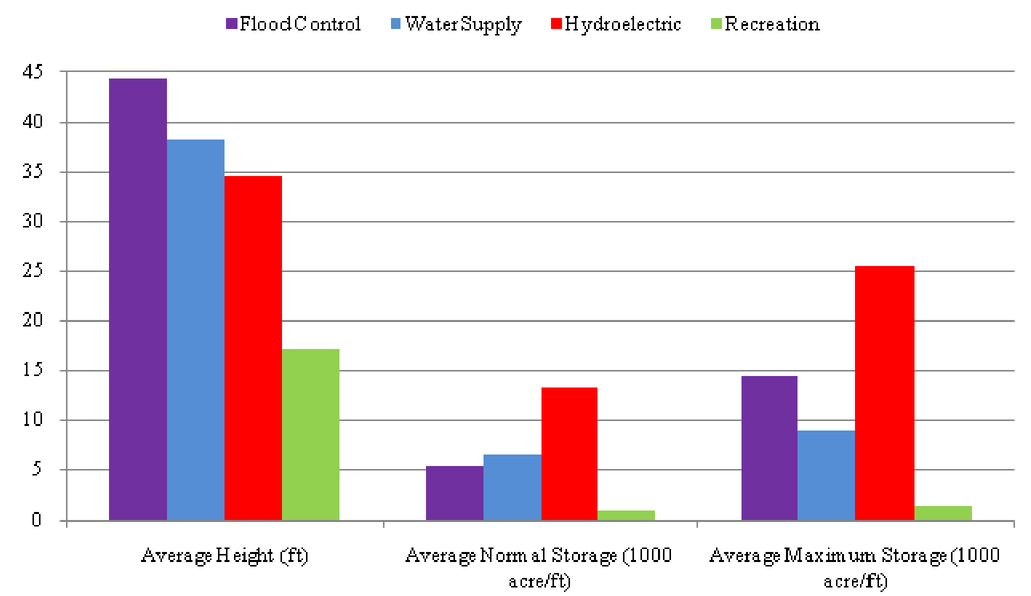


Figure 8. Number and type of dams on streams with a drainage area over 1 square mile.



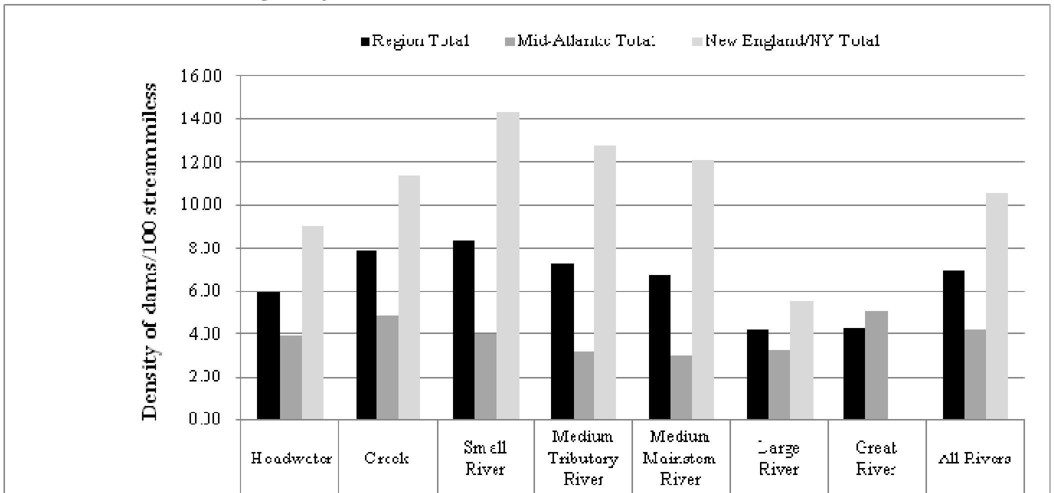
	Region	Mid-Atlantic	New England
Total	14034	4837	9197
Recreation	4105	2102	2003
Water Supply	1034	401	633
Hydroelectric	668	110	558
Flood Control	636	341	295
Irrigation	172	91	81
Navigation	85	34	51
Fish and wildlife pond	75	8	67
Tailings	44	42	2
Other	994	504	490
Unknown	6221	1204	5017

Figure 9. Average height and storage characteristics of dams sorted by primary purpose.



On average, there were 7 dams for every 100 miles of streams and rivers in the region. The density of dams in the northern subregion was 2.5 times the density in the Mid-Atlantic (Figure 10). The density of dams was highest on small rivers, 8 per 100 stream miles, and was even higher in the New England and New York subregion with 14 per 100 stream miles. In the Mid-Atlantic, the dam density was highest on the small creeks and great rivers (5 per 100 stream miles). Hydroelectric dams had their highest density on medium and large rivers, while the density of recreational dams was highest in the headwaters and creeks (Figure 11). The small watersheds (HUC 12) with the highest dam density are in Rhode Island, Connecticut, Massachusetts, New Jersey, and southern New York; these watersheds have over 25 dams per 100 stream-miles (Map 5).

Figure 10. The density of dams on streams and rivers. The chart shows the number of dams per 100 stream-miles and arranged by stream size class.



	Headwater	Creek	Small River	Medium Tributary River	Medium Mainstem River	Large River	Great River	All Rivers
Region Total	5.96	7.84	8.33	7.25	6.74	4.20	4.21	6.94
Mid-Atlantic Total	3.88	4.84	3.97	3.23	2.93	3.27	5.08	4.18
New England/NY Total	8.99	11.36	14.23	12.74	12.13	5.54	0.00	10.62

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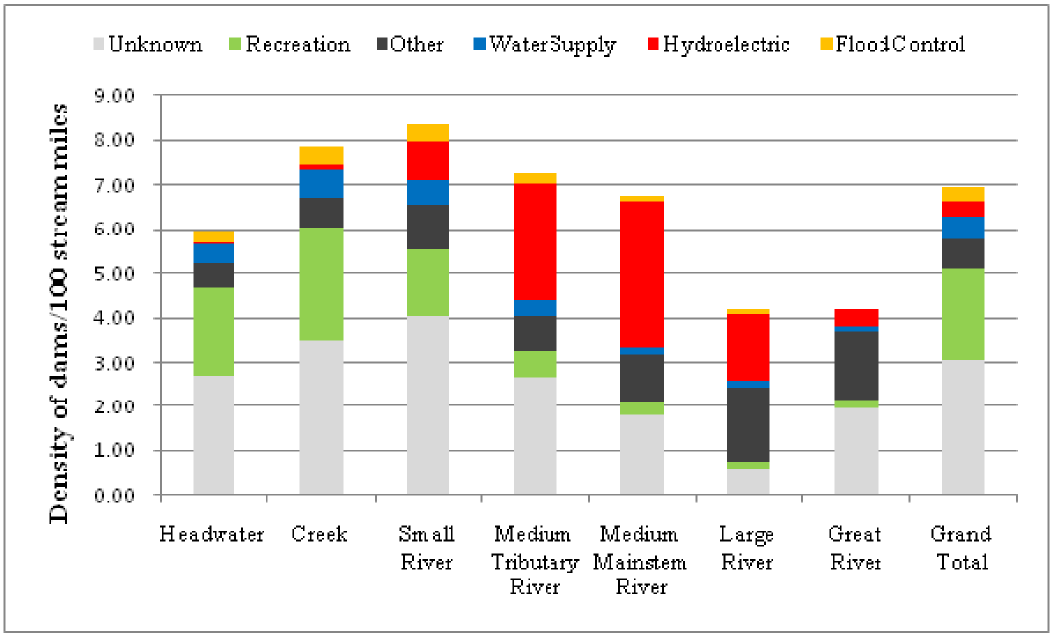
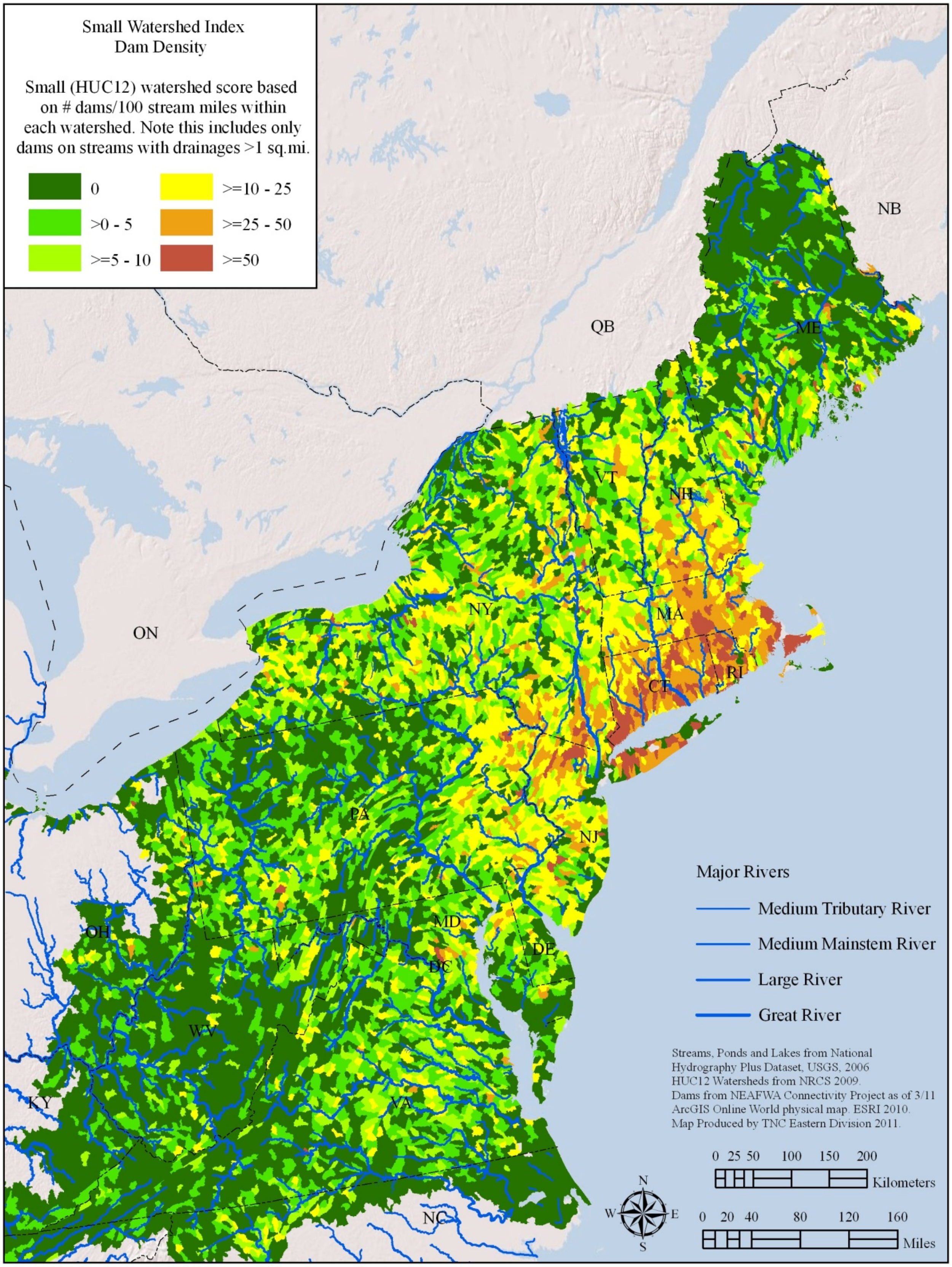
Figure 11. Density of dams by primary purpose and river size class.



Map 5. Dam density in small watersheds.



The region's streams are also fragmented by impassable culverts at thousands of road-stream crossings. On larger streams, road crossings are usually facilitated by bridges and are less obstructive to fish passage, but many culverts installed at small stream crossings act as partial to total barriers at certain times of the year. A simple count of the number of road-stream crossings on headwaters and creeks amounted to 177,801 (not including crossings at 4-wheel drive trails and other trails), although it was not possible to determine how many of these had impassable culverts. This translates to an overall density of 106 crossing per 100 miles of headwaters and creeks (Table 4.). Road crossing density ranged from a low of 89 crossings per 100 creek miles in New England and New York to a high of 118 crossing per 100 headwater miles in the Mid-Atlantic. When combined with the 7 dams per 100 stream miles, these numbers are sobering. Further work is necessary to determine which of these culverts are currently acting as full or partial barriers, and which could be retrofitted to improve passage.

<u>Connected Stream Networks:</u> The length of connected stream and river networks in the region has been profoundly changed by dams and impassable culverts. Stream barriers impact both resident species that move within the freshwater network, and diadromous species that move between freshwater streams and the ocean. Diadromous species in the northeast that have suffered from reduced access to spawning and nursery habitats include Atlantic salmon, American shad, alewife, blueback herring, Atlantic sturgeon, shortnose sturgeon, rainbow smelt, and American eel.

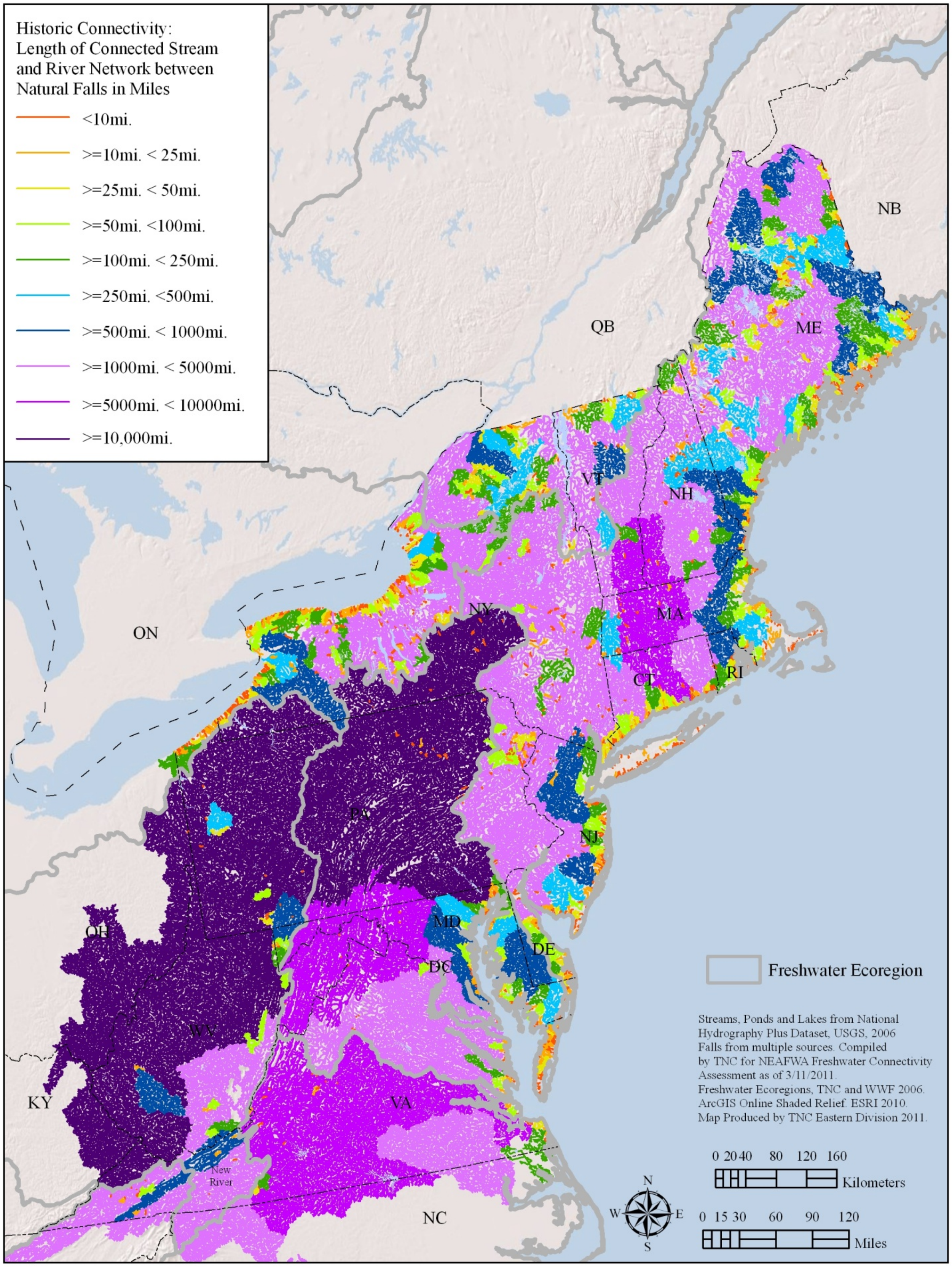
Resident fishes also move extensively throughout the freshwater network, to access seasonal habitats for feeding and spawning, to find refuge during times of stress, and to colonize new areas. Some species of trout and sucker, for example, regularly move 1 to 10 km within a stream network to spawn. Barriers to upstream re-colonization after a catastrophic event can fragment and isolate populations resulting in local extinctions. These impacts disproportionally affect rare species and they may have a cascading effect on other species. For instance, barriers have been implicated in the decline of freshwater mussels because the parasitic larval stage of most freshwater mussels requires a fish as a host. Thus, the blockages that fragment the host fish populations end up isolating the freshwater mussel populations also, leading to local extinctions. The distribution of the federally endangered dwarf wedgemussel (*Alasmidonta heterodon*) in certain streams is confined to stream reaches below blockages, suggesting that impediments to the upstream movement of host fishes restrict the mussels to downstream habitats.

To evaluate change in the length and distribution of the region's functionally connected stream networks in the region, a connected stream network data layer was created in GIS. One version –historic connectivity – was built by linking all existing streams that connect to each other, using only major waterfalls to split the network; a theoretically dam-free system (Map 6). A second version – current connectivity – was created using dams in addition to waterfalls to split the network (Map 7). In both cases, the emergent connected networks were bounded by fragmenting features (falls or dams) and/or the topmost extent of headwater streams (Figure 12). This allowed us to measure the length of every network between fragmenting features. Our intent was to quantify the distance that a fish or aquatic animal could

Table 4. Number and density of road-stream crossings on headwaters and creeks.

	# Road Crossings on Headwaters	# Road Crossings on Creeks	Total # of Road Crossings on Headwaters and Creeks	Density of Road Crossings on Headwaters/100 stream miles	Density of Road Crossings on Creeks/100 stream miles	Density of Road Crossings on Headwaters and Creeks/100 stream miles
Mid-Atlantic	64,802	44,252	109,054	118	109	114
New England & New York	37,778	30,969	68,747	100	89	95
Region Total	102,580	75,221	177,801	111	100	106

Map 6. Historic connectivity.



Map7. Current connectivity.

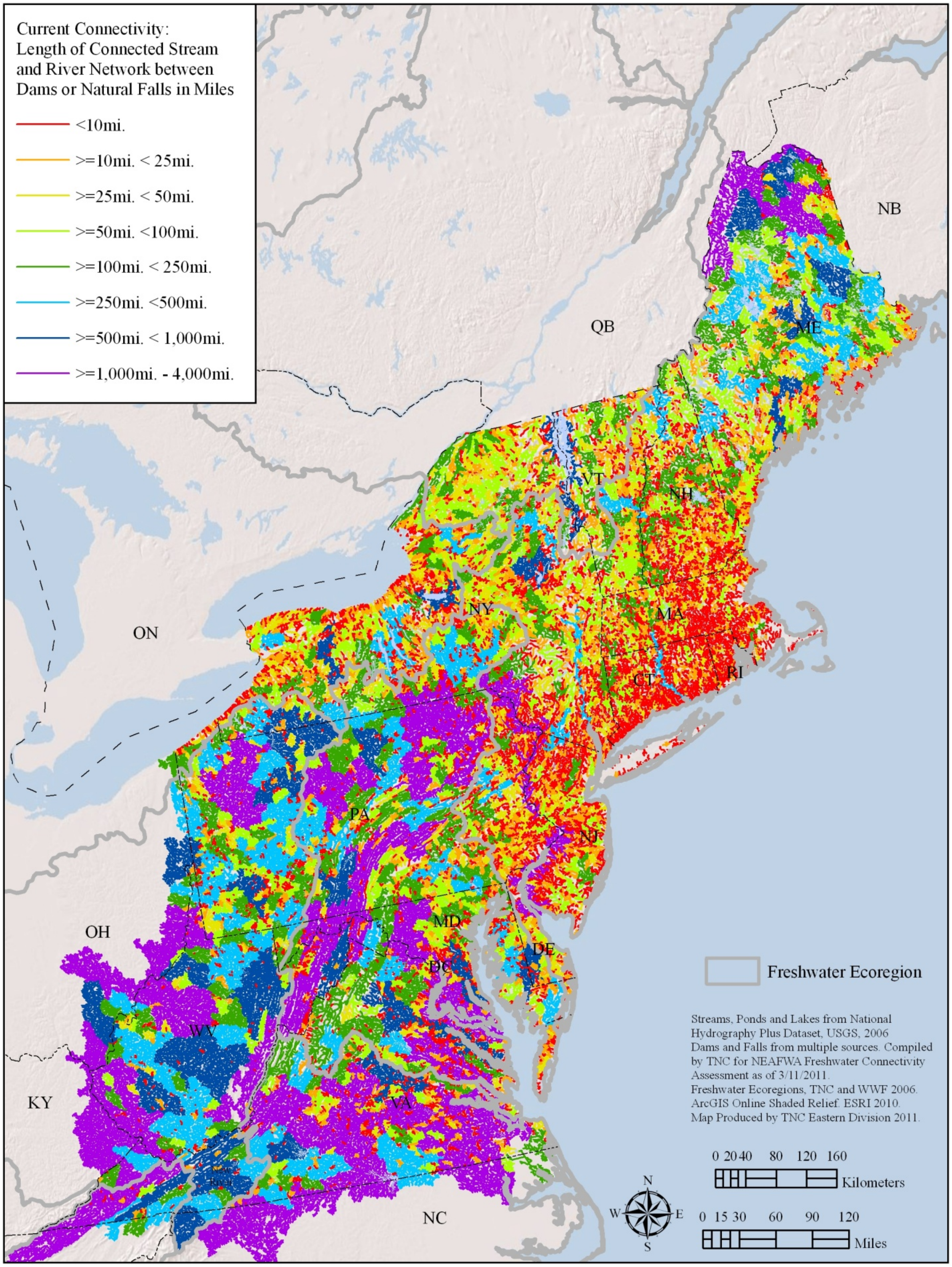
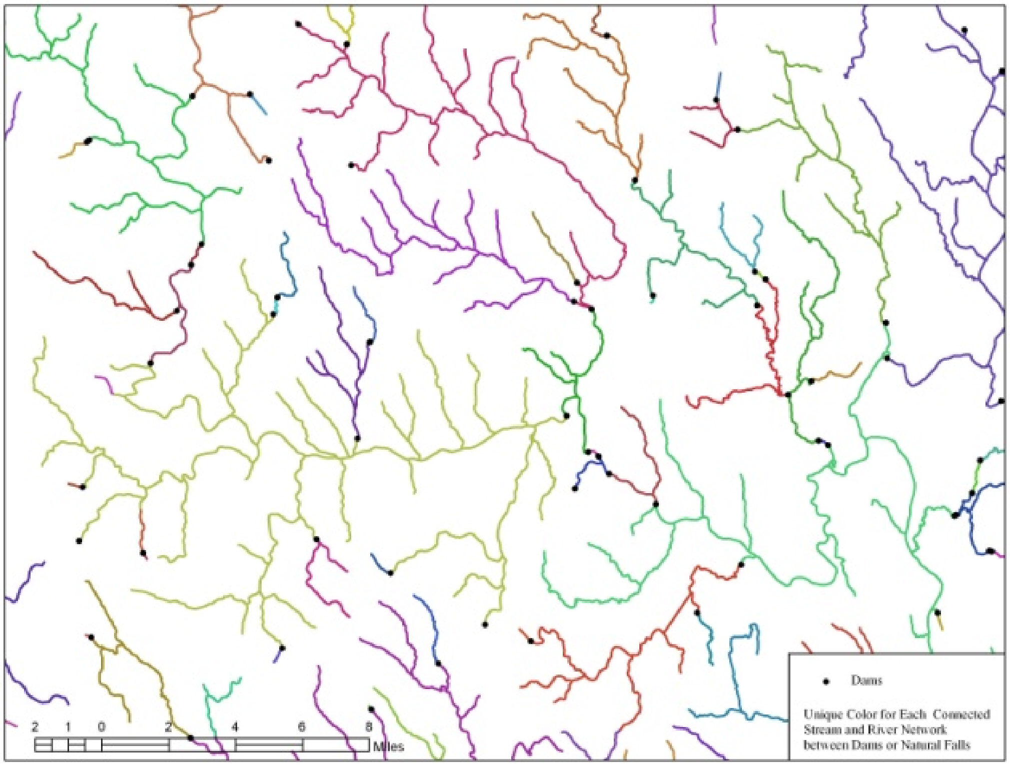
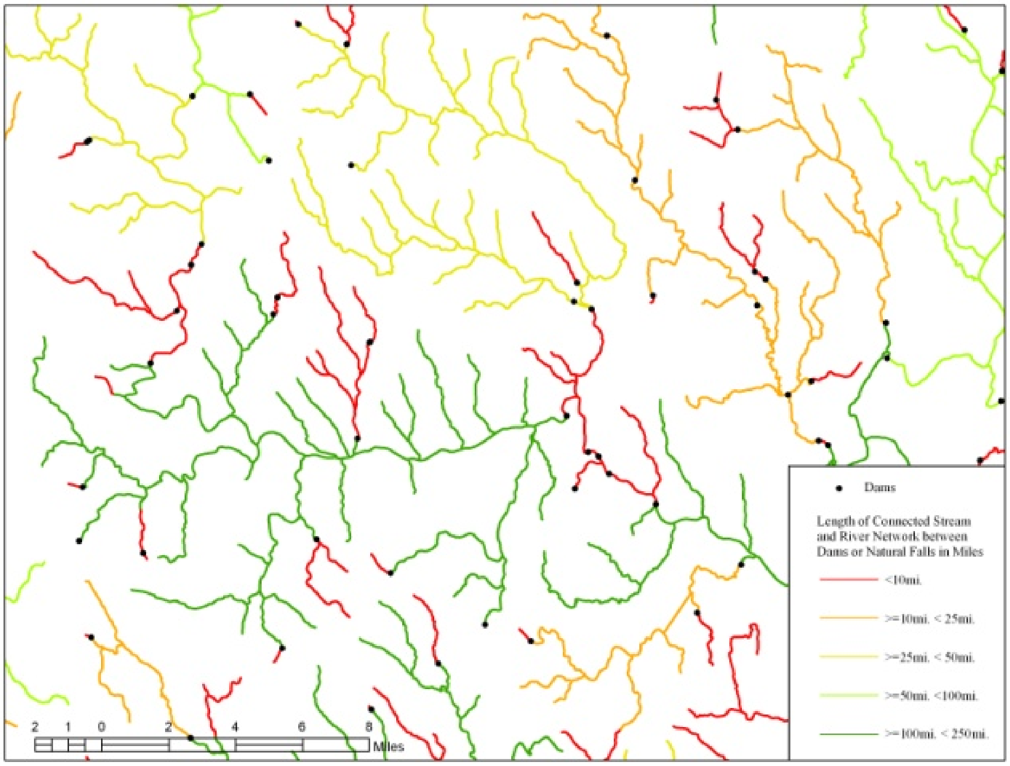


Figure 12 (a, b). Example of functionally connected stream networks. Each network is bounded by dams and/or the topmost extent of headwater streams.

a: Unique color for each connected network



b: Each connected network symbolized by its total connected length class.



move within until reaching one of these bounding features (Figure 12). Please remember that dams on small streams with less than a 1 square mile drainage area were omitted from this analysis due to the lack of consistency in their mapping, see detailed methods for more information.

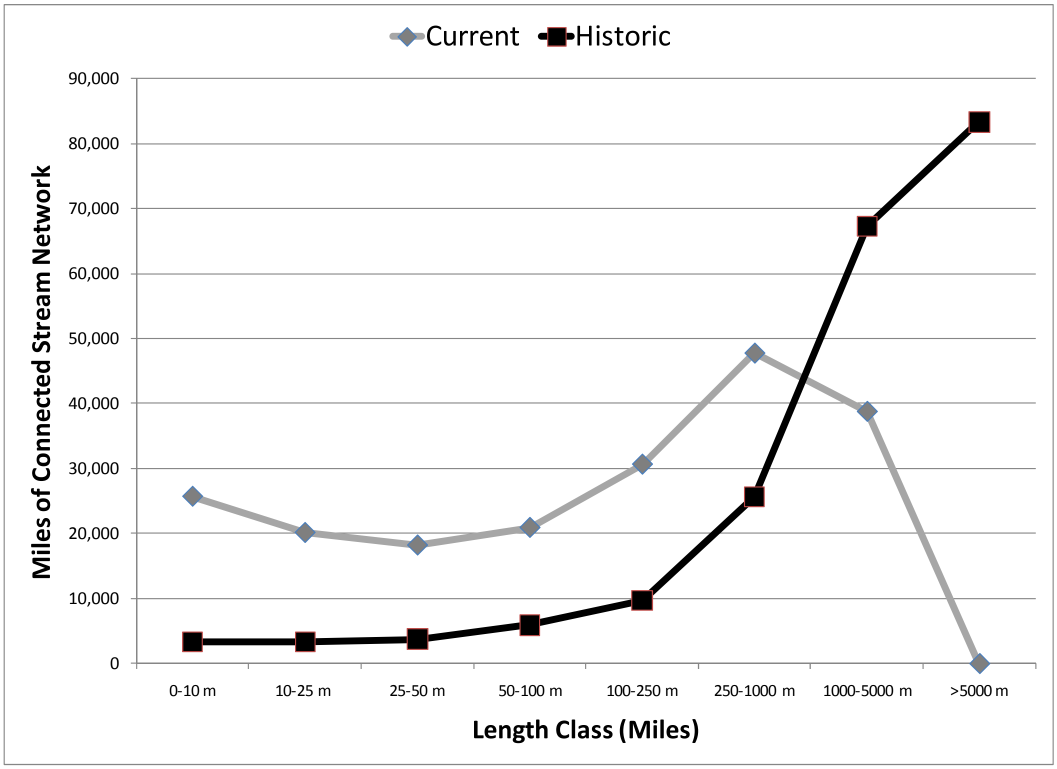
Comparing the current to the historic connected networks revealed a striking loss of large networks and a corresponding gain of smaller networks (Table 5, Figure 13, Map 6 and 7). Historically 83 percent of stream miles were part of connected networks over 500 miles in length; currently only 29 percent of stream miles are in these large networks. Moreover, there are no longer any networks in the region larger than 5,000 miles, while historically 41 percent of all stream miles were in these very large networks. At the other end of the scale, historically only 3 percent of stream miles were in short networks of less than 25 miles, but currently these account for 23 percent of all stream miles in the region. The largest remaining connected network in the region, nearly 4,000 miles long, extends through much of the Upper Susquehanna and up into the West Branch Susquehanna drainages.

Results by subregion showed a similar pattern of network loss and gain, however the loss of large networks and gain of smaller networks was exaggerated in New England and New York region that now had 63 percent of its stream miles in networks under 100 miles and 10 percent in connected networks over 500 miles in length. In the Mid-Atlantic, 27 percent were in networks less than 100 miles long and 44 percent in larger connected networks over 500 miles long.

Table.: Length of stream miles within each functionally connected network size class

	Region		Mid-Atlantic		New England/New York	
Network Length Class	Current Miles	Historic Miles	Current Miles	Historic Miles	Current Miles	Historic Miles
1. <10mi.	25,715	3,375	9,469	1,074	16,246	2,301
2. >=10mi. <25mi.	20,151	3,278	7,339	1,220	12,811	2,057
3. >=25mi. <50mi.	18,217	3,762	6,169	866	12,048	2,896
4. >=50mi. <100mi.	20,992	5,915	8,083	2,293	12,909	3,623
5. >=100mi. <250mi.	30,657	9,680	15,862	2,384	14,795	7,297
6. >=250mi. <500mi.	27,106	8,424	18,220	2,049	8,886	6,374
7. >=500mi. <1000mi.	20,611	17,242	15,644	7,836	4,966	9,406
8. >=1,000mi. < 5,000mi.	38,759	67,221	34,823	27,198	3,936	40,024
9. >=5,000mi. <10,000mi.		28,644		23,257		5,387
10. >=10,000mi.		54,665		47,432		7,233
Grand Total	202,207	202,207	115,609	115,609	86,598	86,598

Figure 13. Distribution of stream miles within each connected network size class. The current and historical number of stream miles falling within each connected network size class is plotted by increasing network size. The chart shows a smooth increase in network sizes in the historic condition compared to the increase in small networks, and the loss of large network, in the current condition.



Flow Alteration: Flow is the essence of a stream, the "master variable" that structures the physical habitat both in the channel and on the adjacent floodplain. The natural timing, magnitude, and frequency of stream flow influences the evolutionary adaptations of river biota, and controls many physical and chemical processes. High flows shape the stream channel, move sediment, and deposit silt-laden floodwaters on adjacent floodplains, replenishing the soil, and creating feeding and nursery grounds for fish. Low flows define the smallest habitat area available to stream biota during the year, and many riparian and stream species have evolved to complete their life histories during periods when water is available.

Changes in flow can be caused by dams, water withdrawals, ground water pumping, changes in land cover, and changes in climate. Altered flow magnitudes are frequently linked to ecological impairment, and are the primary predictor of biological integrity for fish and macro-invertebrate communities. Diminished maximum flows are associated with significant changes in riverine ecosystem structure and have been implicated in the decline of many floodplain and riparian communities.

Only recently have data become available to assess alteration to stream flows across large geographic areas. In 2010, the USGS employed 2,888 stream gages throughout the coterminous U.S. to apply standardized indicators of alteration to minimum and maximum flows (Carlisle et al. 2010). Their methods utilized 27 years of data (1980-2007) to calculate mean annual minimum flows (7-day moving average) and mean annual maximum flows (daily average), and compare them to reference conditions. They used the ratio of observed conditions to expected conditions (O/E) as a standard metric to report on relative alterations. For this metric, gages were grouped into three categories: 1) *Inflated* = the O/E value was greater than 90 percent of those from reference sites (O/E value >=9), 2) *diminished* = O/E values were less than 90 percent of those from reference sites (O/E value <= 0.1), or 3) *unaltered* = the O/E value was within the above limits (O/E value 0.1 to 9.0). This analysis is conservative in terms of reporting only very large alterations to maximum or minimum flows, and does not attempt to detect other alteration to flow such as timing.

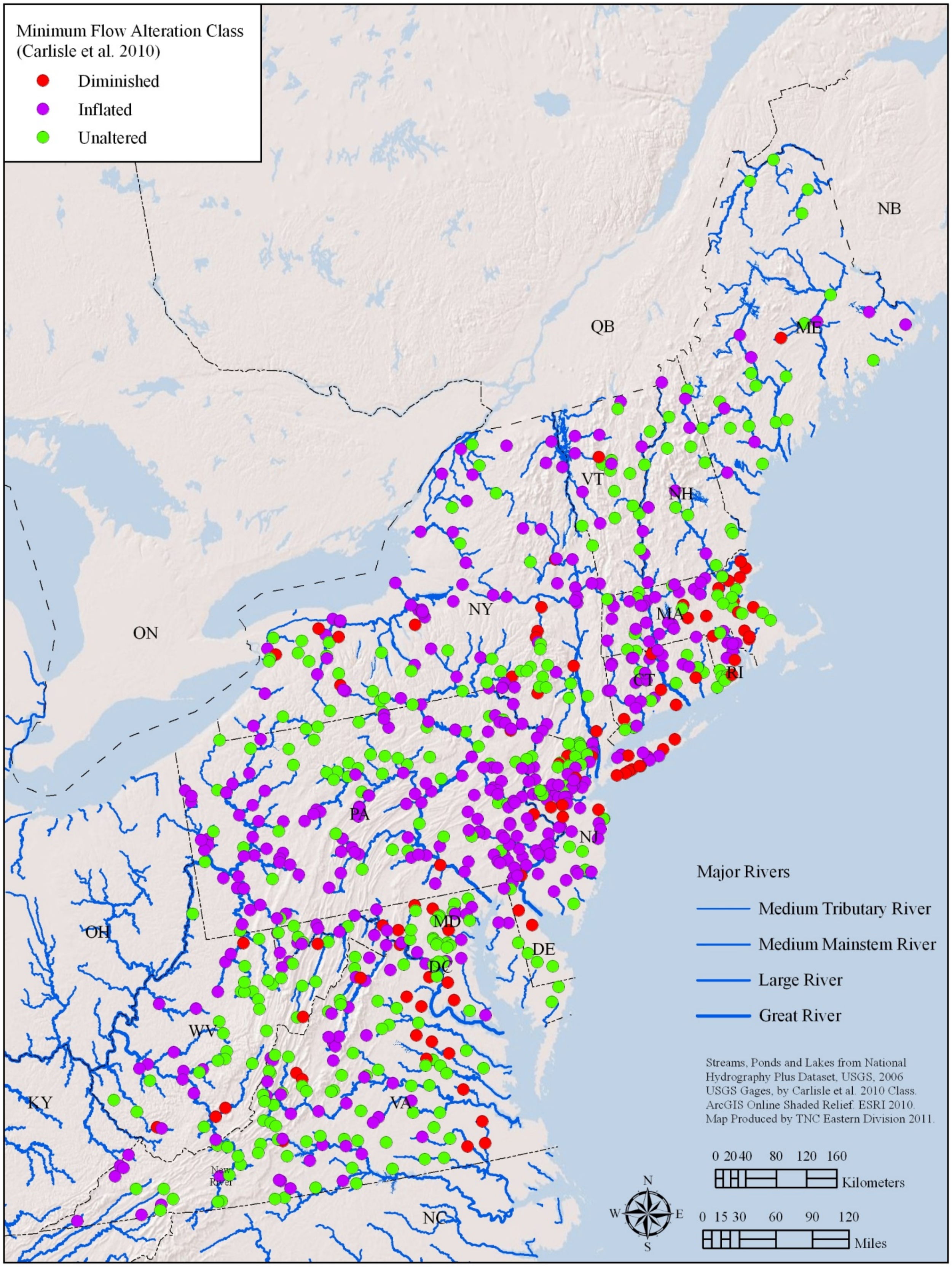
Results for the 807 gages in our region showed that 66 percent of the sites had either altered minimum flows, altered maximum flows, or both; 34 percent were unaltered (Table 6). Minimum flows were the most effected: 49 percent had inflated minimum flows, 11 percent had diminished minimums and 40 percent were unaltered (Map 8). The results for maximum flows indicated: 70 percent were unaltered, 24 percent had diminished maximums, and 6 percent had inflated maximums (Map 9). These overall patterns were similar between the two sub-regions; however, New England and New York had a higher percentage of diminished maximum flows (33 percent vs. 19 percent) and of diminished minimum flows (16 percent vs. 9 percent) than the Mid-Atlantic.

As streams increased in size, a smaller proportion of them were affected by diminished minimum flows and a larger percentage were affected by diminished maximum flows (Table 6, Figure 15). This suggest that diminished flows are more of a problem for our headwaters, creeks and small rivers, while diminished maximum flows are more of a problem in our medium to great rivers. Medium sized mainstem rivers were particularly affected by diminished maximum flows with over half of the samples showing diminished flows (56 percent), and 77 percent of the large and great rivers also showing diminished maximum flows.

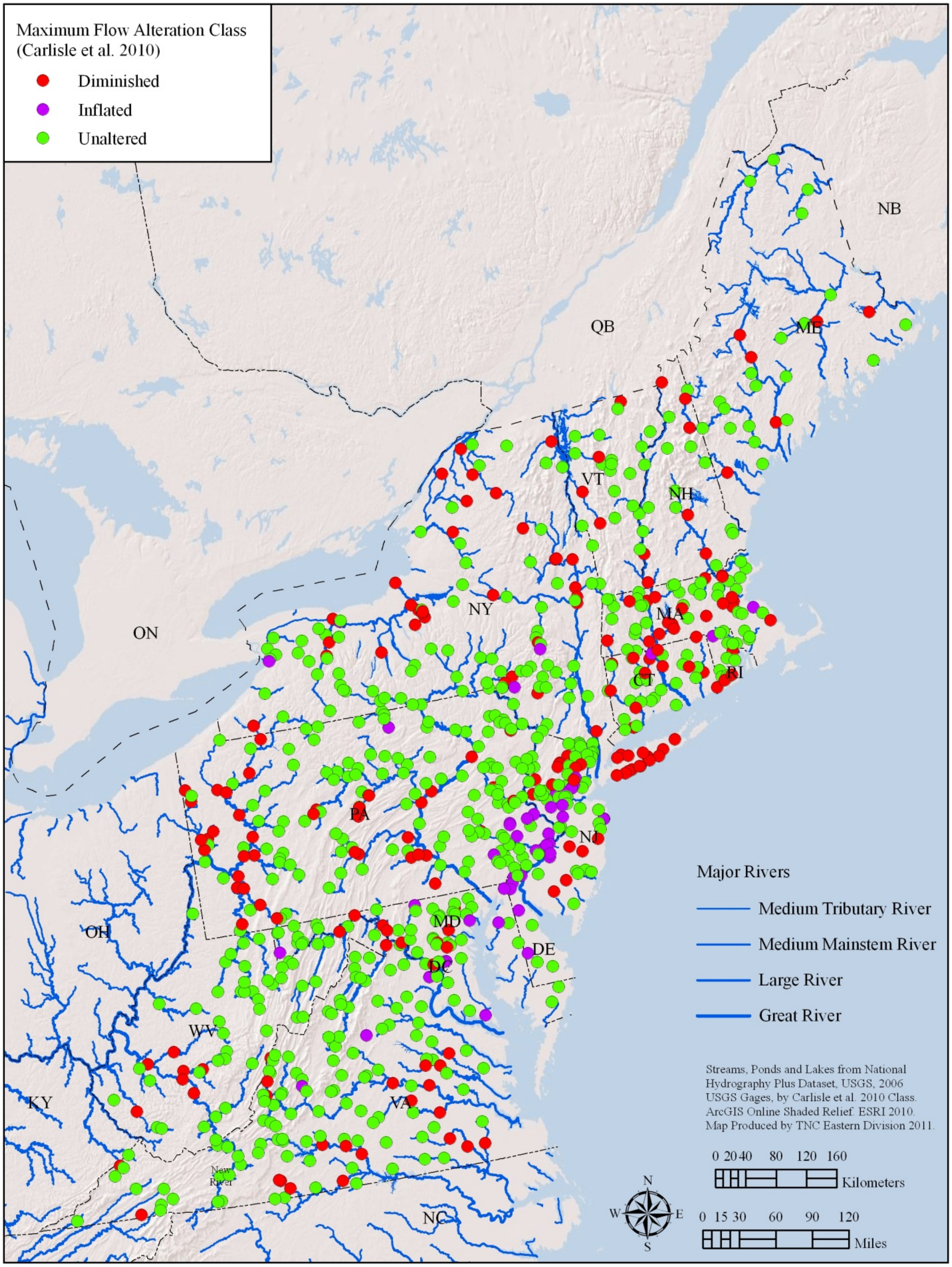
Table 6. Streams and rivers by size class, region or subregion, and flow alteration class.

		Minimum Flows			Maximum Flows		
	Number of Gages	%Diminished	%Inflated	%Unaltered	%Diminished	%Inflated	%Unaltered
Mid-Atl. Headwater	6	33%	17%	50%	17%	33%	50%
Mid-Atl. Creek	81	14%	46%	41%	10%	30%	60%
Mid-Atl. Small River	193	9%	41%	50%	10%	7%	83%
Mid-Atl. Medium Tributary River	154	6%	53%	41%	18%	1%	81%
Mid-Atl. Medium Mainstem River	45	7%	76%	18%	47%	0%	53%
Mid-Atl. Large River	20	0%	95%	5%	60%	0%	40%
Mid-Atl. Great River	6	0%	83%	17%	100%	0%	0%
MID-ATL. TOTAL	505	9%	51%	41%	19%	8%	73%
New Eng./NY Creek	67	34%	28%	37%	28%	6%	66%
New Eng./NY Small River	109	14%	39%	47%	22%	1%	77%
New Eng./NY Medium Tributary River	86	9%	58%	33%	40%	2%	58%
New Eng./NY Medium Mainstem River	31	3%	61%	35%	45%	0%	55%
New Eng./NY Large River	9	0%	100%	0%	100%	0%	0%
NEW ENG./NY TOTAL	302	16%	46%	38%	33%	2%	65%
Headwater	6	33%	17%	50%	17%	33%	50%
Creek	148	23%	38%	39%	18%	19%	63%
Small River	302	11%	40%	49%	14%	5%	81%
Medium Tributary River	240	8%	55%	38%	26%	2%	73%
Medium Mainstem River	76	5%	70%	25%	46%	0%	54%
Large River	29	0%	97%	3%	72%	0%	28%
Great River	6	0%	83%	17%	100%	0%	0%
REGION TOTAL	807	11%	49%	40%	24%	6%	70%

Map 8. Minimum flow alteration class.



Map 9. Maximum flow alteration class.



Impairment to fish communities has been found most prominently at sites with 1) diminished maximum flows, 2) diminished minimum flows, or 3) inflated minimum flows but unaltered maximum flows (Carlisle et al. 2010). Applying these categories to our region (Table 7) suggests likely impacts to fish communities in 61 percent of the region (67 percent of northern sub-region and 58 percent of Mid-Atlantic).

Table 7. Gages by their minimum flow alteration class and maximum flow alteration class.

			Region		New England/New York		Mid-Atlantic	
	Minimum Flow Class	Maximum Flow Class	# of gages	% of gages	# of gages	% of gages	# of gages	% of gages
*	Diminished	Diminished	27	3%	19	6%	8	2%
*	Diminished	Inflated	12	1%	3	1%	9	2%
*	Diminished	Unaltered	52	6%	25	8%	27	5%
*	Inflated	Diminished	136	17%	65	22%	71	14%
	Inflated	Inflated	27	3%	2	1%	25	5%
*	Inflated	Unaltered	233	29%	73	24%	160	32%
*	Unaltered	Diminished	32	4%	16	5%	16	3%
	Unaltered	Inflated	10	1%	2	1%	8	2%
	Unaltered	Unaltered	278	34%	97	32%	181	36%
		Totals	807	100%	302	100%	505	100%

* Combinations most likely to result in impaired fish communities (Carlisle et al. 2010)

Figure 14. Maximum Flow: percentage of altered maximum flows for streams by size class, and region.

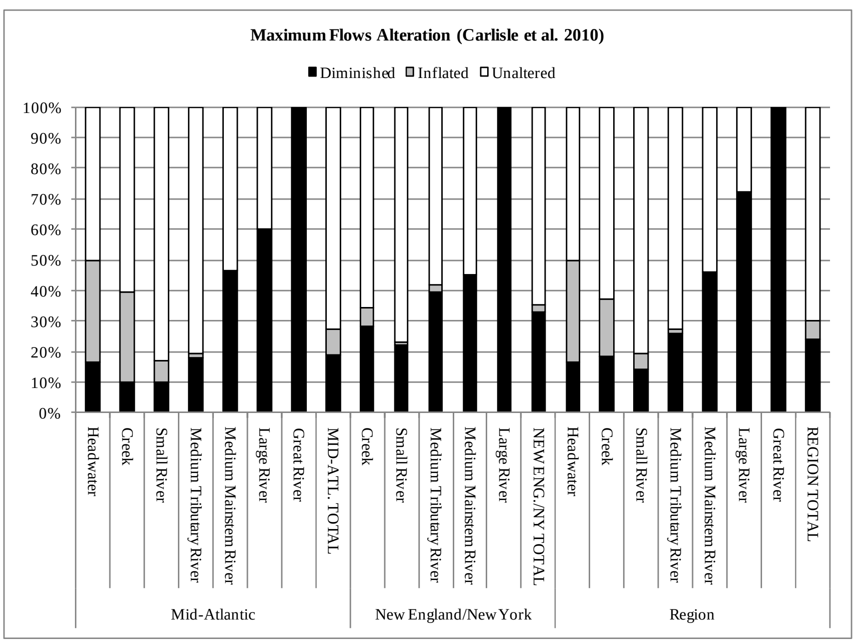
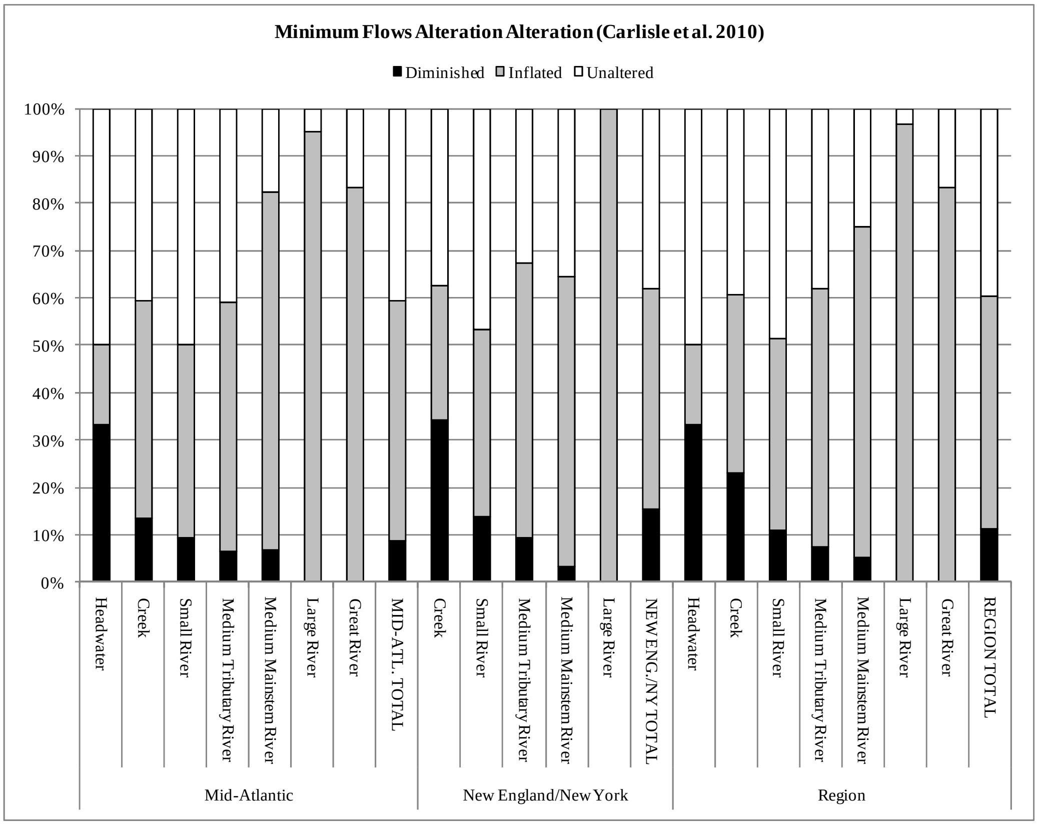


Figure 15. Minimum Flows: percent of altered minimum flows in streams by size class, and region.



Biotic Patterns and Trends

Distribution and Population Status of Native Eastern Brook Trout: Many species of fishes, amphibians, crayfishes, freshwater mussels, and insects have been severely affected by human activities, but few northeastern species have gained as much attention as the native eastern brook trout, a species with strong public appeal. Brook trout is a useful indicator of condition because it integrates water quality and habitat condition, and is typically found where both of these factors are of high quality. Thus, loss of eastern brook trout from streams and watersheds may represent a loss of ecosystem integrity.

Data on the distribution and status of brook trout within the region has been collected by the Eastern Brook Trout Joint Venture (EBTJV) for all watersheds in the region. In small watersheds, where there was no information, the Joint Venture used a GIS model to predict the status of brook trout based on watershed characteristics. Although more data is needed to verify the predicted status of brook trout in these watersheds, we report below the pattern of brook trout distribution and status in the region as in found by the EBTJV model (Hudy et al. 2008, Theiling, 2006).

Results show that brook trout are thought to be extirpated in 26 percent of their historic regional range (Figure 16, Map 10) and reduced in 42 percent of their historic range. There have been higher levels of extirpation in the Mid-Atlantic (44 percent) than in New England and New York (14%). The amount of intact range is a mirror image of that: 14 percent in Mid-Atlantic and 45 percent in New England and New York. The majority of the intact watersheds are found in Maine, New Hampshire, New York, Vermont, and Virginia.

Map 10. Eastern brook trout status.

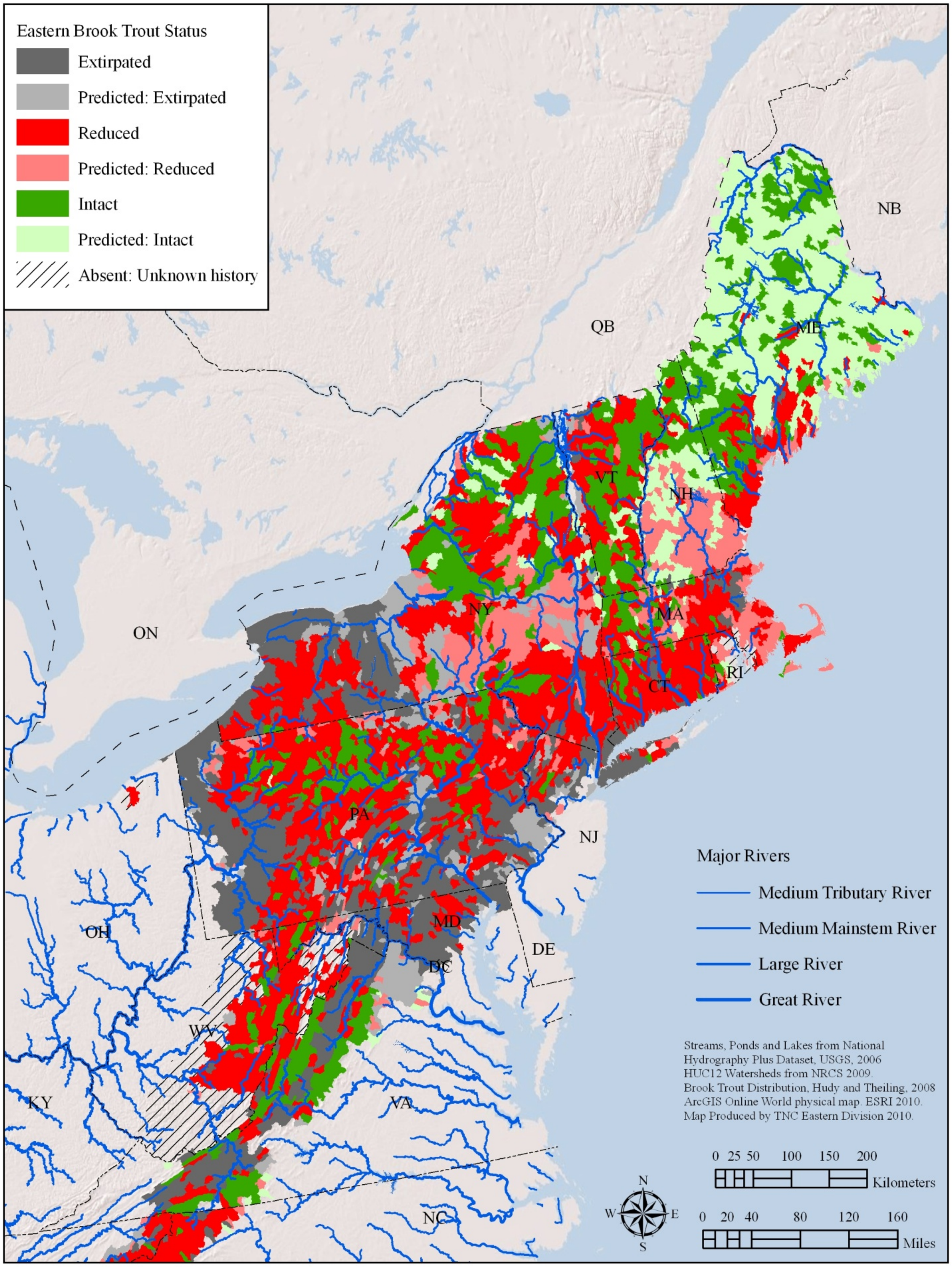
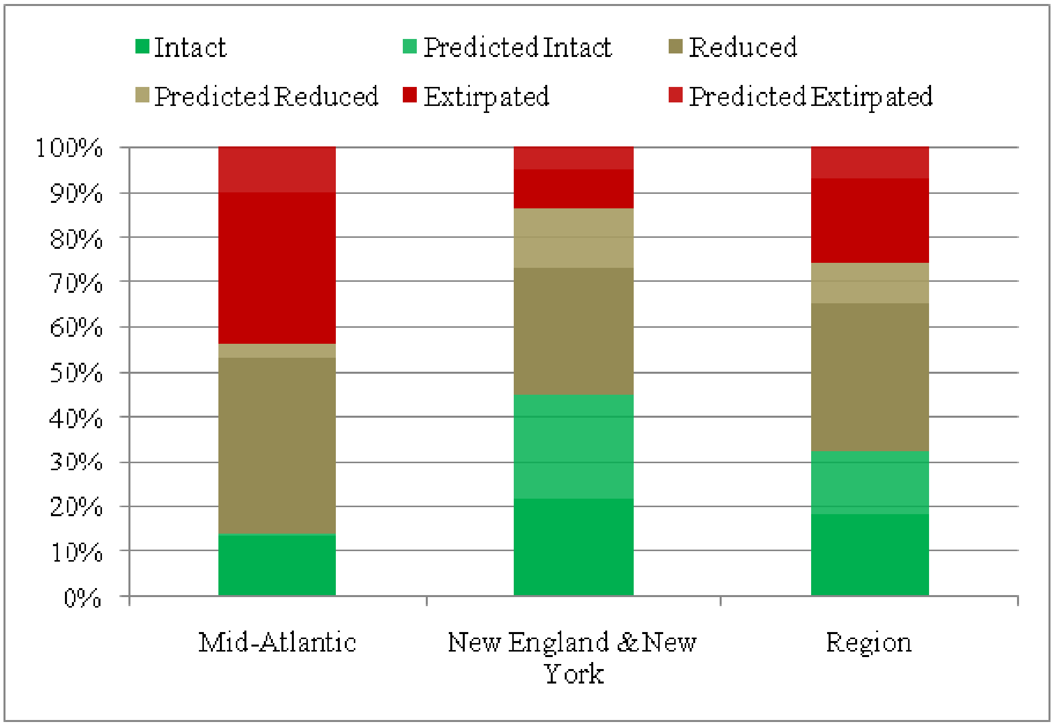


Figure 16. The Percent of the historic brook trout range by current status.

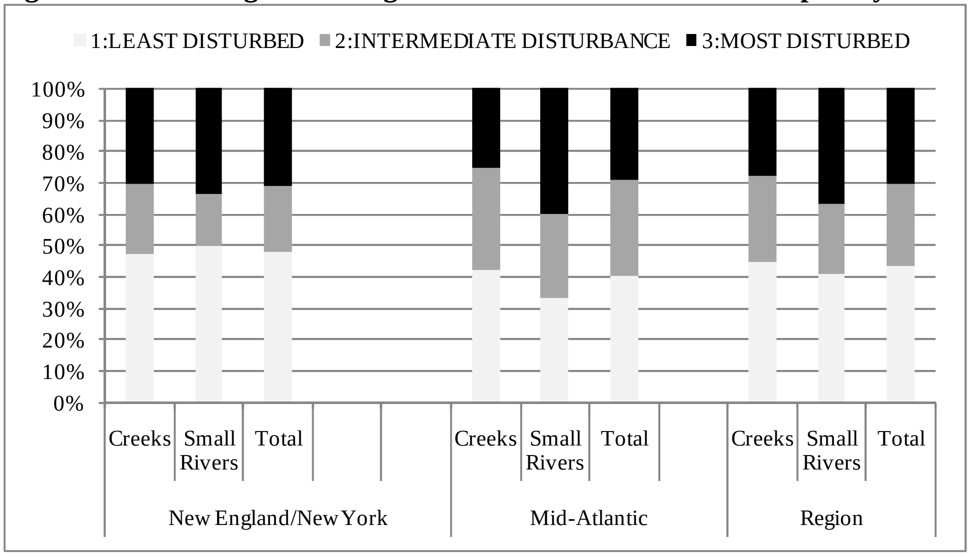


Index of Biotic Integrity: The biological condition of water resources can be assessed by analyzing the characteristics of the benthic organism communities. These characteristics include the composition and relative abundance of key macro-invertebrates that reflect the quality of their environment and respond to human disturbance in predictable ways. The EPA's Index of Biotic Integrity (IBI) based on benthic macro-invertebrates is a multi-metric measure that integrates across many indices describing the benthic community including: taxonomic richness, taxonomic composition, taxonomic diversity, feeding groups, habits, and pollution tolerance. The index is widely used by state and federal agencies to assess the ecological quality of streams, and it has been incorporated into the water quality criteria regulations of some state agencies.

Here we summarize IBI data obtained from the EPA Wadeable Stream Assessment (EPA 2006) for 103 stream sites in our region. This is the only consistently applied and sampled IBI dataset in the region, but it was only dependably collected for wadeable streams, the equivalent of creeks and small rivers in our size classification. An IBI is created by first identifying and counting all benthic macro-invertebrates found from a stream sampling event. Each metric is then tabulated using these raw data. After the metrics are calculated, they are then converted to three categorical scores: A value of "5 -least disturbed" is assigned for the range of expected results (i.e., the score for each metric) in undisturbed sites. A value of "3 -intermediate disturbance" is designated for results expected from a somewhat degraded sites, and a value of "1-most disturbed" is assigned for values expected in severely degraded sites. Several states have developed state specific benthic macro-invertebrate IBI indices, and these can helpful in assessing the state specific conditions.

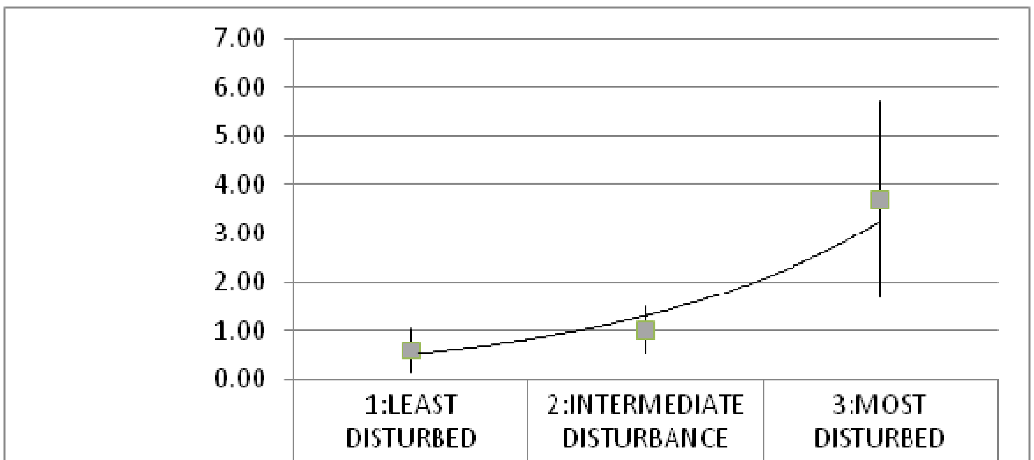
For this region, the EPA results indicated that 44 percent of creeks and small rivers were in the undisturbed class, 26 percent in the intermediate disturbance class and 30 percent in the most disturbed class. Creeks appear to be slightly less disturbed than small rivers (Figure 17). In New England and New York wadeable streams appeared slightly more intact than those of the Mid-Atlantic.

Figure 17. Percentage of the region's EPA wadeable stream samples by benthic IBI class.



Relationship of IBI to Imperviousness Surfaces: We tested whether the IBI score for the sampled streams correlated with the amount of impervious surfaces in the watershed by calculating the mean and standard deviation of impervious surfaces for samples in each of the three disturbance classes (Figure 18). Average impervious surface levels were 0.06 percent for undisturbed, 1.0 percent for the somewhat degraded and 3.7 percent for the severely degraded sites, suggesting a fairly direct relationship described by a slightly exponential relationship (Figure 18). These results support recent research showing impacts to stream biodiversity at very low levels of upstream impervious surfaces.

Figure 18. IBA and impervious surfaces: Mean and confidence interval for the percent of upstream imperviousness surfaces calculated for samples in each IBI disturbance class. Line is an exponential trend line fit to the three points.



	1:LEAST DISTURBED	2:INTERMEDIATE DISTURBANCE	3:MOST DISTURBED
Upper 95% Mean	1.05	1.50	5.73
Lower 95% Mean	0.15	0.53	1.67
Mean	0.60	1.01	3.70

Non-Indigenous Aquatic Species: Non-indigenous aquatic species (NAS) are individuals or populations of a species that enters an aquatic ecosystem outside of its historic or native range. They may be vertebrates, invertebrates, plants, or diseases. Invasive NAS may alter ecosystems by preying on natives, competing with natives, hybridizing with natives, or spreading diseases to native species. NAS may be more likely to become established when stream and watershed conditions are degraded.

The most comprehensive survey of NAS is the USGS Non-indigenous Aquatic Species program that maintains a useful website of information (http://nas.er.usgs.gov/queries/). This site was established as a central repository for accurate and spatially referenced biogeographic accounts of NAS, obtained from a variety of sources such as researchers, field biologists, and fishermen. Because the reports are opportunistic, rather than based on comprehensive surveying, some states have better reporting than others. The reports are also influenced by publications, or lack thereof, and by news coverage, or the news-worthiness, of the species (Fuller, per. com). Data from NAS was extracted and summarized for the region and subregions by Pam Fuller, USGS Nonindigenous Aquatic Species Program, Gainesville, FL as of 1/2011, and we are grateful to her for the charts and summaries in the following section.

Over 300 non-indigenous aquatic species occur in the region and two-thirds of them are fish. The next most common taxa group is mollusks, followed by crustaceans, reptiles, amphibians, annelids, bryozoans, coelenterates, and mammals. This pattern is similar between the two sub-regions (Figure 19). Mapping the results by watershed revealed that there were few areas of the region with less than 5 NAS species (Map 11). These areas include northern Maine, major tributaries of the St. Lawrence and Northeastern Lake Ontario, major tributaries of the Mid-Upper Connecticut River, eastern Chesapeake Bay major rivers, major tributaries of the Allegheny, the Upper Ohio-Beaver, Upper Monongahela, and Lower Kanawha and its major tributaries. In contrast, areas with high number of NAS species include the middle and lower Connecticut River, Housatonic, middle Hudson, lower Susquehanna, mid to lower Potomac, upper Roanoke, New River, and Kanawha. It is important to remember that these patterns partly reflect survey effort.

In addition to the individual species, the NAS program tracks the method of introduction for each species and its location. Summaries of this data show that the most common introduction pathways in the region are stocking, bait release, and shipping, followed by hitch-hiker, aquarium release, canal, pet release, and food release. Stocking and bait release account for over half of the major pathways (Figure 20).

When a species shows up in a new area (state, county, or HUC) and is reported within a year of discovery, it is tracked as an alert by the NAS program. Figure 23 depicts all alerts for each state during the last five years, but does not distinguish the level of that alert. The species may have been found in the state previously but was moved to a new drainage or county, or a species may be totally new to a state. A total of 137 alerts were tracked by NAS over the last five years for the Northeast and Mid-Atlantic area. New York had the highest number of alerts, followed by Maryland and Pennsylvania (Figure 21).

Map 11. Number of Non-indigenous aquatic species per drainage.

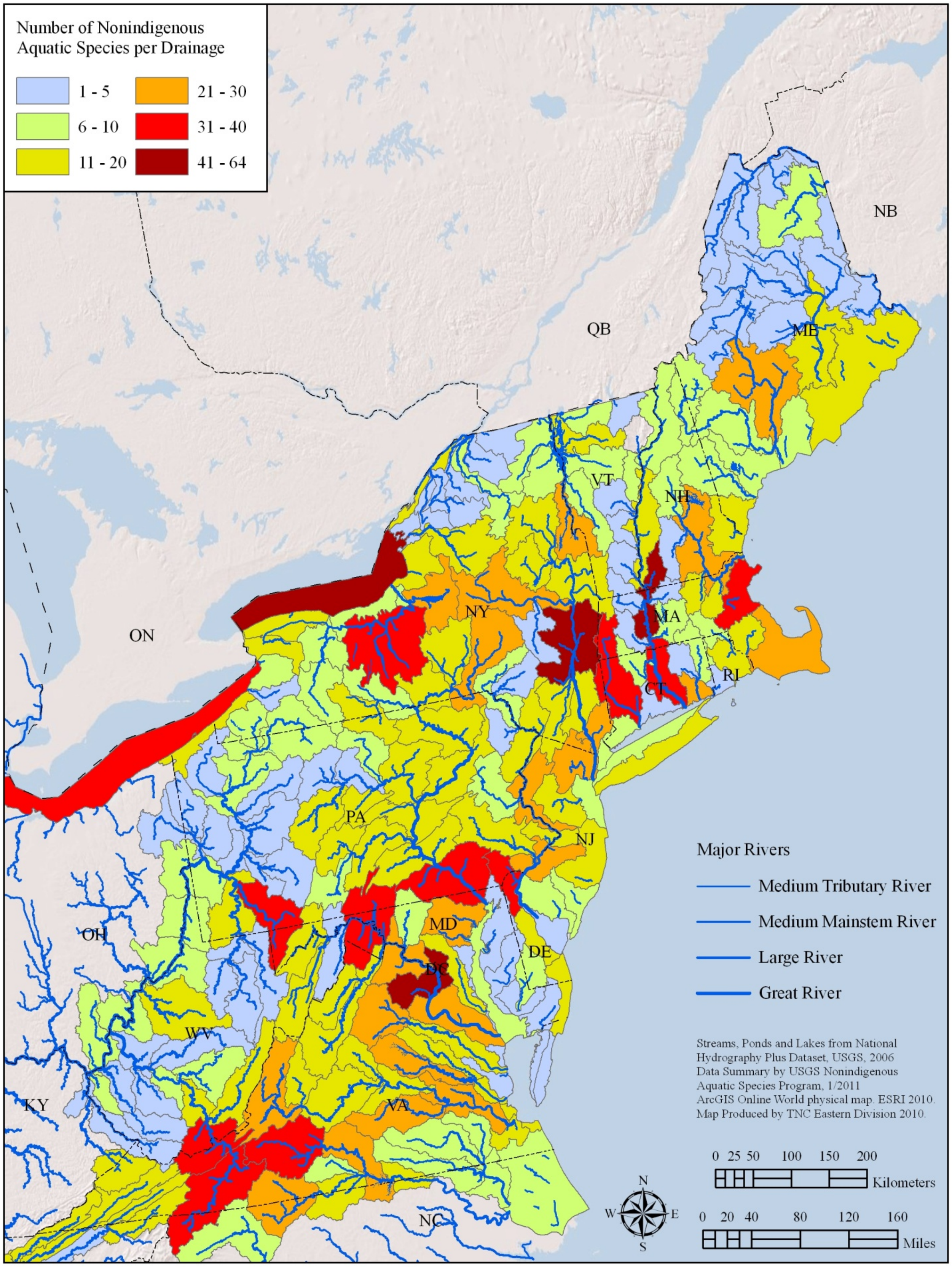


Figure 19. Non-indigenous Aquatic Species. The charts show the major taxonomic groups for the full region and both sub-regions.

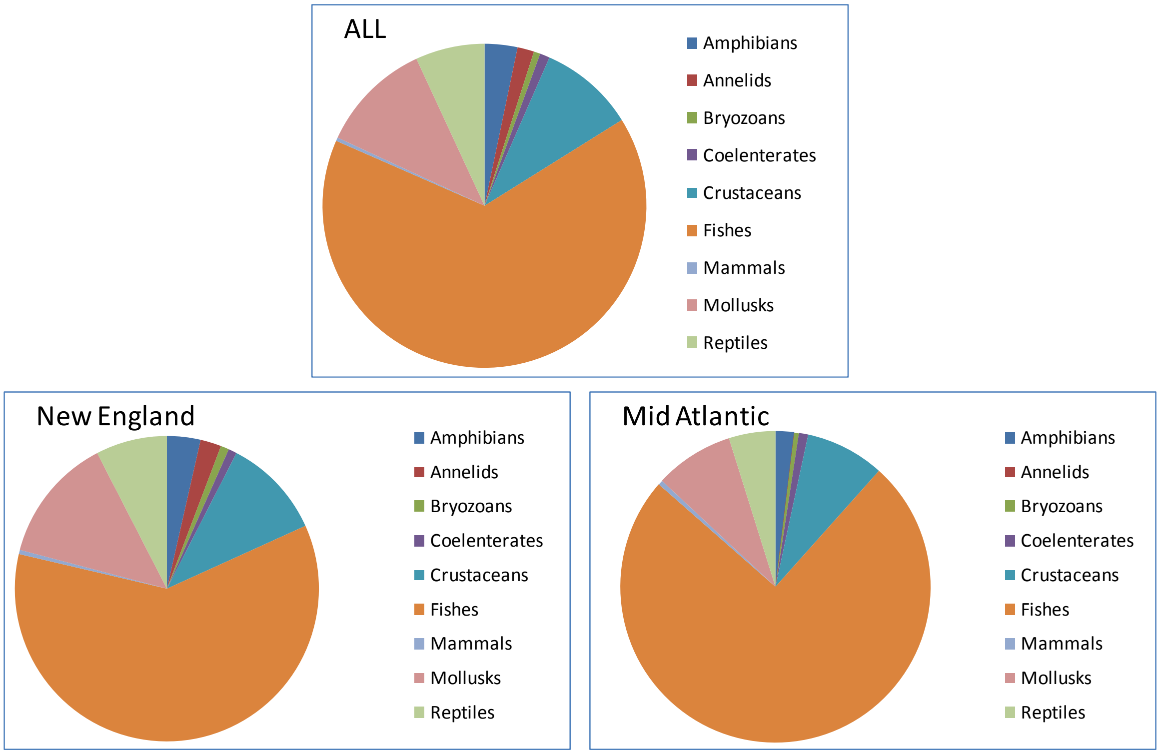


Figure 20: Major pathways of non-indigenous aquatic species introductions.

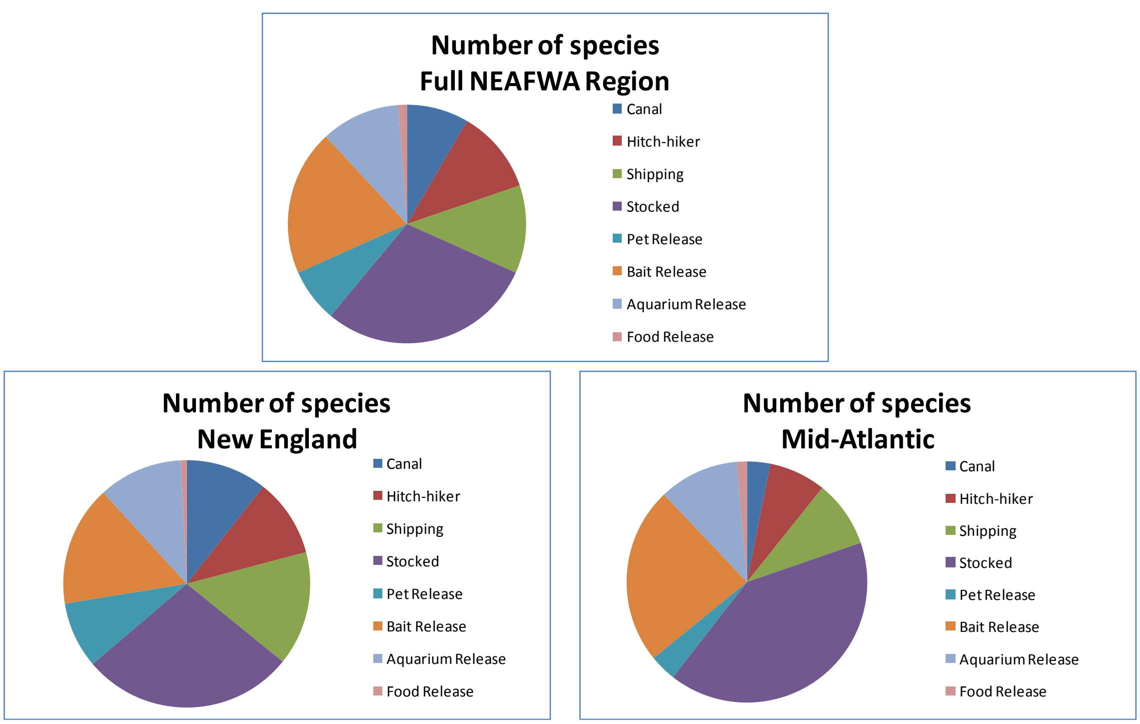
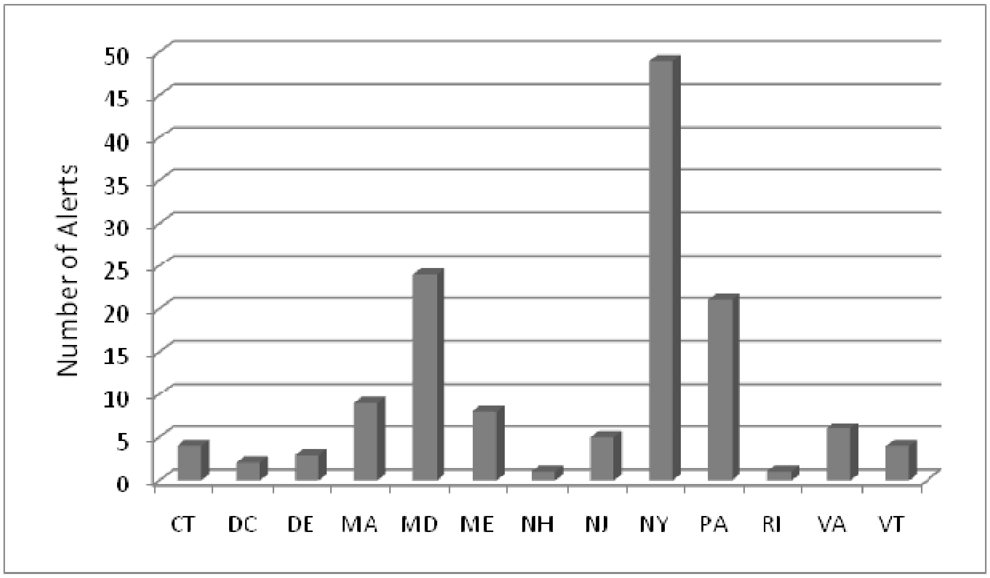


Figure 21. Number of non-indigenous aquatic species alerts by state in alphabetical order.



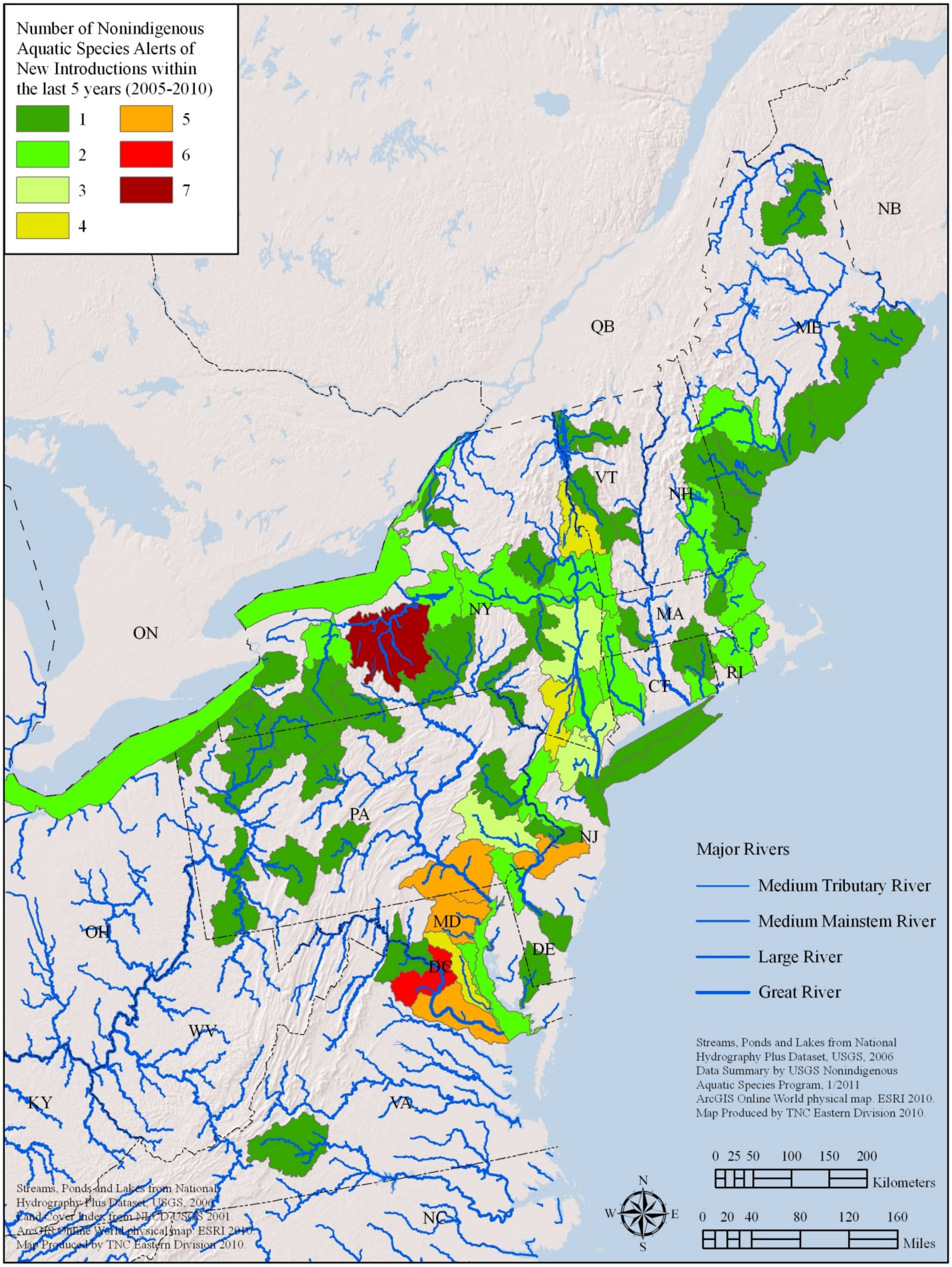
The spatial distribution of alerts by HUC8 watershed (Map 12), shows that watersheds with more than three alerts seem to be associated with the lower mainstems watersheds of large rivers such as the Potomac, Susquehanna, Delaware, and Hudson and in the watersheds of the Finger Lakes and Southern Lake Champlain. Coastal watersheds from Maine through Long Island Sound and along the Great Lakes coast also show a higher proportion of watersheds with low levels of 1-2 alerts. The remaining watersheds have had no alerts reported in the last 5 years. Further work is needed to determine whether areas with reports of more recent invasions share similar characteristics that make them more susceptible to invasion.

Reduction in Native Fish Diversity: The EPA indicator of Fish Faunal Intactness, tracks the completeness of the native freshwater fish fauna in each of the nation's major watersheds by comparing the current faunal composition of those watersheds with their historical composition. We applied this indicator in the Northeast and Mid-Atlantic by looking at the reduction in native species diversity in each major watershed (HUC 8: USGE 8-digit hydrologic cataloging unit). Intactness is expressed as a percent based on the formula:

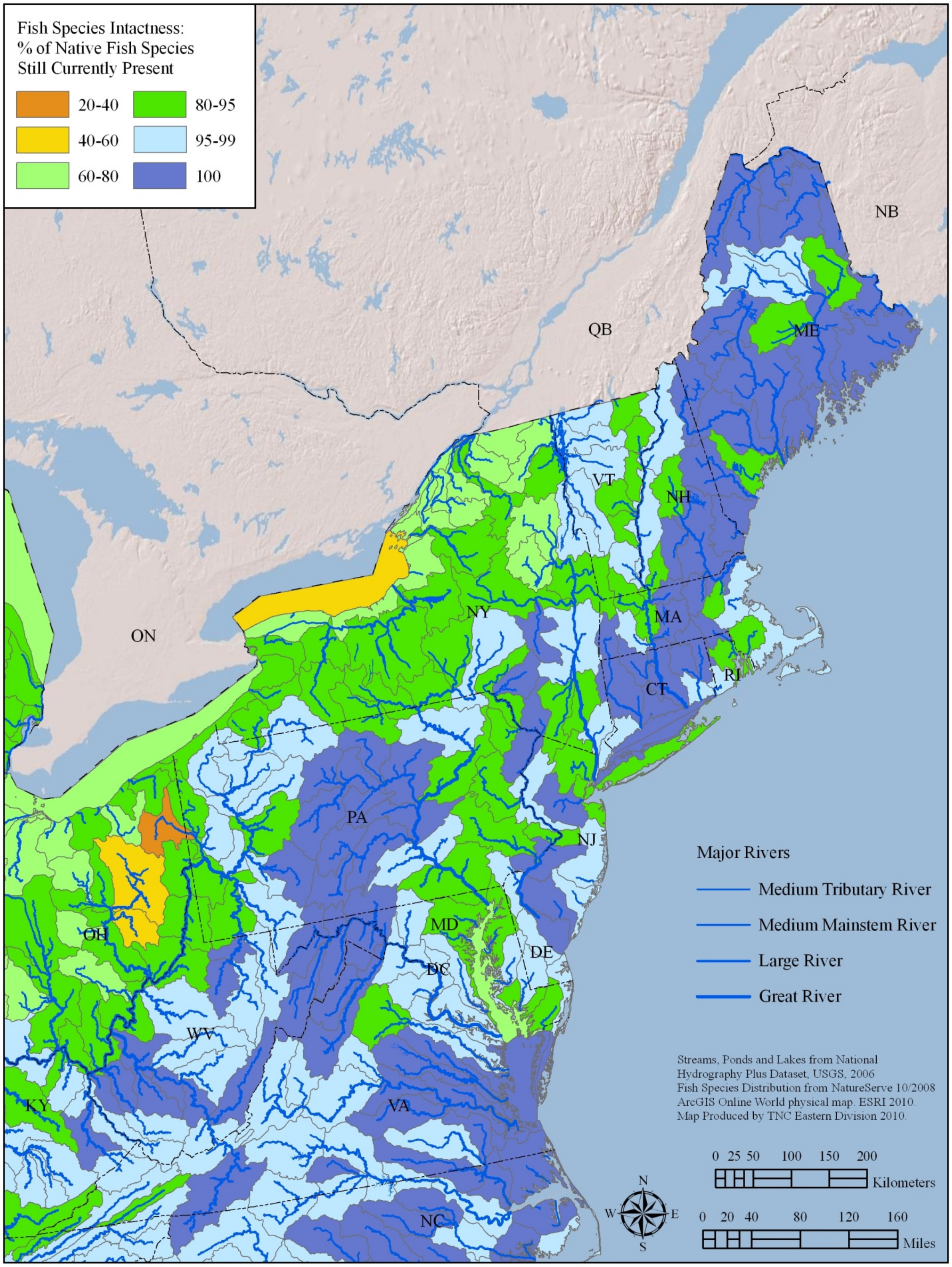
*Fish Faunal Intactness = (# of current native species / # of historic native species * 100)*

Results for this region indicated that the majority of the northeast watersheds still had 95-100% of their native fish species present (Map 13). Areas of less intactness were concentrated in parts of New York State, the Lower Delaware watershed, and the Lower Susquehanna watershed. Although the region appears quite intact, particularly in comparison to other areas of the United States, it is important to note that this indicator does not reflect declines in the populations of native species; it can only highlight where there has been a total extirpation of a species from a watershed. Further work could be done to investigate which watershed characteristics were associated with reductions in fish faunal intactness.

Map 12. Number of non-indigenous aquatic species alerts of new introductions.



Map 13. Fish species intactness.



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Please see the data sources (appendix A) and detailed methods (appendix B) sections of the main report for more information on the data sources and analysis methods used in this chapter.

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Appendix 7-1

Acres of Land within 100m buffer of Streams and Rivers

		Non-Secured Agriculture	Non-Secured Developed	Non-Secured Natural	GAP1&2 Total	GAP 3 Total	Total
CT	Headwater	12,691	32,466	98,530	6,941	17,149	167,778
	Creek	11,348	33,634	68,429	7,197	14,156	134,765
	Small River	2,158	6,951	12,532	2,205	3,199	27,044
	Medium Tributary River	1,476	3,442	7,271	772	2,010	14,971
	Medium Mainstem River	145	2,138	2,348	216	308	5,155
	Large River	7	83	143		18	251
	Great River	311	1,137	4,575	850	947	7,820
	CT Total	**28,135**	**79,851**	**193,829**	**18,182**	**37,787**	**357,784**
DC	Headwater	8	261	53		223	545
	Creek	1	94	10	0	168	274
	Small River	8	403	147		1,130	1,688
	Great River	7	140	109	0	480	736
	DC Total	**24**	**898**	**320**	**1**	**2,002**	**3,244**
DE	Headwater	38,416	3,849	36,225	2,548	7,866	88,904
	Creek	14,116	3,559	25,915	2,363	5,886	51,839
	Small River	1,083	975	7,724	902	2,303	12,986
	Medium Tributary River	180	780	1,020	75	469	2,524
	Great River	218	409	2,443	1,417	1,742	6,230
	Total	**54,014**	**9,572**	**73,327**	**7,305**	**18,265**	**162,483**
MA	Headwater	16,733	40,029	129,203	7,123	46,130	239,218
	Creek	14,157	35,924	90,310	6,057	36,532	182,980
	Small River	4,279	12,823	22,509	2,181	9,960	51,753
	Medium Tributary River	2,408	6,194	11,232	906	2,574	23,313
	Large River	1,575	3,469	4,983	165	1,031	11,223
	MA Total	**39,153**	**98,438**	**258,237**	**16,432**	**96,227**	**508,486**
MD	Headwater	124,498	34,934	181,365	11,836	34,710	387,343
	Creek	67,347	20,954	130,085	11,116	25,259	254,762
	Small River	25,326	10,580	55,584	8,729	16,683	116,902
	Medium Tributary River	12,289	6,995	25,563	5,273	9,264	59,384
	Medium Mainstem River	13	5	366	1,159	522	2,066
	Large River	71	75	973	2,994	184	4,297
	Great River	2,629	830	6,015	1,692	1,443	12,608
	MD Total	**232,173**	**74,373**	**399,951**	**42,800**	**88,065**	**837,362**
ME	Headwater	26,208	25,364	667,134	31,318	87,284	837,309
	Creek	21,574	25,802	628,849	25,284	106,525	808,034
	Small River	7,468	8,971	133,569	7,896	22,928	180,833
	Medium Tributary River	4,455	5,447	52,177	8,331	11,613	82,023
	Medium Mainstem River	4,394	5,328	31,887	3,957	3,657	49,223
	Large River	1,789	3,846	16,663	203	898	23,400
	ME Total	**65,888**	**74,759**	**1,530,280**	**76,990**	**232,905**	**1,980,822**

	Non-Secured Agriculture	Non-Secured Developed	Non-Secured Natural	GAP1&2 Total	GAP 3 Total	Total
NH						
Headwater	11,847	20,112	176,731	19,809	56,973	285,471
Creek	11,380	21,731	130,752	17,178	50,014	231,055
Small River	4,331	10,158	29,964	1,589	10,973	57,015
Medium Tributary River	3,028	4,678	11,363	767	3,638	23,474
Medium Mainstem River	2,436	3,050	6,222	362	2,725	14,794
Large River	662	638	2,271	113	404	4,088
NH Total	**33,684**	**60,366**	**357,302**	**39,817**	**124,728**	**615,898**
NJ						
Headwater	40,002	38,538	114,884	52,140	6,167	251,729
Creek	23,107	32,563	92,562	43,278	6,087	197,597
Small River	6,659	12,835	28,035	14,551	3,107	65,187
Medium Tributary River	678	4,399	6,703	3,925	877	16,582
Medium Mainstem River	85	293	747	2,116		3,241
Large River	379	1,623	2,825	1,554	91	6,472
Great River	418	1,148	1,383	1,896		4,845
NJ Total	**71,327**	**91,399**	**247,139**	**119,460**	**16,329**	**545,654**
NY						
Headwater	387,598	102,951	834,985	143,408	135,447	1,604,388
Creek	283,157	120,559	710,909	116,707	92,276	1,323,608
Small River	64,718	41,135	169,043	25,168	17,730	317,794
Medium Tributary River	33,342	18,676	88,452	8,176	7,779	156,424
Medium Mainstem River	10,409	10,654	31,202	1,137	2,794	56,196
Large River	2,159	4,230	10,174	709	1,400	18,672
Great River	304	2,310	5,038	372	1,517	9,540
NY Total	**781,687**	**300,514**	**1,849,803**	**295,677**	**258,943**	**3,486,623**
PA						
Headwater	396,715	183,735	908,563	40,536	234,414	1,763,962
Creek	250,149	170,118	622,399	30,390	146,305	1,219,361
Small River	64,236	49,880	179,585	8,766	19,867	322,335
Medium Tributary River	19,206	21,029	79,239	8,237	9,569	137,281
Medium Mainstem River	3,742	11,355	31,401	3,220	4,144	53,862
Large River	5,334	10,246	22,867	1,881	801	41,128
Great River	1,597	9,027	11,779	163	1,312	23,877
PA Total	**740,979**	**455,390**	**1,855,832**	**93,193**	**416,413**	**3,561,806**
RI						
Headwater	1,947	6,248	20,744	1,739	4,817	35,496
Creek	1,223	5,372	10,116	1,305	5,061	23,077
Small River	312	2,103	2,437	135	718	5,705
Medium Tributary River	167	2,550	1,689	422	227	5,054
RI Total	**3,650**	**16,273**	**34,986**	**3,601**	**10,823**	**69,332**
VA						
Headwater	286,251	98,235	921,715	34,445	96,551	1,437,197
Creek	225,546	91,485	655,851	29,664	56,777	1,059,323
Small River	67,698	29,400	194,184	5,829	10,909	308,019
Medium Tributary River	30,700	11,577	100,651	1,617	6,962	151,507
Medium Mainstem River	18,642	6,571	57,072	1,154	7,141	90,579
Large River	5,890	3,130	20,094	486	3,712	33,312
Great River	2,252	1,245	5,053	385	951	9,886
VA Total	**636,980**	**241,641**	**1,954,620**	**73,579**	**183,003**	**3,089,823**

	Non-Secured Agriculture	Non-Secured Developed	Non-Secured Natural	GAP1&2 Total	GAP 3 Total	Total
VT						
Headwater	23,978	13,844	129,142	7,491	25,117	199,571
Creek	46,325	29,739	151,341	10,052	31,935	269,392
Small River	18,420	11,697	29,041	1,617	3,747	64,522
Medium Tributary River	9,480	5,789	13,164	996	828	30,256
Medium Mainstem River	2,058	1,154	2,788	82	164	6,246
Large River	976	735	1,775	248	74	3,808
VT Total	**101,237**	**62,957**	**327,251**	**20,486**	**61,865**	**573,795**
WV						
Headwater	91,485	106,060	662,596	7,590	78,989	946,720
Creek	82,892	110,604	381,849	5,992	47,570	628,908
Small River	29,228	36,935	103,869	765	21,393	192,191
Medium Tributary River	16,371	21,238	63,406	515	8,378	109,907
Medium Mainstem River	5,685	9,557	23,586	6	3,245	42,080
Large River	728	3,726	6,661	7	4,049	15,171
Great River	3,684	6,887	6,742		1,762	19,074
WV Total	**230,073**	**295,007**	**1,248,708**	**14,875**	**165,387**	**1,954,050**
Region Total	**3,019,004**	**1,861,437**	**10,331,585**	**822,396**	**1,712,740**	**17,747,162**

CHAPTER

8

Lakes and Ponds

Condition and Conservation Status

April 2011

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Lakes and ponds are bodies of standing water with a discernible shoreline. Collectively, the region's 33,744 waterbodies have a surface area of 2.8 million acres (over twice the area of Delaware), and they range in size from small ponds to huge lakes over 10,000 acres. Here we review the characteristics of lake and pond systems, examine their loss, degradation, and conservation, and assess the implication of these trends to wildlife. Note that although lakes are commonly fed and drained by streams, flowing water systems have different properties and are assessed separately in the river section of this report.

Summary of Findings

Distribution, Loss, and Protection: Of the regions 34 thousand waterbodies, 13 percent are fully secured against conversion to development. Small lakes, 10 to 100 acres in size, have the highest level of securement (16 percent), while very large lakes over 10,000 acres have the least (4 percent).

Shoreline Conversion: Forty percent of the region's waterbodies have severe disturbance impacts in their shoreline buffer zones, reflecting high levels of development, agriculture, and roads in this ecologically sensitive area. However, shoreline zones also have a high level of securement and in most lake types the amount of securement exceeds the amount of conversion. The exception is in ponds where conversion outweighs securement 2:1.

Roads, Impervious Surfaces, and Dams: Lakes and ponds in this region are highly accessible; only seven percent are over one mile from a road and 69 percent are less than one tenth of a mile from a road, suggesting that most are likely to have non-native species. In spite of this, half of the waterbodies in the region have less than one percent impervious surfaces in their direct watershed. On the other hand, 11 percent have such a high degree of impervious surfaces (over 10 percent of their watershed) that they are likely experiencing severe impacts including a loss of diversity and an increase in chemical pollutants. Dams are fairly ubiquitous, 70 percent of the very large lakes, 52 percent of the large lakes, and 35 percent of the medium size lakes, have dams associated with them and are likely to be somewhat altered in terms of temperature and water levels.

Biological Integrity: Over half of our small to large waterbodies have lost over 20 percent of their expected plankton and diatom taxa, and over a third have lost over 40 percent. In small lakes this correlates roughly, but not significantly, with the amount of shoreline conversion. Recently, common loons, indicators of high quality lake habitats, have been producing slightly less chicks per breeding pair than the estimated 0.48 needed to maintain a stable population.

Waterbody Types and Associated Species

Lakes and ponds provide habitat to thousands of species, the types of which depend on the characteristics of the waterbody; and waterbodies differ substantially in size, depth, shape, water properties (clarity, color, pH, nutrient level), and in their location in the stream network. While these characteristics shape the identity of their flora and fauna, total surface area is the best predictor of overall species richness.

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A wide variety of plant and animal life rely on lakes and ponds for primary habitat. Typical plants range from sponges, mosses and algae, to an array of specialized rooted plants such as: spatterdock, pondweed, duckweed, stonewort, fanwort, hornwort, elodea, water milfoil, water lily, and lotus. Standing water supports a wide variety of microscopic animals, worms and insects, the larval stages of midges, mosquitoes, dragonflies, and damselflies, and freshwater snails, mussels, and clams. The rich invertebrate fauna in turn supports a wide range of amphibian, reptiles, fish and birds. In addition to the lake proper, the shoreline habitat provides feeding and breeding areas for great blue heron, black-crowned night heron, green heron, kingfisher, bald eagle, osprey, cormorants, spotted sandpiper, red-winged blackbirds, and mammals such as moose and mink.

Herptiles: mudpuppy, spotted salamander, red-spotted newt, bullfrog, leopard frog, green frog, pickerel frog, eastern painted turtle, Blanding's turtle, common water snake

Fish: bluegill, pumpkinseed, black crappie, golden shiner, yellow perch, chain pickerel, largemouth bass, brown bullhead. **Coldwater fish (deep lakes):** lake trout, brook trout, rainbow smelt, burbot, landlocked Atlantic salmon

Birds: mallard, blue-winged teal, green-winged teal, wood duck, ruddy duck, pied-billed grebe, hooded merganser, bufflehead, common goldeneye, redhead, lesser scaup, and common loon.

Waterbody size may be thought of as a gradient within which multiple habitat types can exist, so larger lakes tend to contain a wider diversity of habitat types and support a broader suite of species (Minns 1989, Tonn & Magnuson 1982). In this report, we distinguished between ponds (waterbodies less than10 acres in size) and lakes (waterbodies 10 acres or larger) because the small size of ponds has a direct influence on the physical components of their ecosystem. Ponds are shallow enough to have light penetration throughout, supporting rooted plant growth from shore to shore, and their waters do not stratify by temperature (e.g. they are monomictic). Lakes are more likely to become temperature stratified in the summer (dimictic), and usually have deep areas without enough light penetration to support plants. In addition to ponds, we report on four size classes of lakes, each increasing by an order of ten (Map 1):

- ponds 0 -<10 acres
- small lakes 10 -<100 acres
- medium lakes 100 -<1000 acres
- large lakes 1,000 -< 10,000 acres
- very large lakes 10,000 or more acres

While there are true biological differences between the small and large lakes, these size classes do not necessarily reflect any biologically identified thresholds, rather this is simply a common and practical way to summarize the lakes in this region. These size classes match the lake classification in the Northeast Aquatic Habitat Classification System (Olivero and Anderson 2008) and those used by New Hampshire DES and Maine DEP.

Distribution, Loss, and Protection Status

Lakes and ponds are primarily features of the glaciated northern region, and currently, two thirds of the individual lakes and 83 percent of the lake area are in New England and New York (Map 1). While the northern region has most of the large lakes, the 18,000 ponds are fairly evenly spread among the two sub-regions. Ponds, however, account for only 3 percent of the lake area. In contrast, the 331 large lakes make up 62 percent of the total surface area (Figure 1, Table 1).

Map 1. Lakes by size class.

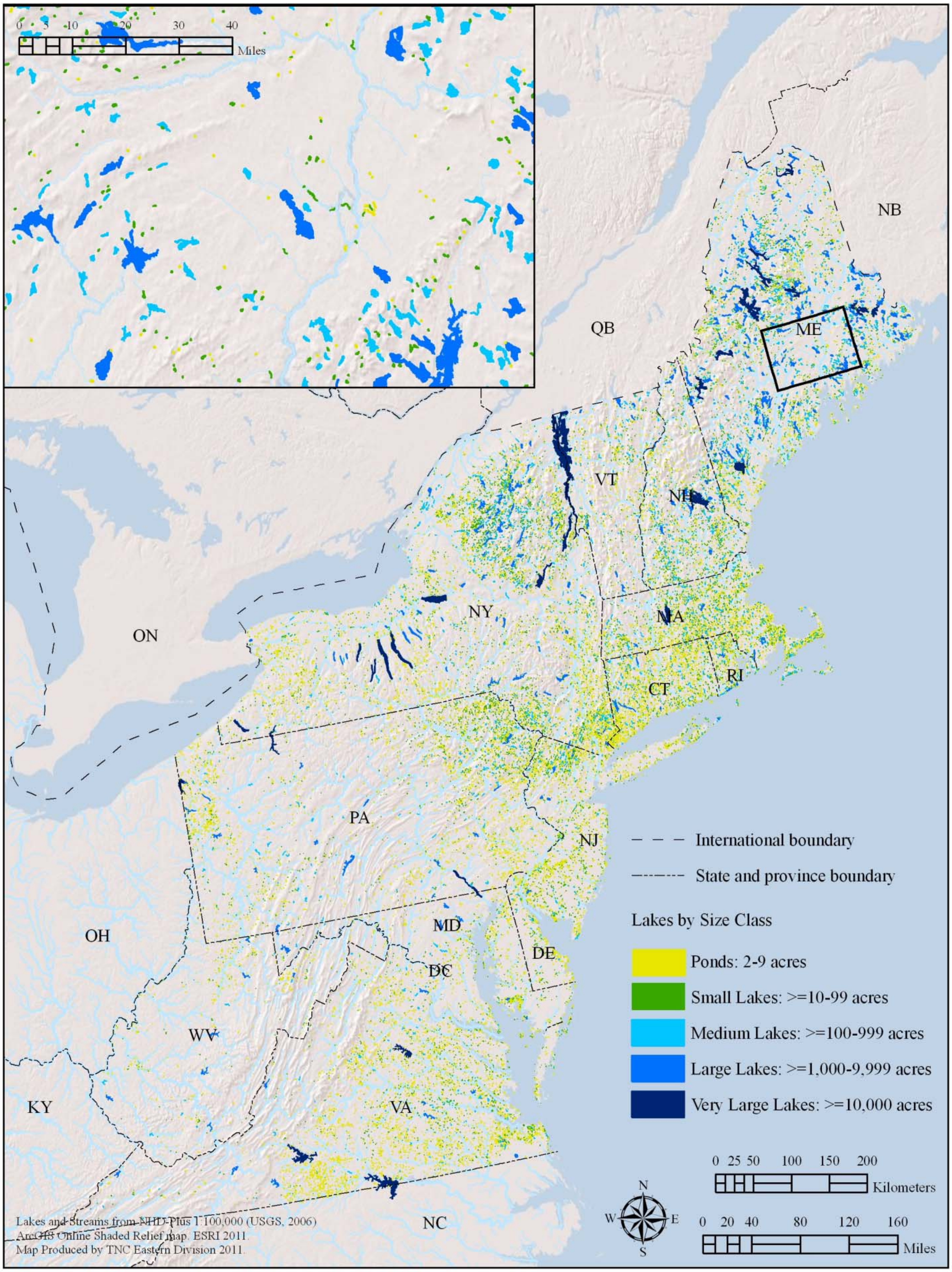


Figure 1. The area of lakes and ponds (in acres) in the region and sub-regions.

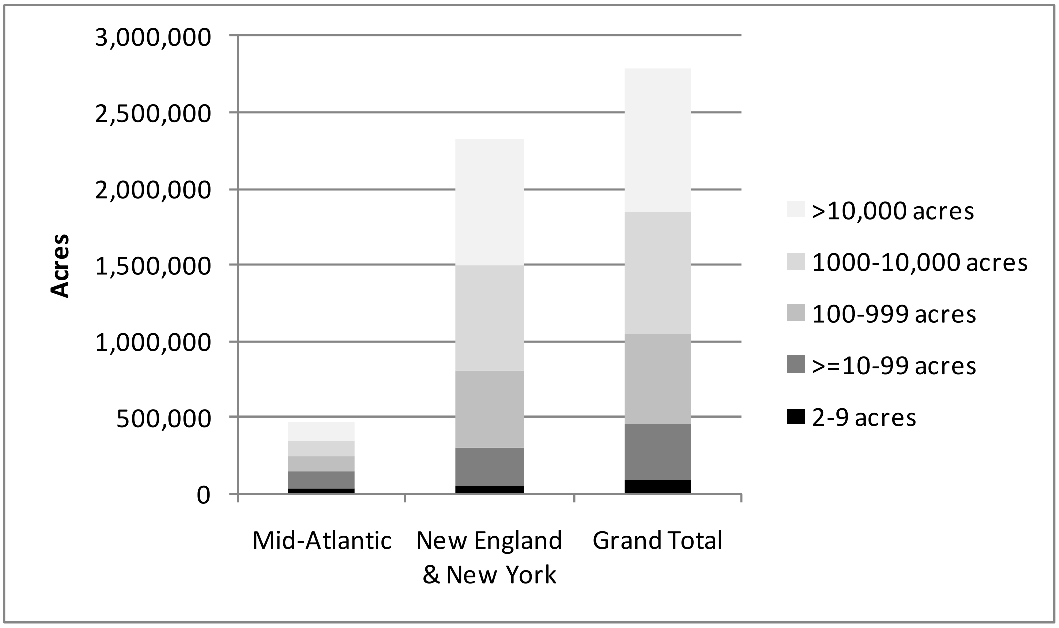


Table 1. Number and acreage of lakes and ponds in the region (also see Map 1).

	Ponds: 2-9 ac.		Small Lakes: 10-99 ac.		Medium Lakes: 100-999 ac.		Large Lakes: 1,000-10,000 ac.		Very Large Lakes: >10,000 ac.		Grand Total	
	Number	*Acres*	Number	*Acres*	Number	*Acres*	Number	*Acres*	Number	*Acres*	Number	*Acres*
Mid-Atlantic	8582	*39,921*	4272	*111,504*	379	*96,164*	43	*96,520*	6	*124,405*	13282	*468,514*
New England & New York	9791	*49,128*	8563	*252,059*	1825	*502,484*	262	*697,153*	21	*816,406*	20462	*2,317,231*
Grand Total	18373	*89,050*	12835	*363,563*	2204	*598,648*	305	*793,674*	27	*940,811*	33744	*2,785,746*

Securement Status: Many of the region's lakes and ponds occur on land that is protected, or at least secured from development. To assess how many, we overlaid the TNC secured lands dataset on the 100 m buffer zone surrounding each waterbody, and tabulated the amount of securement within the buffer (TNC 2009). This method was used because in the GIS data water was often clipped out of the secured land boundary.

In total, 24 percent of lake and pond buffer *acreage* was secured against conversion, and this was distributed among individual waterbodies such that 13-19 percent of them could be considered secured. We defined a secured waterbody as one that had 50 percent of its buffer secured (high estimate) or 90 percent of its buffer secured (low estimate). By the high estimate, 19 percent of all ponds and lakes were secured, including 15 percent of all ponds, and over 20 percent of all other size classes (Figure 2). By the low estimate, 13 percent of all waterbodies were fully secured including 11 percent of ponds, 16 percent of small lakes, and a steadily declining percentage of the other size classes (Figure 2). Thus, by the conservative estimate, 87 percent of the region's waterbodies had some unsecured buffer, and only one of the 27 very large lakes was fully secured (Figure 2). The Mid-Atlantic had a higher percentage of ponds and lakes with no securement (81 percent) than New England and New York (61 percent). Additionally, a larger proportion of lakes were protected than ponds (Map 2).

Map 2. Percentage of pond or lake buffer in secured land.

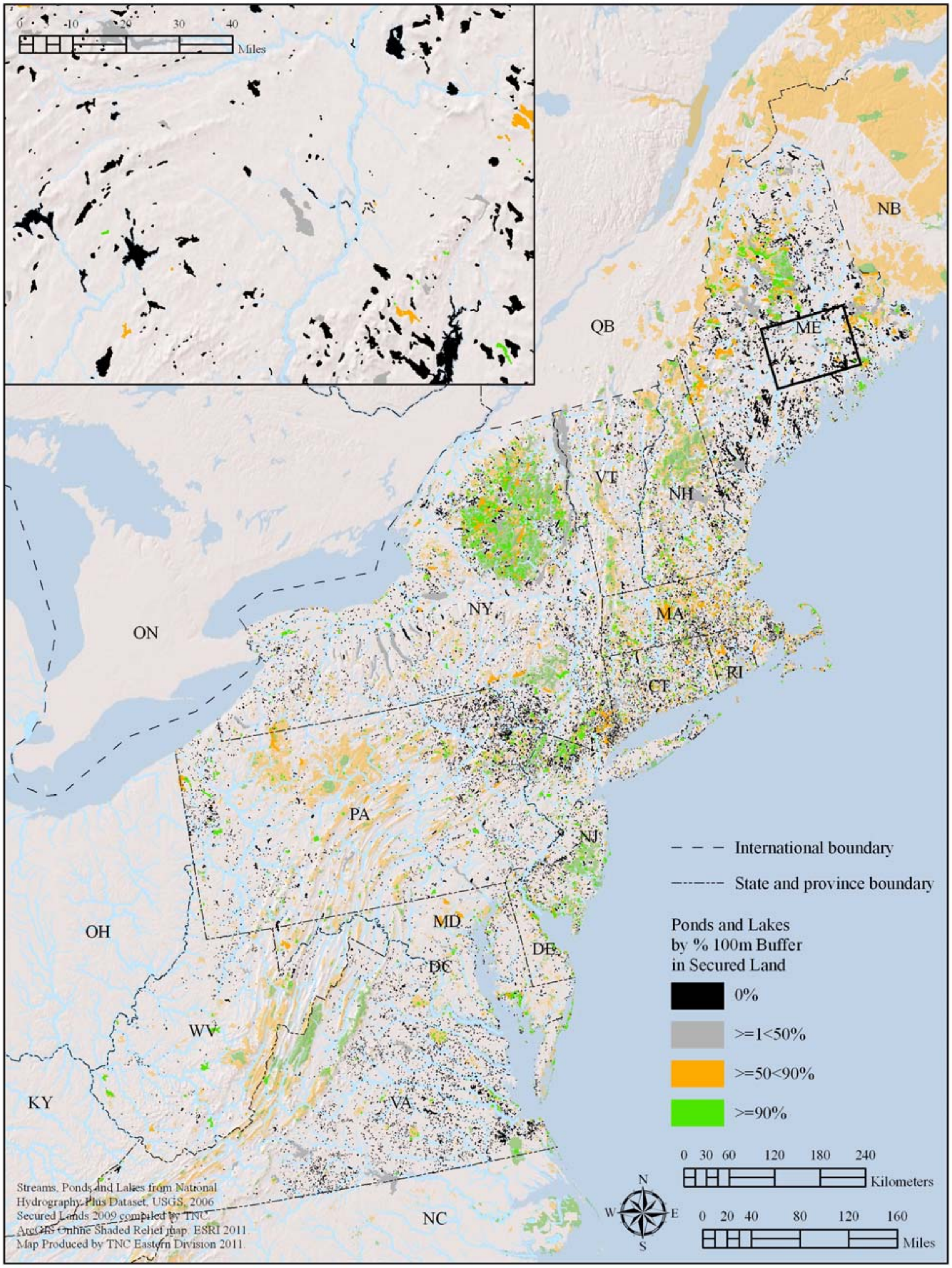
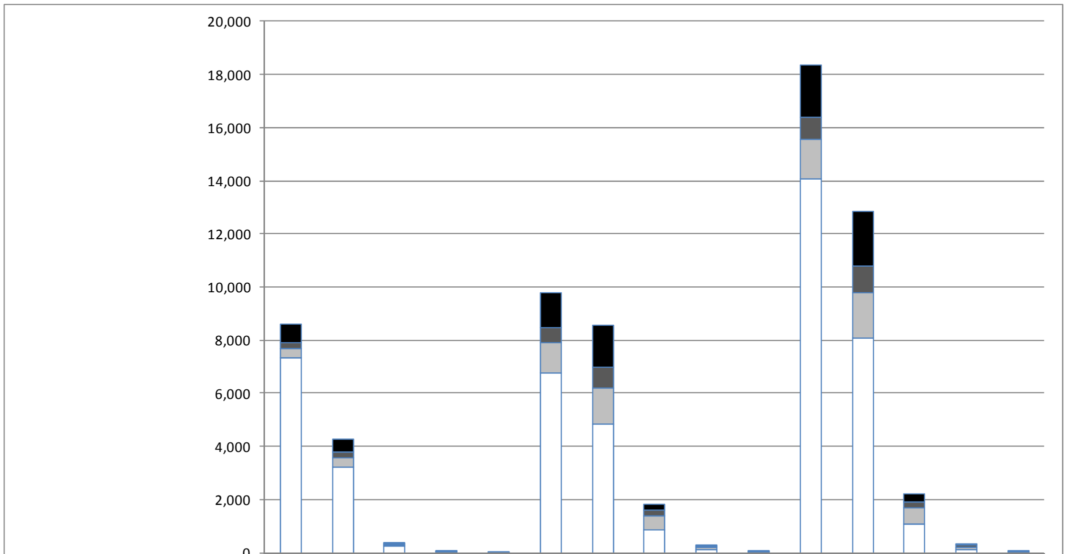


Figure 2. Conservation status of lakes and ponds by individual occurrences. Note that water bodies do not always fall completely inside or outside the secured land boundaries. For our purposes a feature may be considered secured if greater than 50-90 percent of the buffer is within secured land. We calculated the amounts for > 50 and >90 percent, but most fall somewhere below that.



	Mid Atlantic					NE / NY					Region				
	Ponds	Small Lakes	Medium Lakes	Large lakes	Very Large Lakes	Ponds	Small Lakes	Medium Lakes	Large lakes	Very Large Lakes	Ponds	Small Lakes	Medium Lakes	Large lakes	Very Large Lakes
4. Buffer>=90% Secured	695	495	67	16		1,302	1,569	223	13	1	1,997	2,064	290	29	1
3. Buffer>=50% <90% Secured	203	198	24	8	2	602	799	217	55	3	805	997	241	63	5
2. Buffer>=1% <50% Secred	370	348	62	10	4	1,142	1,368	526	101	17	1,512	1,716	588	111	21
1. Buffer 0% Secured	7,314	3,231	226	9		6,745	4,827	859	93		14,059	8,058	1,085	102	

<u>Conversion in the Shoreline Buffer Zone:</u> Farming and home development along lake shorelines has a variety of impacts on lake ecosystems. These may include declines in fish abundance and diversity, loss of reptiles and amphibian diversity, and avoidance by loons (depending on the extent and intensity of development). For an accessible discussion of the unique impacts of shoreline development, and recommendations for shoreline management, see “Crafting a Lake Protection Ordinance” by Karen Cappiella and Tom Schueler: http://yosemite.epa.gov/r10/water.nsf/Ordinance.pdf.

Although any amount of development in the shoreline may cause disruption to some component of a lake or pond ecosystem, we sought to apply the reporting thresholds for shoreline development used by the National Lake Assessment. To do this, we first measured amount of agriculture and developed land within the 100 m buffer of each lake using the National Land Cover 2001 land cover map (Homer et al. 2004), and created a numeric impact index by totaling the percent of development and agriculture in the buffer zone, after weighting the categories to reflect the degree of impact:

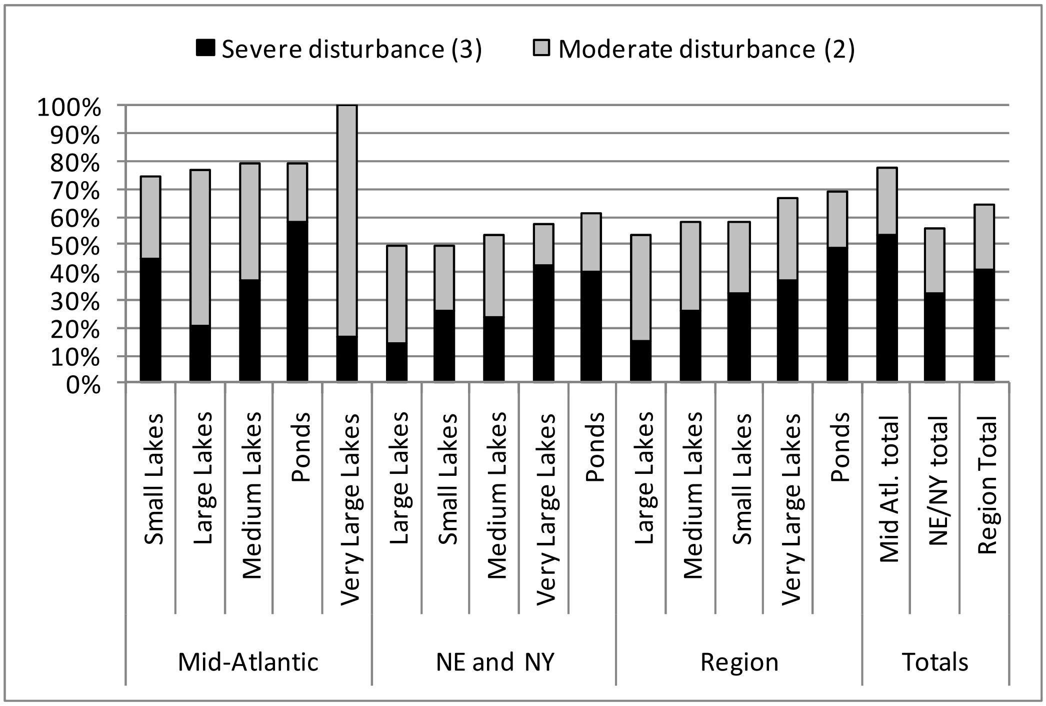
> *0.5 * % agriculture + 0.75* % low intensity development+ 1.0* % high intensity development* (NLCD cover classes 81/82, 21/22, 23/24).

The summed impact index ranged from 100 for a lake with its shoreline completely developed, to 0 where the shoreline was completely composed of natural cover types. To develop classes, we compared the impact index scores against the field measured scores of shoreline human disturbance for 188 lakes sampled by the National Lake Assessment (EPA National Lake Assessment 2009) in our region. We related the two independent measurements using a regression analysis. The field-measured scores had a statistically significant relationship to the GIS-based impact index (R squared = 0.56, p < 0.0001, log scale). Lastly, to create the classes, we calculated the mean and standard deviations of the impact index for lakes in each of the three disturbance categories reported by the National Lake Assessment. For thresholds between classes, we took the numeric value halfway between the means (transformed to a linear scale):

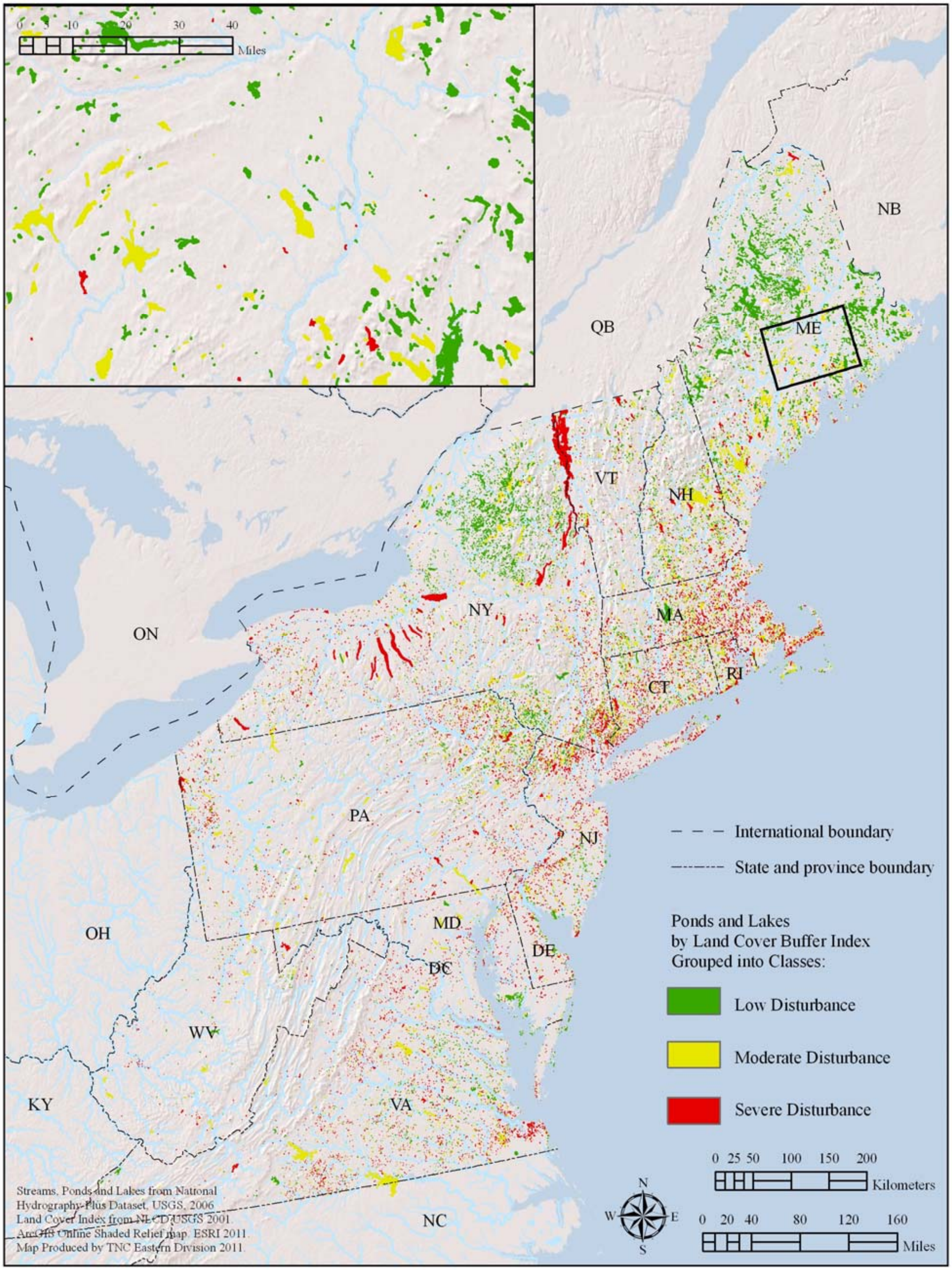
1. Low disturbance: impact index 0 < 3.7 (mean 1.3)
2. Moderate disturbance: impact index >= 3.7 < 15.0 (mean 8.4)
3. Severe disturbance: impact index >=15.0 (mean 26.2)

Results showed that the region's waterbodies were distributed fairly evenly across the disturbance classes: 36:27:41 from low to severe (Figure 4, Table 2, Map 3). Compared to the Mid-Atlantic, New England and New York had twice the proportion of lakes in the low disturbance class (45 vs. 22 percent), and a lower percentage in the severe disturbance class (32 vs. 53 percent). Ponds had the highest level of shoreline impacts with 49 percent of them in severe disturbance class, probably reflecting their dispersed distribution among homes and farms. The next most impacted type of waterbody was the very large lakes with 37 percent in the severe disturbance class.

Figure 4. The percentage of each of the region's 33,774 lakes and ponds that fall within each disturbance class. Within each sub-region the waterbodies are arranged from left to right based on the amount of moderate and severe disturbance.



Map 3. Lake or pond by disturbance class.

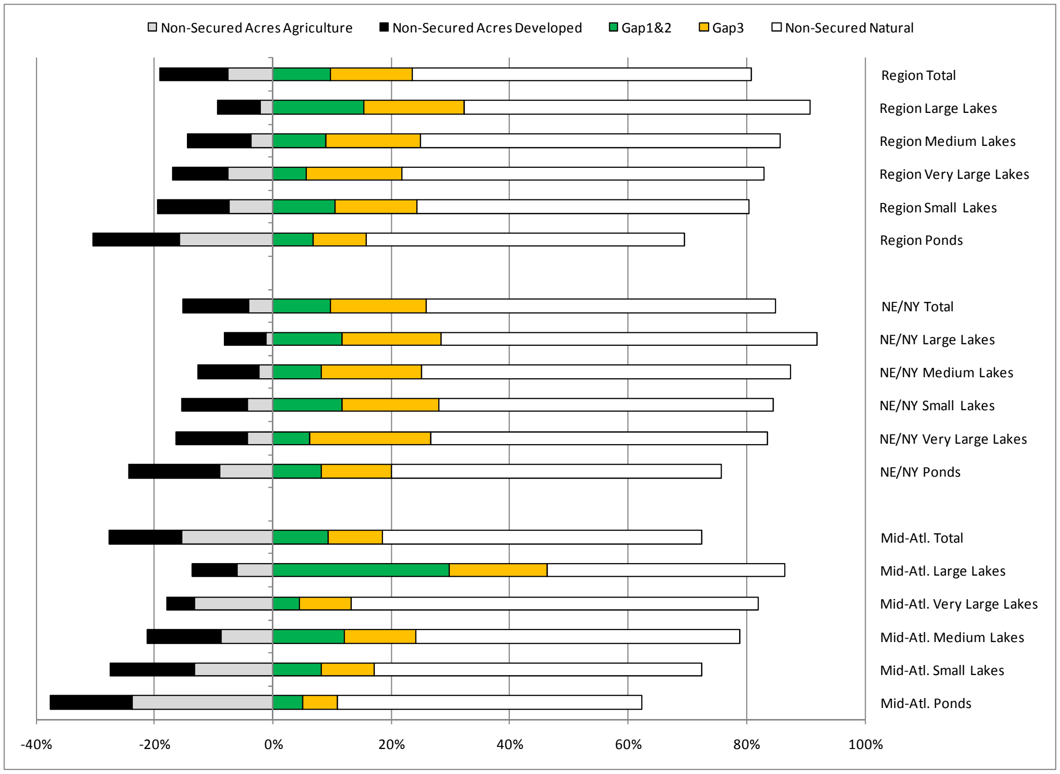


<u>Conversion Versus Securement:</u> To test whether conversion or securement dominated in the shoreline buffer zone, we contrasted the amount of agriculture and developed land with the amount of secured land within the buffer using the two datasets previously described. In general, conversion decreased and securement increased as the lakes got larger; the ratio ranging from 2:1 in ponds where conversion exceeded securement, to 0.3 in large lakes where the opposite was true (Table 2 and Figure 5). Very large lakes were somewhat of an exception as they had high levels of conversion in their shoreline areas (17 percent) but still less conversion than securement (22 percent). Across all size classes, securement exceeded conversion, 24 percent to 19 percent. Note: the small amount of secured lands with roads (developed) or fringing agriculture were not differentiated as converted in our secured lands dataset.

Table 2. Conversion and secured land status of lakes and ponds in the region. Status is based on an assessment of a 100 m buffer area around each water body. The units are acres in the buffer area. CRI-S is the ration of conversion to securement and CIR-P is the ratio of conversion to protection. State by state details are in the appendix 8-1.

		Acres Developed	%	Acres Agriculture	%	Acres Gap 1&2	%	Acres Gap 3	%	Acres Unsecured Natural	%	Total Acres	% converted	% secured	CRI-S	CRI-P
Region	Ponds	61,959	15%	67,351	16%	28,503	7%	38,509	9%	228,210	54%	424,531	30%	16%	1.9	4.5
	Small Lakes	80,163	12%	48,355	7%	68,839	10%	91,839	14%	369,781	56%	658,977	20%	24%	0.8	1.9
	Medium Lakes	44,289	11%	15,102	4%	37,159	9%	65,566	16%	250,575	61%	412,692	14%	25%	0.6	1.6
	Large Lakes	19,732	7%	6,165	2%	42,866	15%	46,727	17%	162,103	58%	277,592	9%	32%	0.3	0.6
	Very Large Lakes	15,048	9%	12,132	8%	8,953	6%	25,833	16%	98,227	61%	160,194	17%	22%	0.8	3.0
Region Total		221,191	11%	149,105	8%	186,319	10%	268,474	14%	1,108,896	57%	1,933,985	19%	24%	0.8	2.0
Mid-Atlantic	Ponds	27,062	14%	46,915	24%	9,751	5%	11,510	6%	101,308	52%	196,545	38%	11%	3.5	7.6
	Small Lakes	31,371	14%	29,569	13%	18,030	8%	19,718	9%	122,914	55%	221,603	27%	17%	1.6	3.4
	Medium Lakes	10,481	12%	7,539	9%	10,186	12%	10,389	12%	46,437	55%	85,032	21%	24%	0.9	1.8
	Large Lakes	4,434	8%	3,617	6%	17,556	30%	9,855	17%	23,643	40%	59,106	14%	46%	0.3	0.5
	Very Large Lakes	2,689	5%	7,748	13%	2,558	4%	5,084	9%	40,051	69%	58,129	18%	13%	1.4	4.1
Mid-Atlantic Total		76,037	12%	95,387	15%	58,082	9%	56,556	9%	334,353	54%	620,415	28%	18%	1.5	3.0
NE & NY	Ponds	34,897	15%	20,437	9%	18,751	8%	26,999	12%	126,903	56%	227,986	24%	20%	1.2	3.0
	Small Lakes	48,792	11%	18,786	4%	50,808	12%	72,122	16%	246,867	56%	437,374	15%	28%	0.5	1.3
	Medium Lakes	33,809	10%	7,563	2%	26,973	8%	55,178	17%	204,137	62%	327,660	13%	25%	0.5	1.5
	Large Lakes	15,298	7%	2,548	1%	25,310	12%	36,871	17%	138,459	63%	218,486	8%	28%	0.3	0.7
	Very Large Lakes	12,359	12%	4,384	4%	6,395	6%	20,749	20%	58,177	57%	102,064	16%	27%	0.6	2.6
NE & NY Total		145,154	11%	53,718	4%	128,237	10%	211,918	16%	774,542	59%	1,313,570	15%	26%	0.6	1.6

Figure 5. Percent conversion compared with the percent securement for all lakes and ponds. Results are based on a 100 m buffer area around each waterbody. Each bar represents 100 percent of area assessed. Area to the left of the "0" axis indicates acreage converted to development or agriculture, to the right is remaining natural area and the degree to which it is secured by GAP 1-3 land.



Ecological Condition

Impervious Surface: The proportion of nonporous features (e.g. roads, parking lots, driveways, and roof-tops) in a lake's upstream collection area has been associated with the degradation of ecological processes and a loss of diversity. Reduced infiltration of rainwater leads to more frequent flooding and increased sediment loading and may contribute to a rise in water temperatures. Chemical pollution also tends to be higher in areas with an abundance of roads and parking lots. Less research has been done on lakes than on rivers, but many of the negative effects appear to be similar (CWP 2003). How much impervious surface cover a waterbody can tolerate in its upstream area before biotic impacts are noted is a subject of much research. Many studies have found detectable impacts at impervious surface levels above 10 percent of the upstream collection area, while some studies have detected significant impacts and loss of taxa at levels as low as 2 percent of the watershed, or even 0.5 percent in some cases (Stranko et al 2008, Hilderbrand et al 2010, Southerland and Stranko 2008, King and Baker 2010).

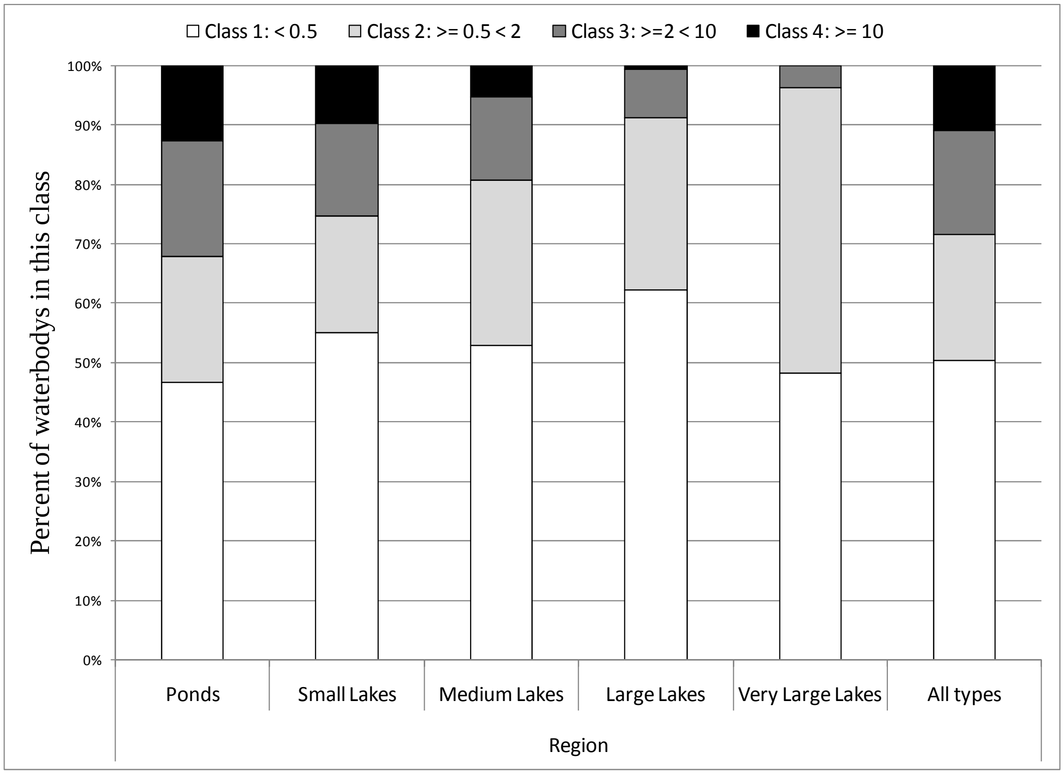
To create this metric, we overlaid the USGS 2001 National Land Cover Impervious Surface Dataset (Yang 2002) on the upstream watershed area of each waterbody and tabulated the amount of impervious surface present. For lakes that were connected to streams, we used the impervious surface of their entire upstream drainage area (e.g. watershed based on the USGS 1:100,000 National Hydrography Plus dataset). For isolated lakes, or ones connected only to unmapped headwater creeks, we used the impervious surface in a 500 m shoreline buffer area to approximate their small watershed areas.

To determine impact classes, we again used information from the 188 lakes sampled by the National Lake Assessments, and tracked in their database. Lakes in the low disturbance category, for both taxonomic loss and the diatom index of biological integrity, had a mean upstream impervious score of 0.64. Lakes in the intermediate disturbance class had a mean score of 1.46, and lakes in the most disturbed class had a mean score of 2.6. Thus, this field-based assessment suggested detectable impacts to aquatic biodiversity at fairly low levels of upstream impervious surface. Although there was substantial variance within each category, we used the information and guidance from thresholds emerging from King and Baker (2010) to create four reporting classes:

- Class 1: Undisturbed 0-0.5 percent impervious surfaces in the watershed
- Class 2: Low impacts 0.5-2 percent impervious surfaces in the watershed
- Class 3: Moderately impacted 2-10 percent impervious surfaces in the watershed
- Class 4: Highly impacted >10 percent impervious surfaces in the watershed

Applying the classes to all the lakes and ponds in the region indicated that 50 percent of all waterbodies had no impervious surface impacts (Class 1), but that 11 percent were highly impacted (Class 4, Figure 3, Map 4). Ponds were the most impacted class with 13 percent in the highly impacted class. High impacts decreased with lake size (Figure 3, Table 3), the latter pattern perhaps reflecting the increased watershed size of larger lakes. The patterns were similar across the sub-regions.

Figure 3. Impervious surface impact classes by lake type. Class 1: Undisturbed (0-0.5 percent), Class 2: Low impacts (0.05-2 percent), Class 3: Moderately impacted (2-10 percent), Class 4: Highly impacted (>10 percent).



Map 4. Ponds and lakes by percentage impervious surface category.

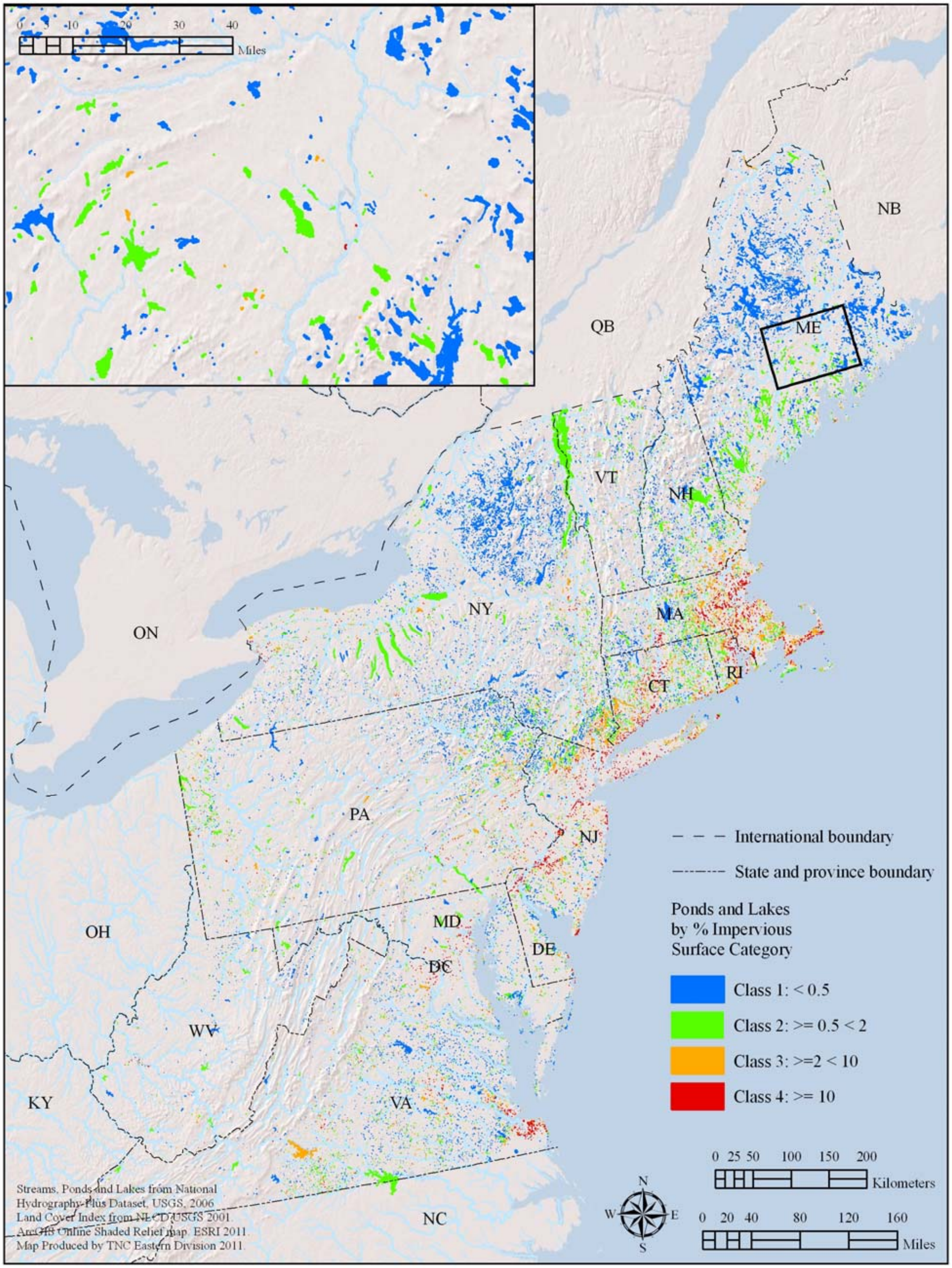


Table 3. Percent of Lakes and Ponds by Upstream Impervious Class

		Undisturbed Class 1: < 0.5	**Low Class 2:** >= 0.5 < 2	**Moderate Class 3:** >=2 < 10	**High Class 4:** >= 10
Region	Ponds	47 %	21 %	19 %	13 %
	Small Lakes	55 %	20 %	16 %	10 %
	Medium Lakes	53 %	28 %	14 %	5 %
	Large Lakes	62 %	29 %	8 %	1 %
	Very Large Lakes	48 %	48 %	4 %	0 %
Region Total		50 %	21 %	17 %	11 %
Mid-Atlantic	Ponds	46 %	23 %	19 %	12 %
	Small Lakes	49 %	22 %	17 %	12 %
	Medium Lakes	39 %	34 %	21 %	7 %
	Large Lakes	33 %	53 %	14 %	0 %
	Very Large Lakes	33 %	50 %	17 %	0 %
Mid-Atlantic Total		47 %	23 %	18 %	12 %
NE & NY	Ponds	47 %	20 %	20 %	13 %
	Small Lakes	58 %	18 %	15 %	9 %
	Medium Lakes	56 %	27 %	13 %	5 %
	Large Lakes	67 %	25 %	7 %	1 %
	Very Large Lakes	52 %	48 %	0 %	0 %
NE & NY Total		53 %	20 %	17 %	10 %

Isolation from Roads: Access to a lake from a road or trail is correlated with the loss of native species, and with the presence of non-native species (Silk and Ciruna 2004). Field surveys to document the presence of non-indigenous species in lakes only cover a handful of the lakes and ponds in the region, so we used the minimum distance from a mapped road as an estimate of potential introductions. We assumed that the more difficult the lake is to access, the less likely it is to contain non-indigenous species, as the primary entry point for many lake exotics are citizens seeking to create a local sport fishery, inadvertently transporting species attached to boats or discarding excess bait.

For each waterbody, we tabulated the distance to the nearest road including major highway, local thoroughfares, neighborhood connectors, and rural roads. Four-wheel drive roads and other trails were not included due to inconsistencies in their mapping across the region in the source dataset. Source data sets are described in the appendix A (Tele Atlas North America, Inc. 2009).

The results indicated that ponds and lakes in this region were highly accessible to people; 83 percent were within a quarter mile of a road and 69 percent were within one-tenth of a mile. Only 11 percent of lakes in the region were more than a half mile from a road and only 7 percent were greater than a mile from a road (Figure 5, Map 5). The Mid-Atlantic had fewer remote lakes with only 4 percent being more than one-half mile from a road compared to 15 percent for New England and New York. The larger the lake, the closer roads were to it: regionally 67 percent of ponds, 70 percent of small lakes, 84 percent of medium lakes, 86 percent of large lakes, and 100 percent of very large lakes have a road within one-tenth of a mile (Figure 5). This pattern was found in both sub-regions.

Map 5. Ponds and lakes by minimum distance (in miles) to a road.

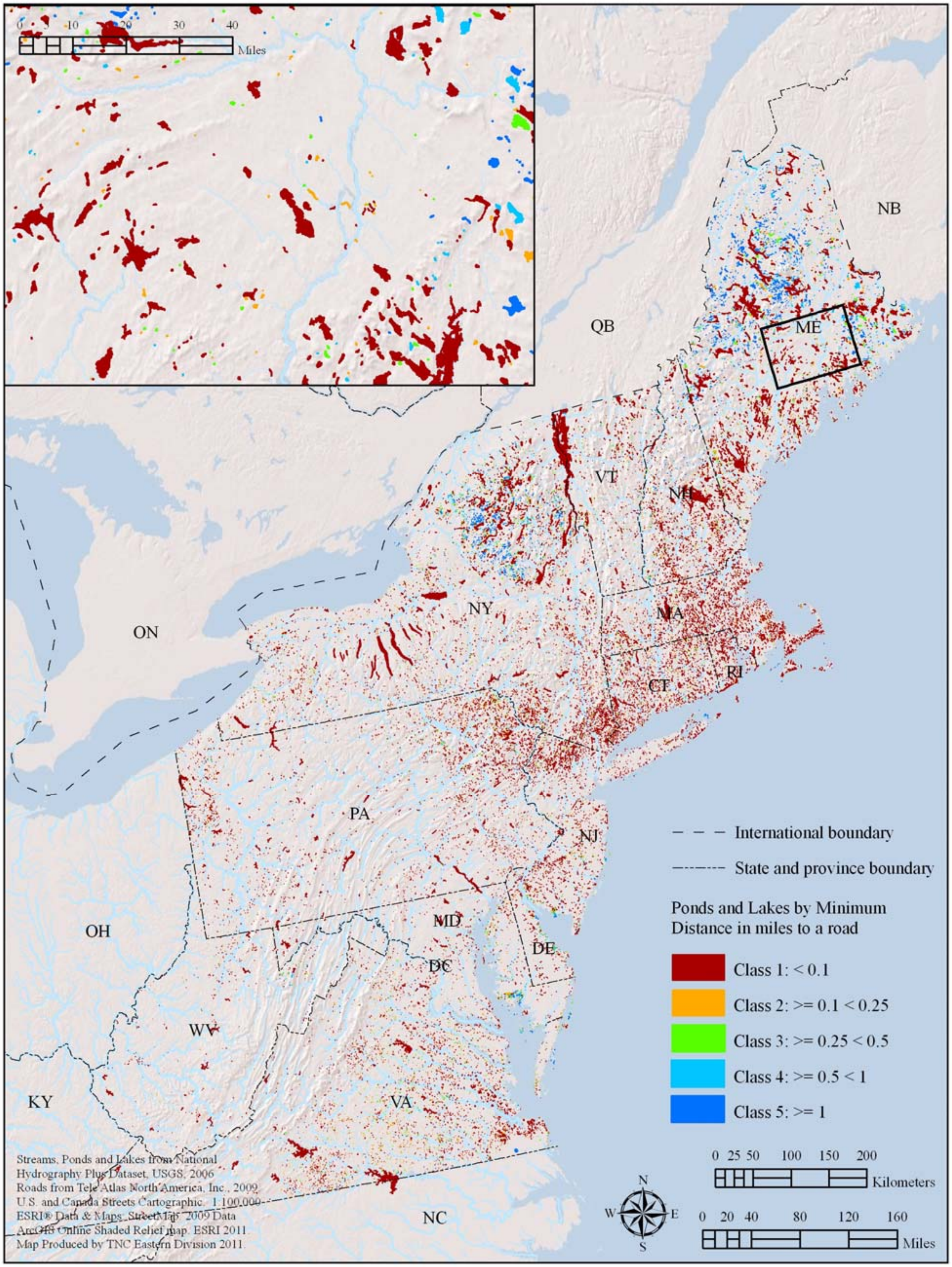
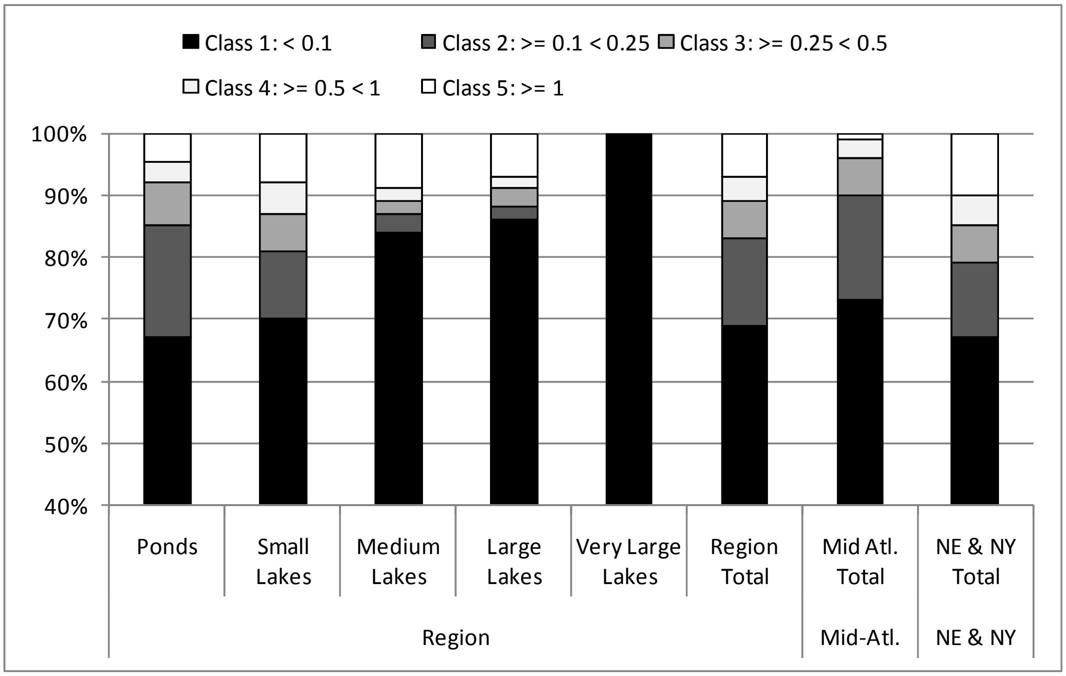


Figure 5. The proportion of each lake type in each distance to road class (in miles). Few lakes and ponds are over 1 mile from a road (Class 5, 7 percent). Most are less than one tenth mile from a road (Class 1, 69 percent).



Road Density: *Note: although this metric was requested in Tomajer et al. (2008) we found it to be tightly correlated with impervious surfaces, essentially conveying the same information and we omitted it.*

Presence of Dams: Dams within formerly natural lakes or reservoirs have been linked to significant negative ecological impacts on both plant and animal communities (see Vaux 2005, Jiffry 1984, Jansson et al 2000). Dams alter lake habitat by augmenting or reducing water levels depending on the operation of the inflow and outflow dams; impounded lakes also often experience altered temperature, oxygen, and sedimentation regimes. Further, dams that fragment connected networks of streams and lakes disrupt the natural dispersal patterns of many aquatic plant and animals. For example, dams have resulted in a substantial reduction in the amount of lake spawning habitat for diadromous species (such as alewife) and migratory freshwater species (such as brook trout).

To evaluate the impacts of dams, we compiled a database of dams for the entire region using a variety of state sources (see data sources) and queried the database for any lake with a dam within 500 m. This buffer distance was necessary to account for spatial inconsistencies between the mapped dams and the lakes upon which they were located, and it allowed us to consider the adverse effect a nearby dam might have on a lake upstream or downstream from it.

Results of the analysis indicate that 17 percent of all lakes and ponds in the region have a dam directly upstream or downstream. The percentage of dammed waterbodies increases as the lakes increase in size, only 11 percent of ponds are dammed but 70 percent of very large lakes have a dam directly associated with it (Figure 6, Table 4).

Figure 6. The percentage of lakes and ponds in the region with a dam directly upstream or downstream.

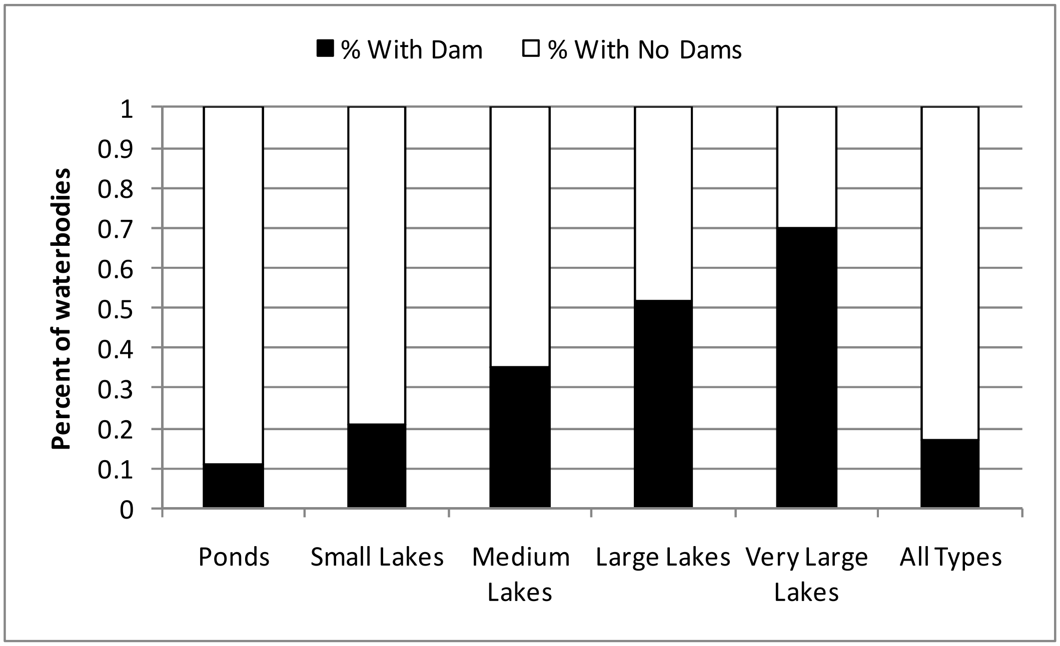


Table 4. The percentage of lakes with upstream or downstream dams, arranged by type and sub-region.

	Region		Mid-Atlantic		New England & New York	
	% With No Dams	**% With Dams**	**% With No Dams**	**% With Dams**	**% With No Dams**	**% With Dams**
Ponds	89%	11%	92%	8%	87%	13%
Small Lakes	79%	21%	75%	25%	82%	18%
Medium Lakes	65%	35%	53%	47%	67%	33%
Large Lakes	48%	52%	44%	56%	48%	52%
Very Large Lakes	30%	70%	33%	67%	29%	71%
Totals	83%	17%	85%	15%	82%	18%

Biological Integrity

Index of taxa loss: There is a marked lack of consistent and comparable state datasets on the biological condition of lakes and ponds in the region. Here we provide a summary of the biological condition metrics for 142 lakes sampled by the National Lake Assessment (NLA) that had information on biological condition. As the first baseline study of the condition of the nation's lakes, the assessment provides an unbiased estimate of the condition of lakes larger than ten acres and at least one meter deep (i.e. ponds were not assessed). The assessment used a sampling scheme wherein lakes were selected at random and stratified by size, state, and ecoregion. Because of the small number of samples in some states, only multistate and regional summaries of the data are recommended by the authors.

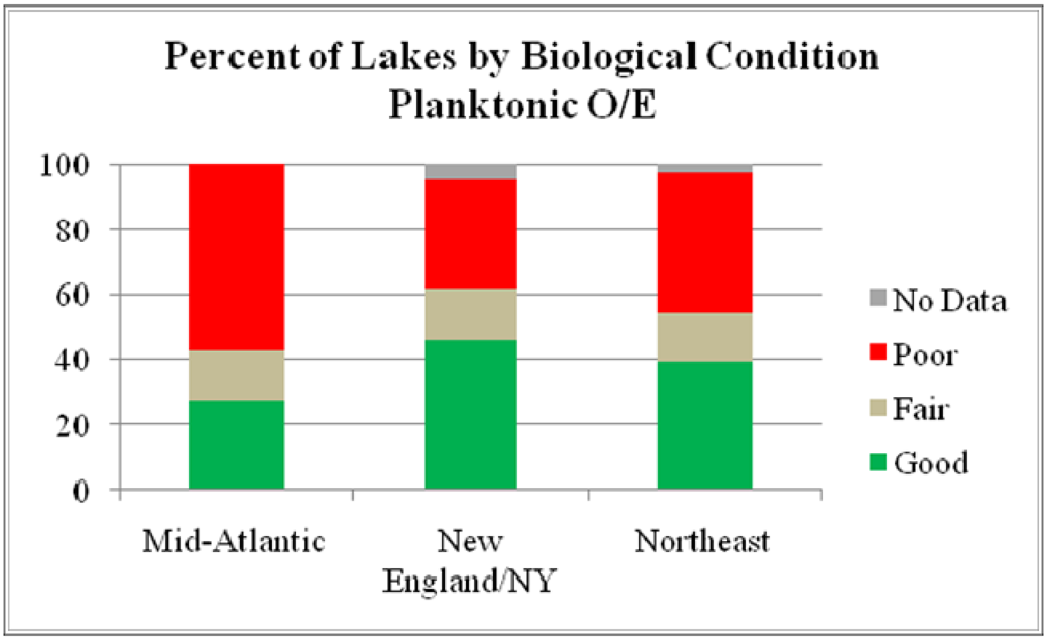
In the NLA, the biology of each lake was characterized in terms of the diversity and abundance of fish, insects, plants, and other organisms, and this information was used as a direct measure of a lake's biological health. The primary measure used was an index of taxa loss applied to the phytoplankton and zooplankton data. This metric looked at whether or not the organisms one would expect to find, based on reference lakes, are present. The list of expected phytoplankton and zooplankton taxa at individual sites are predicted from a model developed from data collected at reference sites. Comparing the list of taxa observed ("O") at a site with those expected to occur ("E"), they quantified the proportion of taxa that have been lost as the ratio of O to E. Thus, O/E values are interpreted as the percentage of the expected taxa present. For example, an O/E score of 0.9 indicates that 90% of the expected taxa are present. The closer the percentage is to one, the healthier the lake. As with all indicators, O/E values must be interpreted in context of the quality of reference sites because the quality of reference sites available in a region sets the baseline for what taxa were expected to occur.

The Lake Assessment defined three categories of plankton taxa loss:

1. Good condition (less than 20 percent taxa loss)
2. Fair condition (20-40 percent taxa loss)
3. Poor condition (greater than 40 percent taxa loss)

The results showed that, based on all available samples for the region, 39 percent were in good condition, 16 percent in fair, and 43 percent in poor. Thus over half of the lakes tested had lost 20 percent or more of their taxa. The percentage of lakes in the good category was substantially higher in New England/NY sub-region than in the Mid-Atlantic subregion (46 vs. 27 percent, Figure 7).

Figure 7. The percentage of lakes in each of the three catagories of taxa loss: good (<20% taxa loss). fair (20-40% taxa loss), poor (>40% taxa loss).



<u>Correspondence between Taxa Loss and Lake Condition:</u> We tested whether the patterns indicated by the taxa loss scored correlated with those indicated by the GIS condition metrics (buffer land cover index, impervious surface, distance to road, dams). To do this, we calculated the means and standard deviations of each condition value for the samples in each of the taxa loss classes. We found no statistically significant differences between the condition values of samples in the three O/E taxa classes, but there was general correspondence between the O/E loss and shoreline impact values (Figure 8) and the amount of impervious surface in the watershed (Figure 9). Correspondence in both measures was highest in the size small lakes (size 2) and weakest in the large lakes (size 4). Further research is needed to investigate these patterns, as well as whether other lake characteristics (like depth, network position, flushing rate, underlying geology, elevation, and non-native species presence) play a significant role in altering planktonic biota.

Figure 8. Correspondence between the index of taxa loss (O/E) and the shoreline impact index. In general more loss is associated with higher scores but there is wide variation and the groups are not statistically different (P = 0.82). The relationship is strongest for size small lakes (size 2) and least for the large lakes (size 4).

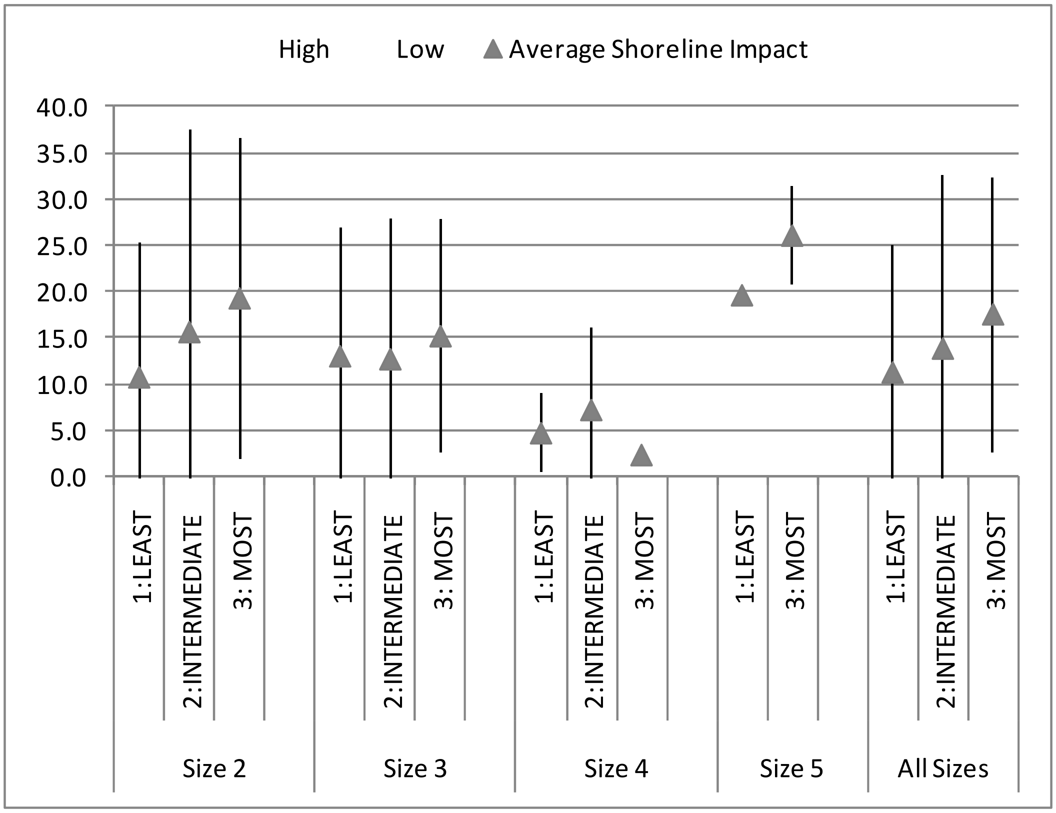
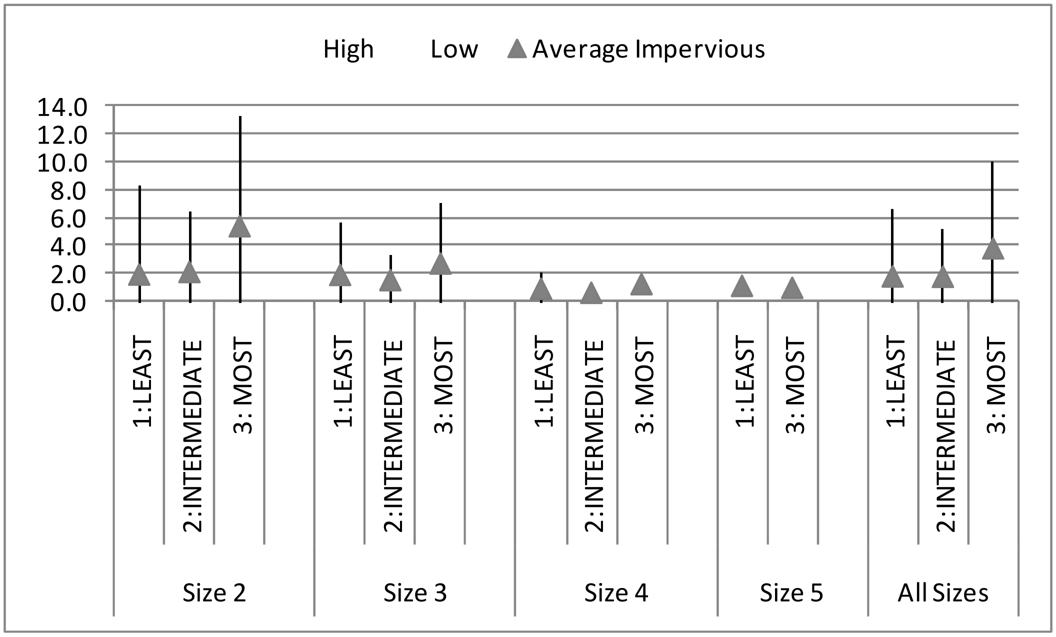


Figure 9. Correspondence between the index of taxa loss (O/E) and the amount of impervious surface in the watershed. Across all sizes severe loss is associated scores over 3 percent but there is wide variation and the groups are not statistically different (P = 0.20).

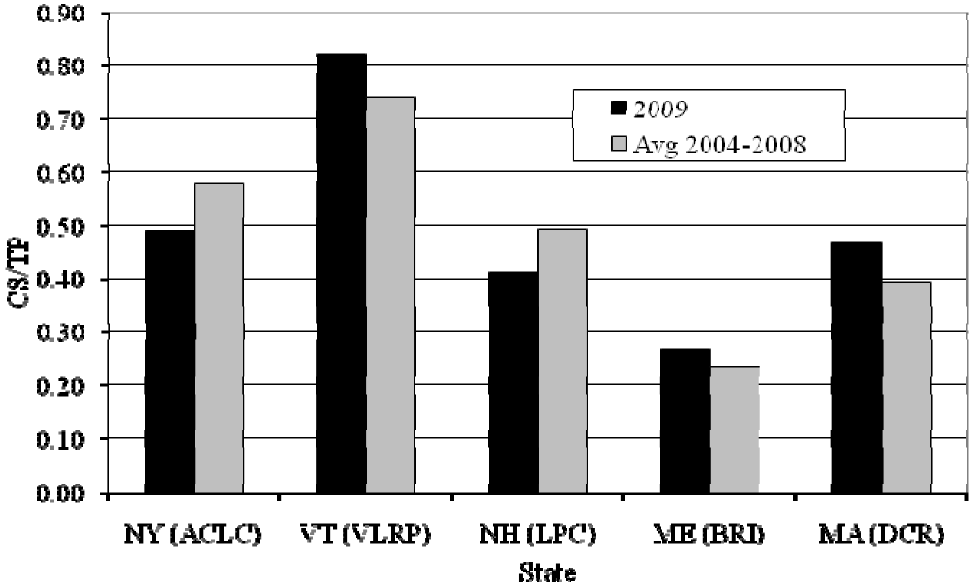


<u>Trends in Loon Abundance:</u> Loons (Gavia spp.) are generally considered to be indicators of high quality lake habitats and have been used as indicator of aquatic health and landscape-level alterations in aquatic environments (Evers 2004). As a top predator in the aquatic food chain of many lakes, the common loon may also serve as an indicator of mercury in lacustrine systems. So it is thought that monitoring the status of common loons may provide wildlife managers with insight into the status of other species that utilize lakes in the northernmost northeast states (MA, ME, NH, NY, and VT).

Overall loon productivity is estimated by counting the number of territorial pairs and the number of fledged young within a target area and calculating the ratio of chicks fledged per territorial pair. Because the number of young that actually fledge is difficult to substantiate, most monitoring programs use a surrogate of “chicks greater than 6 weeks of age” (or nearly in full basic plumage). Chick mortality after six weeks is minimal and serves as a suitable predictor of fledging rate (Evers 2004). State surveys of the loon population and reproductive success have been compiled by the Northeast Loon Study Working Group for the last 6 years. Although Maine and New York sample only a subset of the total state-wide population, this dataset is still the best available monitoring to date (Vogel, pers. comm.)

In 2009, the last year for which data is available, the total number of territorial pairs found in surveys across the study region was 641 and the total number of chicks surviving was 280; an average of 0.44 chicks surviving per pair. This was a slightly lower survivorship than the previous 5 year average of 0.45, but all years are lower that the estimated number needed to maintain a stable population: 0.48 (Vogel, pers. comm.). State statistics also show that Vermont had substantially higher productivity than the other states in 2009 and in the previous 4 years (Figure 10).

Figure 10. The number of common loon chicks surviving per territorial loon pair (CS/TP) arranged by state.



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Appendix 8-1

Acres of Land within 100m buffer of Ponds and Lakes

	Size Class	GAP1&2 Total	GAP 3 Total	Non-Secured
Mid-Atlantic				
DC	Ponds	0	41	22
	Small Lakes	0	85	117
	DC Total	**0**	**127**	**139**
DE	Ponds	636	1,254	3,953
	Small Lakes	742	1,479	6,672
	Medium Lakes	389	743	2,715
	DE Total	**1,767**	**3,475**	**13,341**
MD	Ponds	1,702	2,488	11,028
	Small Lakes	2,932	4,060	13,697
	Medium Lakes	888	982	3,154
	Large Lakes	6,486	477	4,158
	MD Total	**12,009**	**8,007**	**32,038**
NJ	Ponds	5,022	1,168	23,055
	Small Lakes	10,152	2,184	34,939
	Medium Lakes	4,524	429	8,882
	Large Lakes	1,992	0	2,402
	NJ Total	**21,691**	**3,780**	**69,278**
PA	Ponds	1,366	3,422	53,917
	Small Lakes	2,635	5,990	58,479
	Medium Lakes	3,348	3,646	26,911
	Large Lakes	8,701	452	9,817
	Very Large Lakes	2,474	1,805	5,740
	PA Total	**18,524**	**15,316**	**154,864**
VA	Ponds	854	2,348	74,487
	Small Lakes	1,570	4,761	63,345
	Medium Lakes	1,037	2,773	20,959
	Large Lakes	376	1,948	13,012
	Very Large Lakes	84	3,279	44,748
	VA Total	**3,921**	**15,109**	**216,550**
WV	Ponds	171	789	8,822
	Small Lakes	0	1,158	6,605
	Medium Lakes	0	1,817	1,836
	Large Lakes	0	6,978	2,305
	WV Total	**171**	**10,742**	**19,567**
Mid-Atlantic Total		**58,082**	**56,556**	**505,777**

	Size Class	GAP1&2 Total	GAP 3 Total	Non-Secured
New England & New York				
CT	Ponds	1,339	3,313	26,839
	Small Lakes	2,267	6,535	26,424
	Medium Lakes	787	2,867	14,897
	Large Lakes	219	342	5,225
	CT Total	**4,612**	**13,057**	**73,385**
MA	Ponds	1,335	6,803	28,242
	Small Lakes	3,254	17,335	53,935
	Medium Lakes	920	10,890	31,852
	Large Lakes	0	2,398	2,022
	Very Large Lakes	0	4,183	787
	MA Total	**5,508**	**41,610**	**116,838**
ME	Ponds	3,304	4,274	30,398
	Small Lakes	6,753	14,510	77,437
	Medium Lakes	6,540	16,647	101,835
	Large Lakes	9,262	17,629	99,091
	Very Large Lakes	3,447	12,775	26,351
	ME Total	**29,306**	**65,836**	**335,112**
NH	Ponds	1,531	2,857	10,689
	Small Lakes	2,391	8,966	31,079
	Medium Lakes	836	5,759	24,512
	Large Lakes	1,138	2,271	11,077
	Very Large Lakes	138	366	8,154
	NH Total	**6,034**	**20,218**	**85,511**
NY	Ponds	10,522	7,876	73,611
	Small Lakes	34,341	19,314	103,831
	Medium Lakes	17,056	14,153	57,016
	Large Lakes	14,470	13,080	32,483
	Very Large Lakes	2,810	3,424	39,629
	NY Total	**79,199**	**57,847**	**306,569**
RI	Ponds	387	760	4,315
	Small Lakes	551	1,799	9,194
	Medium Lakes	461	2,026	5,938
	Large Lakes	181	900	1,819
	RI Total	**1,580**	**5,484**	**21,267**
VT	Ponds	333	1,116	8,142
	Small Lakes	1,252	3,663	12,544
	Medium Lakes	373	2,836	9,457
	Large Lakes	39	252	4,588
	VT Total	**1,998**	**7,866**	**34,731**
New England & New York Total		**128,237**	**211,918**	**973,415**
Grand Total		**186,319**	**268,474**	**1,479,192**

CHAPTER

9

Regionally Significant Species of Greatest Conservation Need

Condition and Conservation Status

April 2011

M. Anderson and A. Olivero Sheldon

Over 2,300 species and subspecies were listed as species of concern in the 13 Northeast and Mid-Atlantic State Wildlife Action Plans. Here, we identify and examine a subset of 360 species that emerge as species of the greatest regional conservation need. This includes: 1) **high responsibility species**: species for which the region contains over 50 percent of their entire range, and 2) **high concern species**: species that a majority of the Northeast and Mid-Atlantic states listed in their Wildlife Action Plans, usually due to extreme rarity, rapid declines, or high vulnerability. In this report, we explain the criteria for assigning species to these categories, and, for each species with sufficient data, we examine its conservation status and distribution.

Summary of Findings

Species of High Regional Responsibility: Out of all species-of-concern, 112 have their distributions centered in this region, and occur across four or more states. For example: Bicknell's thrush, blue spotted salamander, Atlantic sturgeon, dwarf wedgemussel, eastern small-footed bat and wood turtle. This region bears the responsibility for the conservation of these species, and currently 25 percent of their known locations occur on secured land. This includes 9 percent on land protected for biodiversity and 16 percent on multiple use land. Surprisingly, locations of high regional responsibility species were secured at levels below those of low responsibility (25 percent versus 32 percent).

Species of Widespread High Concern: For species found in four or more states, 246 were listed as species-of-concern in half of their State Wildlife Action Plans, even if this region is not the center of their distribution. Examples include: bald eagle, eastern spadefoot toad, American brook lamprey, cherrystone drop snail, Indiana bat and Blanding's turtle. Currently 32 percent of the known locations of these species are on secured land including 16 percent on land protected for biodiversity

Conservation across Taxonomic Groups: Among all species-of-concern, birds had the highest amount of inventoried locations and the most locations secured against development (36 percent secured out of 11,849 locations). Reptiles (26 percent out of 5,825 locations) and amphibians (40 percent out of 2,099) both also had considerable inventory and securement levels. Mammals had the highest percentage of secured locations (42 percent out of 899 locations). Fish had the lowest level of inventory and securement (14 percent out of 575 locations).

Identifying the Species of Greatest Conservation Need

Characterizing the Species: To identify which species were of highest conservation concern, we followed the recommendations put forth by the Northeast Partners in Amphibian and Reptile Conservation (NEPARC) Wildlife Action Plan Working Group (2008). They suggested that regional focus be placed on a subset of species listed in the State Wildlife Action Plans (SWAP) where the species had either 1) the majority of their distribution centered in this region and/or 2) the species had recognized high levels of concern in the northeast as evidenced by 50 percent or more of the states in its northeast range listing them as SWAP species of concern.

Altogether 2,378 unique species and/or subspecies were named in the SWAPs (Kantor 2007, 13 states plus DC). To keep the task of summarizing their conservation status manageable for this report, we excluded marine species (87), subspecies (106), and arthropods (1,242) focusing specifically on 943 terrestrial and freshwater species encompassing mammals, birds, reptiles, amphibians, fish, mussels, crayfish, and other non-arthropod insects. For each of these species, we obtained information on its current range (NatureServe 2010). Specifically we evaluated 1) how many U.S. states each species occurred in, and 2) how many of this region's 13 states each species occurred in. States records were not counted if the species was currently extirpated (SX), possibly extirpated (SH, known from only historic records), or ranked as Not Applicable (SNA, species was not a suitable target for conservation activities, e.g. an occasionally seen non-breeding migrant.). We omitted 38 species which, although listed in a SWAP, were not listed as present in any of the 13 states by NatureServe, and three species with no distributional information: McClung cave snail (Fontigens spp), a branchiobdelid worm (Ankyrodrilus legacus), and Pilsbry's spire snail (Pyrgulopsis lustrica).

Using the information described above, we categorized the resulting 902 species in two ways. First, we tabulated what percent, of the northeast states that contained the species, had listed it as a species of concern in their SWAP. Second, we tabulated what percent of the species total distribution fell in the 13 Northeast and Mid-Atlantic states. From this information, we grouped the species into four levels of regional concern, and two levels of responsibility:

Level of Regional Concern: (13 Northeast and Mid-Atlantic States only)

- Low concern = listed in less than 25 percent of states that contained it.
- Moderate concern = listed in >=25-50 percent of the states that contained it.
- High concern = listed in >=50-75 percent of the states that contained it.
- Widespread concern = listed in >=75 percent of the states that contained it.

Level of Regional Responsibility:

- High responsibility = greater than or equal to 50 percent of the U.S. distribution in the 13 states
- Low responsibility = less than 50 percent of the U.S. distribution in the 13 states

To focus this study on species of region-wide concern, we excluded species that occurred in only one state (211 species), with the assumption that responsibility for those species rests with individual states not the region (NEPARC Wildlife Action Plan Working Group 2008). However, we retained species that occurred in two states (98 species), three states (59 species), or more (534 species).

We summarized information on seven categories of species, with each category representing a combination of regional concern and regional responsibility. High regional responsibility species were divided into five groups corresponding to the four levels of concern, and one additional group was added for species with distributions limited to only two or three states. For low responsibility species, we report on those species of high or widespread levels of concern found in four or more states. The final set of regionally significant species that met these criteria encompassed a total of 360 species.

Data Preparation: For each species, we obtained information on all its known locations. Data came from two sources: NatureServe (11 states plus DC) and the State Natural Heritage and Endangered Species programs (3 states). In most cases, species occurrences were precise locations of populations or breeding areas, but the occurrences represented a variety of situations with a range of precision in the locations. The data was current to January 2011. In addition to locations, we compiled information on each species global conservation rank and status with respect to the U.S. Endangered Species Act.

We filtered out species occurrences that were not useable for this study, this included: occurrences where the last date of observation was prior to 1970, occurrences where the rank was historic (H) or extirpated (X), and occurrences where the location was not precise enough. For the latter, precision of the location had to be accurate within 125 acres to ensure that the overlay with the secured lands would correctly reflect the conservation status. Applying this filter to the data, we had at least one usable occurrence for 235 (65 percent) of the 360 species. Please see the detailed methods (appendix B) section for more information on the source datasets and their precision.

Lastly, for each species we evaluated whether we had usable occurrences in enough states within its northeastern range to be confident that the results truly represented regional trends. We accomplished this by determining what percentage of states, within the species regional range, had usable occurrences. We put the species into one of four data sufficiency categories (Table 1).

For regional reporting, 58 species were in the “not useable” category because we only had usable occurrences in less than 25 percent of the species full range of states. In total, we had enough geographic distribution of usable occurrences to analyze 177 species, 49 percent of the 360 species we had hoped to evaluate (Table 2).

Table 1. Data sufficiency for regional summary statistics. Each of the 360 species was placed into one of the following categories. Only species with S, A, or P level of sufficiency were used in regional secured lands summary statistics.

Sufficient (S)	>= 75% of states where species is currently present also had precise element occurrence locations (n = 56 species)
Adequate (A)	>= 50%-74% of states where species is currently present also had precise element occurrence locations (n = 67 species)
Poor (P)	>= 25%-49% of states where species is currently present also had precise element occurrence locations (n = 73 species)
Not Usable (NU)	<25% of states where species is currently present also had precise element occurrence locations (n = 164 species)

Table 2. The seven species categories used in this report. The groups are combinations of regional concern, regional responsibility, and distribution. The three numbers in parentheses within each box summarize for each group the 1) # of species falling in this group: 2) # of species with any usable element occurrences available for analysis: 3) # of species with adequate distribution of these usable element occurrences across enough northeast states to meet our data sufficiency criteria.

<table>
<tr><th></th><th>Low Responsibility</th><th colspan="2">High Responsibility</th><th></th></tr>
<tr><th></th><th>Found in 4+ states</th><th>Found in 2-3 states</th><th>Found in 4+ states</th><th>Total</th></tr>
<tr><td>Low Concern</td><td></td><td></td><td>Low concern,
High responsibility
(39:7:0)</td><td></td></tr>
<tr><td>Moderate Concern</td><td></td><td rowspan="3">Limited distribution,
High responsibility
(53:26:26)</td><td>Moderate concern,
High responsibility
(22:10:2)</td><td></td></tr>
<tr><td>High Concern</td><td>High concern,
Low responsibility
(78:54:36)</td><td>High concern,
High responsibility
(15:9:5)</td><td></td></tr>
<tr><td>Widespread Concern</td><td>Widespread concern,
Low responsibility
(117:98:80)</td><td>Widespread concern,
High responsibility
(36:31:28)</td><td></td></tr>
<tr><td>Total Species</td><td>195:152:116</td><td>53:26:26</td><td>112: 57:35</td><td>360: 235: 177</td></tr>
</table>

Distribution, Rarity, and Protection Status

The following sections summarize results for the seven groups. Tables in Appendix 9-1 provide a more detailed list of the exact species included, their global conservation rank, scientific name, common name, US Endangered Species rank, distribution, and secured lands regional summary metrics. Tables in Appendix 9-2 provide the detailed state by state results of the numbers of precise element occurrences falling on secured lands for each species.

To evaluate the conservation status of each species we overlaid their precise locations with the TNC secured lands dataset, and tabulated the number of occurrences falling on each level of securement (TNC 2009). The results of the overlay analysis are presented below.

<u>**Species of Widespread Concern and High Regional Responsibility:**</u> Thirty-six species qualified as species of widespread concern (listed in the wildlife action plans by 75-100 percent of the states in which they occur) <u>and</u> of high regional responsibility (50 percent or more of their full distribution is in this region). For 28 of these species (78 percent), we had enough usable occurrences across their northeast range to report regional status. Results of the overlay with secured lands showed that 25 percent (1,819 individual locations) were secured (Table 3). This ranged from a high of 458 locations (22 percent) for wood turtle to 0 for three fish species and one mussel. Four species had over 50 percent of their known locations secured: Bicknell's thrush, seaside sparrow, carpenter frog, and Allegheny woodrat. Overall, reptiles had the most secured locations (908) but birds (46 percent) and mammals (42 percent) had the highest percentages of their occurrences on secured lands. Occurrence data was not sufficiently distributed to report regional trends for Banded Sunfish, Spotfin Killfish, Bridle Shiner. No usable occurrence data was available at all for Purple Sandpiper, American Shad, Rainbow Smelt, Atlantic Salmon, and Brook Trout.

Table 3. Species of Widespread Concern and High Regional Responsibility. This table shows the securement status of species that met minimum criteria for regional reporting (data adequacy of sufficient (S), adequate (A), or poor (P)). Securement refers to the number of species locations on land secured for multiple uses (GAP 3) or land protected for biodiversity (GAP 1-2). Table is sorted by taxa group and by the total number of secured occurrences.

Common Name	Standard name	Data	GAP 1-2	GAP 3	Un-Secured	Total	% GAP 1-2	% GAP 3	% Secured	total secured
Blue-spotted Salamander	Ambystoma laterale	A	73	118	453	**644**	11%	18%	30%	191
Jefferson Salamander	Ambystoma jeffersonianum	A	37	47	216	**300**	12%	16%	28%	84
Carpenter Frog	Rana virgatipes	A	10	3	11	**24**	42%	13%	54%	13
Amphibian Total			**120**	**168**	**680**	**968**	**12%**	**17%**	**30%**	**288**
Bicknell's Thrush	Catharus bicknelli	P	52	7	3	**62**	84%	11%	95%	59
Roseate Tern	Sterna dougallii	P	25	20	97	**142**	18%	14%	32%	45
Glossy Ibis	Plegadis falcinellus	P	27	6	58	**91**	30%	7%	36%	33
American Oystercatcher	Haematopus palliatus	S	8	15	27	**50**	16%	30%	46%	23
Arctic Tern	Sterna paradisaea	A	17	4	26	**47**	36%	9%	45%	21
Saltmarsh Sharp-tailed Sparrow	Ammodramus caudacutus	S	12	6	26	**44**	27%	14%	41%	18
Seaside Sparrow	Ammodramus maritimus	S	7	8	10	**25**	28%	32%	60%	15
Bird Total			**148**	**66**	**247**	**461**	**32%**	**14%**	**46%**	**214**
Round Whitefish	Prosopium cylindraceum	P	2	3	11	**16**	13%	19%	31%	5
Atlantic Sturgeon	Acipenser oxyrinchus	P	1	1	7	**9**	11%	11%	22%	2
Blackbanded Sunfish	Enneacanthus chaetodon	P			3	**3**	0%	0%	0%	0
Mud Sunfish	Acantharchus pomotis	A			2	**2**	0%	0%	0%	0
Shortnose Sturgeon	Acipenser brevirostrum	A			22	**22**	0%	0%	0%	0
Fish Total			**3**	**4**	**45**	**52**	**6%**	**8%**	**13%**	**7**
Brook Floater	Alasmidonta varicosa	S	8	38	168	**214**	4%	18%	21%	46
Eastern Pond Mussel	Ligumia nasuta	A	5	27	212	**244**	2%	11%	13%	32
Dwarf Wedgemussel	Alasmidonta heterodon	S	5	11	61	**77**	6%	14%	21%	16
Tidewater Mucket	Leptodea ochracea	P	6	6	234	**246**	2%	2%	5%	12
Yellow Lampmussel	Lampsilis cariosa	A	4	6	224	**234**	2%	3%	4%	10
Green Floater	Lasmigona subviridis	A	3	2	49	**54**	6%	4%	9%	5
Northern Lance Mussel	Elliptio fisheriana	S			4	**4**	0%	0%	0%	0
Inverts Total			**31**	**90**	**952**	**1073**	**3%**	**8%**	**11%**	**121**
Allegheny Woodrat	Neotoma magister	A	46	156	180	**382**	12%	41%	53%	202
Eastern Small-footed Bat	Myotis leibii	S	21	51	133	**205**	10%	25%	35%	72
New England Cottontail	Sylvilagus transitionalis	P	2	5	70	**77**	3%	6%	9%	7
Mammal Total			**69**	**212**	**383**	**664**	**10%**	**32%**	**42%**	**281**
Wood Turtle	Glyptemys insculpta	A	176	282	1750	**2208**	8%	13%	21%	458
Spotted Turtle	Clemmys guttata	S	112	270	1122	**1504**	7%	18%	25%	382
Bog Turtle	Glyptemys muhlenbergii	S	52	16	372	**440**	12%	4%	15%	68
Reptile Total			**340**	**568**	**3244**	**4152**	**8%**	**14%**	**22%**	**908**
Grand Total			**711**	**1108**	**5551**	**7370**	**10%**	**15%**	**25%**	**1,819**

Species of High Concern and High Regional Responsibility: Fifteen species were of high concern (listed in the wildlife action plans by 50-75 percent of the states in which they occur) and of high responsibility (50 percent or more of their full distribution is in this region), and. Only 5 species (33 percent) had enough usable occurrences to report on regional status. Results of the overlay with secured lands showed that 28 percent (136 individual locations) were secured (Table 4). This ranged from 98 locations (25 percent) for triangle floater to 4 locations for Spruce Knob three-tooth (100 percent) and long-tailed or rock shrew (61 percent). No species of birds or reptiles in this group had adequate data sufficiency for reporting regional secured lands status. Occurrence data was not sufficiently distributed to report regional status for Blueback Herring, Comely Shiner, Alewife Floater, and Redbelly/Red-bellied Cooter/Turtle. No usable occurrence data was available at all for Atlantic Brant, Little Gull, Hickory Shad, Alewife, Atlantic Tomcod, and Shield Darter.

Table 4. Species of High Concern and High Regional Responsibility. This table shows the securement status of species that met minimum criteria for regional reporting (data adequacy of sufficient (S), adequate (A), or poor (P)). Securement refers to the number of species locations on land secured for multiple uses (GAP 3) or land protected for biodiversity (GAP 1-2). Table is sorted by taxa group and total secured. NU indicates that the data was not usable, we show it here only as an example of localized patterns, not regional patterns in securement.

	Common Name	Standard Name	Data	GAP 1 & 2	GAP 3	Un-secured	Total	% Gap 1-2	% Gap 3	% Secured	Total Secured
	Tonguetied Minnow	Exoglossum laurae	S		4	6	10	0%	40%	40%	4
Fish Total					**4**	**6**	**10**	**0%**	**40%**	**40%**	4
	Triangle Floater	Alasmidonta undulata	P	26	72	288	386	7%	19%	25%	98
	Eastern Pearlshell	Margaritifera margaritifera	P		7	35	42	0%	17%	17%	7
	Spruce Knob Three-tooth	Triodopsis picea	P	3	1		4	75%	25%	100%	4
Inverts Total				**29**	**80**	**323**	**432**	**7%**	**19%**	**25%**	**109**
	Long-tailed or Rock Shrew	Sorex dispar	A	6	17	15	38	16%	45%	61%	23
Mammal Total				**6**	**17**	**15**	**38**	**16%**	**45%**	**61%**	23
Grand Total				**35**	**101**	**344**	**480**	**7%**	**21%**	**28%**	**136**
Data not usable											
Fish	**Blueback Herring**	Alosa aestivalis	NU			2	2	x	x	x	x
Fish	**Comely Shiner**	Notropis amoenus	NU			2	2	x	x	x	x
Inverts	**Alewife Floater**	Anodonta implicata	NU			3	3	x	x	x	x
Reptile	**Red-bellied Cooter**	Pseudemys rubriventris	NU			1	1	x	x	x	x

Species of Moderate Concern and High Regional Responsibility: Twenty-two species were of moderate concern (listed in the wildlife action plans by 25-50 percent of the states in which they occur), and of high regional responsibility (50 percent or more of their full distribution is in this region). Only two species (9 percent) had enough usable occurrences across their northeast range to report regional status. Results of the overlay with secured lands showed that only one species, the variegate darter, had any securement and this amounted to two individual locations (Table 5). No species of amphibians, birds, or mammals in this group had adequate data sufficiency for reporting regional secured lands status. Occurrence data was not sufficiently distributed to report regional status for Great Cormorant, Tessellated Darter, Threespine Stickleback, Pearl Dace, Swallowtail Shiner, Eastern Lampmussel, Fisher, Smoky Shrew. No usable occurrence data was available at all for New Jersey Chorus Frog, Mink Frog, Black Guillemot, White Catfish, Fourspine Stickleback, Spotted/Margined Madtom, Sea Lamprey, Buffalo Pebblesnail, Rust Glyph Snail, Chesapeake Ambersnail, Baffled Three-tooth, and Five-tooth/Cylindrically-ornate Wood Snail.

Table 5. Species of Moderate Concern and High Regional Responsibility. This table shows the securement status of species that met minimum criteria for regional reporting (data adequacy of sufficient (S), adequate (A), or poor (P)). Securement refers to the number of species locations on land secured for multiple uses (GAP 3) or land protected for biodiversity (GAP 1-2). Table is sorted by taxa group and by the total number of secured occurrences. NU indicates that the data was not usable, we show it here only as an example of localized patterns; not regional patterns in securement.

	Common Name	Standard Name	Data	GAP 1-2	GAP 3	Un-secured	Total	% Gap 3	% Secured	Total Secured
	Potomac Sculpin	Cottus girardi	p			2	2	0%	0%	0
	Variegate Darter	Etheostoma variatum	p		2	5	7	29%	29%	2
Fish Total					**2**	**7**	**9**	22%	22%	2
Grand Total					**2**	**7**	**9**	22%	22%	2
Data Not Usable										
Bird	**Great Cormorant**	Phalacrocorax carbo	NU	4	6	1	11	x	x	x
Fish	**Pearl Dace**	Margariscus margarita	NU			2	2	x	x	x
Fish	**Swallowtail Shiner**	Notropis procne	NU			3	3	x	x	x
Fish	**Tessellated Darter**	Etheostoma olmstedi	NU			5	5	x	x	x
Fish	**Threespine Stickleb**	Gasterosteus aculeatus	NU			1	1	x	x	x
Inverts	**Eastern Lampmusse**	Lampsilis radiata	NU	4	1	20	25	x	x	x
Mammal	**Fisher**	Martes pennanti	NU	3	1	1	5	x	x	x
Mammal	**Smoky Shrew**	Sorex fumeus	NU	2	5	2	9	x	x	x

Species of Low Concern and High Regional Responsibility: Thirty-nine species were of low concern (listed in the wildlife action plans by 0-25 percent of the states in which they occur), and of high regional responsibility (50 percent or more of their full distribution is in this region). We did not have sufficient data to report regional trends for any of them and we only had any usable occurrences at all for 7 of them (Table 6). No usable occurrence data was available at all for Northern Dusky Salamander, Mountain Dusky Salamander, Northern Two-lined Salamander, Northern Red-backed Salamander, Satinfin Shiner, Sheepshead Minnow, Bluespotted Sunfish, Chain Pickerel, Cutlips Minnow, Banded Killifish, Mummichog, Redbreast Sunfish, Pumpkinseed, Striped Bass, Ninespine Stickleback, Blacknose Dace, Fallfish, Hogchoker, Eastern Mud Minnow, Coastal Plain Tigersnail, Temperate Coil, Squat Duskysnail, Pupa Dusky Snail, Winding Mantleslug, Great Lakes Physa, Vernal Physa, Vertigo bollesiana, Olive Vertigo, Crested Vertigo, Star-nosed Mole, Woodland Jumping Mouse, and Hairy-tailed Mole

Table 6: Species of Low Concern and High Regional Responsibility. This table shows the seven species for which we had any usable occurrence locations; however the geographic distribution of these occurrences covers such a limited portion of their northeast state range that the results below cannot be used to indicate a regional pattern (e.g. data sufficiency = NU: not usable)

Data not Usable	Common Name	Standard Name	Data	GAP 1-2	GAP 3	Un-secured	Total
Amphibian	**Wehrle's Salamander**	Plethodon wehrlei	NU			6	6
Bird	**Great Black-backed Gull**	Larus marinus	NU		1		1
Fish	**Blue Ridge Sculpin**	Cottus caeruleomentum	NU			1	1
Fish	**Eastern Silvery Minnow**	Hybognathus regius	NU	2	4	32	38
Inverts	**Angular Disc**	Discus catskillensis	NU		2		2
Inverts	**Coastal Marsh Snail**	Littoridinops tenuipes	NU		1	3	4
Inverts	**Virginia River Snail**	Elimia virginica	NU	1		7	8

<u>Species of Limited Distribution and High Regional Responsibility:</u> Fifty-three species were of high regional responsibility (50 percent or more of their full distribution is in this region), but were only present in 2 or 3 states. For 26 of these species (49 percent) we had usable occurrences in enough states to report regional status. Results of the overlay with secured lands showed that 36 percent (84 individual locations) were secured (Table 7). This ranged from a high of 22 (96 percent) for the cow knob salamander to 0 for five fish and invertebrates. Six species had over 50 percent of their known locations secured: Razorbill, mountain red-bellied dace, glassy darter, yellow bog anarta, blue ridge springsnail, groundwater planarian. Overall, fish had the most secured locations (39) but amphibians (71 percent) had the highest percentages of their occurrences on secured lands. No usable occurrence data was available for Cumberland Plateau Salamander, Shenandoah Mountain Salamander, Bluestone Sculpin, Longfin Darter, Striped Killfish, Blueside Shiner, Longhorn Sculpin, Sharpnose Darter, Pipefish, A Spire Snail, Oyster, Appalachia Bellytooth, Rader's/Maryland Glyph Snail, Seep Mudalia, Ridged Lioplax, Canadian Duskysnail, Balsam Globe, Lamellate Supercoil, Natural Bridge Supercoil, Round Peaclam, Shale Pebblesnail, Bear Creek Siltmouth, Carter Three-toothed Snail, Pittsylvania Three-tooth, Cupped Vertigo, Maryland Shrew, Short-headed Garter Snake

Table 7: Species of Limited Distribution and High Regional Responsibility. This table shows the securement status of species that met minimum criteria for regional reporting (data adequacy of sufficient (S), adequate (A), or poor (P)). Securement refers to the number of species locations on land secured for multiple uses (GAP 3) or land protected for biodiversity (GAP 1-2). Table is sorted by taxa group and by the total number of secured occurrences.

	Common Name	Standard name	Data	GAP 1-2	GAP 3	Un-Secured	Total	% GAP 1-2	% GAP 3	% Secured	Total Secured
	Cow Knob Salamander	Plethodon punctatus	S	10	12	1	23	43%	52%	96%	22
	Black Mountain Salamander	Desmognathus welteri	A		3	9	12	0%	25%	25%	3
Amphibian Total				**10**	**15**	**10**	**35**	**29%**	**43%**	**71%**	**25**
	Razorbill	Alca torda	P	3	1	2	6	50%	17%	67%	4
	Atlantic Puffin	Fratercula arctica	P	2		2	4	50%	0%	50%	2
Bird Total				**5**	**1**	**4**	**10**	**50%**	**10%**	**60%**	**6**
	Mountain Redbelly Dace	Phoxinus oreas	A		15	8	23	0%	65%	65%	15
	Glassy Darter	Etheostoma vitreum	P	1	6	6	13	8%	46%	54%	7
	Bigmouth Chub	Nocomis platyrhynchus	A		6	18	24	0%	25%	25%	6
	Candy Darter	Etheostoma osburni	A		4	11	15	0%	27%	27%	4
	Kanawha Minnow	Phenacobius teretulus	A	1	1	4	6	17%	17%	33%	2
	Appalachia Darter	Percina gymnocephala	A		1	2	3	0%	33%	33%	1
	Cheat Minnow	Pararhinichthys bowersi	A		1	6	7	0%	14%	14%	1
	Checkered Sculpin	Cottus sp. 7	A		1	1	2	0%	50%	50%	1
	Spotted Darter	Etheostoma maculatum	A		1	2	3	0%	33%	33%	1
	Torrent Sucker	Thoburnia rhothoeca	A		1	1	2	0%	50%	50%	1
	Longhead Darter	Percina macrocephala	A			8	8	0%	0%	0%	0
	New River Shiner	Notropis scabriceps	A			4	4	0%	0%	0%	0
	Stripeback Darter	Percina notogramma	P			3	3	0%	0%	0%	0
Fish Total				**2**	**37**	**74**	**113**	**2%**	**33%**	**35%**	**39**
	James Spinymussel	Pleurobema collina	A		4	15	19	0%	21%	21%	4
	Appalachian Springsnail	Fontigens bottimeri	S		3	7	10	0%	30%	30%	3
	New England Siltsnail	Floridobia winkleyi	P		2	6	8	0%	25%	25%	2
	Yellow Bog Anarta	Anarta luteola	P	1	1		2	50%	50%	100%	2
	Blue Ridge Springsnail	Fontigens orolibas	P	1			1	100%	0%	100%	1
	Groundwater Planarian sp.	Procotyla typhlops	A		1		1	0%	100%	100%	1
	Yellow Lance	Elliptio lanceolata	A		1	27	28	0%	4%	4%	1
	Cave Lumbriculid Worm sp.	Stylodrilus beattiei	S			4	4	0%	0%	0%	0
	Hoffmaster's Cave Planarian	Macrocotyla hoffmasteri	S			5	5	0%	0%	0%	0
Inverts Total				**2**	**12**	**64**	**78**	**3%**	**15%**	**18%**	**14**
Grand Total				**19**	**65**	**152**	**236**	**8%**	**28%**	**36%**	**84**

Species of Widespread Concern and Low Regional Responsibility: One hundred and seventeen species were of widespread concern (listed in the wildlife action plans by 75-100 percent of the states in which they occur), but of low regional responsibility (less than 50 percent of their full distribution is in this region). For 80 species (68 percent) we had usable occurrences in enough states within their northeast range to report regional status. Results of the overlay with secured lands showed that 36 percent (4,589 individual locations) were secured; the most secured locations of any group (Table 8a and b). This ranged from a high of 1,033 (32 percent) for bald eagle to 0 for eight fish species. Twenty-one species had over 50 percent of their known locations secured, the highest being broadhead skink (100 percent) Overall, birds had the most secured locations (3,452) followed by reptiles (590) and amphibians (434). Amphibians (56 percent) and mammals (39 percent) had the highest percentages of their occurrences on secured lands.

Occurrence data was not sufficiently distributed to report regional trends for Whip-poor-will, Black-billed Cuckoo, Northen Bobwhite, Olive-sided Flycatcher, Wood Thrush, Field Sparrow, Eastern Meadowlark, Brown Thrasher, Willet, Blue-winged Warbler, Canada Warbler, American Eel, Least Brook Lamprey, Silver-haired Bat, Eastern Red Bat, Hoary Bat, Queen Snake, and Eastern Box Turtle. No usable occurrence data was available for American Black Duck, Ruddy Turnstone, Sanderling, Semipalmated Sandpiper, Prairie Warbler, Willow Flycatcher, Short-billed Dowitcher, Marbled Godwit, Hudsonian Godwit, Whimbrel, Red Necked Phalarope, Eastern/Rufous-sided Towhee, Horned Grebe, American Woodcock, Louisiana Waterthrush, Greater Yellowlegs, Solitary Sandpiper, Lake Trout, and Pine Marten

Table 8a: Species of Widespread Concern and Low Regional Responsibility. This table shows the securement status of species that met minimum criteria for regional reporting (data adequacy of sufficient (S), adequate (A), or poor (P)). Securement refers to the number of species locations on land secured for multiple uses (GAP 3) or land protected for biodiversity (GAP 1-2). Table is sorted by taxa group and by the total number of secured occurrences.

	Common Name	Standard name	Data	GAP 1-2	GAP 3	Un-Secured	Total	% GAP 1-2	% GAP 3	% Secured	Total Secured
	Eastern Spadefoot Toad	Scaphiopus holbrookii	A	324	24	164	**512**	63%	5%	68%	**348**
	Eastern/Tiger Salamander	Ambystoma tigrinum	S	21	14	104	**139**	15%	10%	25%	**35**
	Green Salamander	Aneides aeneus	A	10	23	30	**63**	16%	37%	52%	**33**
	Eastern Hellbender	Cryptobranchus alleganiensis	S	2	9	39	**50**	4%	18%	22%	**11**
	Upland Chorus Frog	Pseudacris feriarum	P		4	4	**8**	0%	50%	50%	**4**
	Mountain Chorus Frog	Pseudacris brachyphona	P		3	1	**4**	0%	75%	75%	**3**
Amphibian Total				**357**	**77**	**342**	**776**	**46%**	**10%**	**56%**	**434**
	Bald Eagle	Haliaeetus leucocephalus	S	563	470	2190	**3223**	17%	15%	32%	**1033**
	Northern Harrier	Circus cyaneus	S	247	96	312	**655**	38%	15%	52%	**343**
	Piping Plover	Charadrius melodus	S	169	91	391	**651**	26%	14%	40%	**260**
	Least Tern	Sternula antillarum	S	110	84	348	**542**	20%	15%	36%	**194**
	Common Tern	Sterna hirundo	A	126	45	326	**497**	25%	9%	34%	**171**
	Least Bittern	Ixobrychus exilis	S	56	91	123	**270**	21%	34%	54%	**147**
	American Bittern	Botaurus lentiginosus	A	28	115	135	**278**	10%	41%	51%	**143**
	Great Blue Heron	Ardea herodias	A	51	77	305	**433**	12%	18%	30%	**128**
	Peregrine Falcon	Falco peregrinus	S	64	30	207	**301**	21%	10%	31%	**94**
	Pied-billed Grebe	Podilymbus podiceps	A	30	58	142	**230**	13%	25%	38%	**88**
	Grasshopper Sparrow	Ammodramus savannarum	A	10	76	243	**329**	3%	23%	26%	**86**
	Black-crowned Night-heron	Nycticorax nycticorax	A	46	12	65	**123**	37%	10%	47%	**58**
	Short-eared Owl	Asio flammeus	S	28	26	120	**174**	16%	15%	31%	**54**
	Snowy Egret	Egretta thula	A	34	9	65	**108**	31%	8%	40%	**43**
	Sedge Wren	Cistothorus platensis	S	17	24	63	**104**	16%	23%	39%	**41**
	Black Skimmer	Rynchops niger	A	36	5	67	**108**	33%	5%	38%	**41**
	Common Moorhen	Gallinula chloropus	A	14	24	49	**87**	16%	28%	44%	**38**
	Cerulean Warbler	Dendroica cerulea	P	30	7	15	**52**	58%	13%	71%	**37**
	Northern Goshawk	Accipiter gentilis	P	17	16	23	**56**	30%	29%	59%	**33**
	Golden-winged Warbler	Vermivora chrysoptera	A	20	11	29	**60**	33%	18%	52%	**31**
	King Rail	Rallus elegans	A	19	12	30	**61**	31%	20%	51%	**31**
	Sharp-Shinned Hawk	Accipiter striatus	P	12	17	17	**46**	26%	37%	63%	**29**
	Little Blue Heron	Egretta caerulea	A	22	6	52	**80**	28%	8%	35%	**28**
	Spruce Grouse	Falcipennis canadensis	S	15	10	10	**35**	43%	29%	71%	**25**
	Vesper Sparrow	Pooecetes gramineus	P	19	5	107	**131**	15%	4%	18%	**24**
	Black Tern	Chlidonias niger	S	4	19	24	**47**	9%	40%	49%	**23**
	Yellow-crowned Night-heron	Nyctanassa violacea	A	19	3	79	**101**	19%	3%	22%	**22**
	Bobolink	Dolichonyx oryzivorus	P	11	11	83	**105**	10%	10%	21%	**22**
	Tricolored Heron	Egretta tricolor	P	17	2	31	**50**	34%	4%	38%	**19**
	Red Knot	Calidris canutus	P	17	2	45	**64**	27%	3%	30%	**19**
	Barn Owl	Tyto alba	A	12	6	143	**161**	7%	4%	11%	**18**
	Henslow's Sparrow	Ammodramus henslowii	S	6	9	37	**52**	12%	17%	29%	**15**
	Upland Sandpiper	Bartramia longicauda	S	5	9	290	**304**	2%	3%	5%	**14**
	Long-eared Owl	Asio otus	A	7	6	30	**43**	16%	14%	30%	**13**
	Black Rail	Laterallus jamaicensis	A	6	6	14	**26**	23%	23%	46%	**12**
	Kentucky Warbler	Oporornis formosus	P	6	6	15	**27**	22%	22%	44%	**12**
	Gull-billed Tern	Gelochelidon nilotica	S	5	6	19	**30**	17%	20%	37%	**11**
	Harlequin Duck	Histrionicus histrionicus	P	4	7	25	**36**	11%	19%	31%	**11**
	Prothonotary Warbler	Protonotaria citrea	P	4	6	8	**18**	22%	33%	56%	**10**
	Yellow Rail	Coturnicops noveboracensis	P	4	3	1	**8**	50%	38%	88%	**7**
	American Three-toed Woodpecker	Picoides dorsalis	S	5	2	3	**10**	50%	20%	70%	**7**
	Bay-breasted Warbler	Dendroica castanea	P	2	3		**5**	40%	60%	100%	**5**
	Golden Eagle	Aquila chrysaetos	P	2	3	9	**14**	14%	21%	36%	**5**
	Loggerhead Shrike	Lanius ludovicianus	S	1	2	20	**23**	4%	9%	13%	**3**
	Common Nighthawk	Chordeiles minor	P	1	1	10	**12**	8%	8%	17%	**2**
	Dickcissel	Spiza americana	P		2	16	**18**	0%	11%	11%	**2**
Bird Total				**1921**	**1531**	**6336**	**9788**	**20%**	**16%**	**35%**	**3452**

Table 8b: Species of Widespread Concern and Low Regional Responsibility. This table shows the securement status of species that met minimum criteria for regional reporting (data adequacy of sufficient (S), adequate (A), or poor (P)). Securement refers to the number of species locations on land secured for multiple uses (GAP 3) or land protected for biodiversity (GAP 1-2). Table is sorted by taxa group and by the total number of secured occurrences..

	Common Name	Standard name	Data	GAP 1-2	GAP 3	Un-Secured	Total	% GAP 1-2	% GAP 3	% Secured	Total Secured
	American Brook Lamprey	Lampetra appendix	P	4	3	33	40	10%	8%	18%	7
	Blackchin Shiner	Notropis heterodon	A	2	1	22	25	8%	4%	12%	3
	River Redhorse	Moxostoma carinatum	P	1	1	13	15	7%	7%	13%	2
	Ironcolor Shiner	Notropis chalybaeus	P		1	3	4	0%	25%	25%	1
	Ohio Lamprey	Ichthyomyzon bdellium	A	1		20	21	5%	0%	5%	1
	Bluebreast Darter	Etheostoma camurum	A			23	23	0%	0%	0%	0
	Channel Darter	Percina copelandi	A			23	23	0%	0%	0%	0
	Eastern Sand Darter	Ammocrypta pellucida	S			20	20	0%	0%	0%	0
	Mooneye	Hiodon tergisus	A			21	21	0%	0%	0%	0
	Mountain Brook Lamprey	Ichthyomyzon greeleyi	P			6	6	0%	0%	0%	0
	Northern Brook Lamprey	Ichthyomyzon fossor	S			12	12	0%	0%	0%	0
	Streamline Chub	Erimystax dissimilis	P			1	1	0%	0%	0%	0
	Warmouth	Lepomis gulosus	P			2	2	0%	0%	0%	0
Fish Total				**8**	**6**	**199**	**213**	**4%**	**3%**	**7%**	**14**
	Cherrystone Drop Snail	Hendersonia occulta	A	7	5	7	19	37%	26%	63%	12
	Black Sandshell	Ligumia recta	A	2	3	23	28	7%	11%	18%	5
	Deertoe	Truncilla truncata	A		2	10	12	0%	17%	17%	2
	Pocketbook Mussel	Lampsilis ovata	A		2	19	21	0%	10%	10%	2
	Elktoe	Alasmidonta marginata	P		1	12	13	0%	8%	8%	1
Inverts Total				**9**	**13**	**71**	**93**	**10%**	**14%**	**24%**	**22**
	Indiana Bat	Myotis sodalis	S	19	17	89	125	15%	14%	29%	36
	Southern Bog Lemming	Synaptomys cooperi	P	8	15	19	42	19%	36%	55%	23
	Appalachian Cottontail	Sylvilagus obscurus	S		12	3	15	0%	80%	80%	12
	Least Shrew	Cryptotis parva	P	2	2	3	7	29%	29%	57%	4
	Least Weasel	Mustela nivalis	A	2		6	8	25%	0%	25%	2
Mammal Total				**31**	**46**	**120**	**197**	**16%**	**23%**	**39%**	**77**
	Blanding's Turtle	Emydoidea blandingii	S	96	255	851	1202	8%	21%	29%	351
	Timber Rattlesnake	Crotalus horridus	A	59	152	156	367	16%	41%	57%	211
	Corn Snake	Pantherophis guttatus	P	13		35	48	27%	0%	27%	13
	Eastern Hognose Snake	Heterodon platirhinos	P	5	7	28	40	13%	18%	30%	12
	Broadhead Skink	Plestiodon laticeps	P		3		3	0%	100%	100%	3
Reptile Total				**173**	**417**	**1070**	**1660**	**10%**	**25%**	**36%**	**590**
Grand Total				**2499**	**2090**	**8138**	**12727**	**20%**	**16%**	**36%**	**4589**

<u>Species of High Concern and Low Regional Responsibility:</u> Seventy-eight species were of high concern (listed in the wildlife action plans by 50-75 percent of the states in which they occur), but of low regional responsibility (less than 50 percent of their full distribution is in this region). For 36 of these species we had usable occurrences in enough states within their northeast range to report regional status. Results of the overlay with secured lands showed that 32 percent (698 individual locations) were secured (Table 9). This ranged from a high of 103 (34 percent) for osprey to 0 for two fish species. Nine species had over 50 percent of their known locations secured: northern leopard frog, blackpoll warbler, blackburnian warbler, acadian flycatcher, northern parula, brown pelican, gray-cheeked thrush, and striped whitelip, although we do not know how comprehensive the inventories were, especially for warblers and other birds. Overall, birds had the most secured locations (596) followed by amphibians (95). Birds (35 percent), reptiles (31 percent) and amphibians (30 percent) had the highest percentages of their occurrences on secured lands.

Occurrence data was not sufficiently distributed to report regional trends for Longtail Salamander, Red-shouldered Hawk, Broad-winged Hawk, Veery, Swainson's Thrush, Black-throated Blue Warbler, Black-throated Green Warbler, Horned Lark, Yellow-breasted Chat, Black-and-White Warbler, Hooded Warbler, Slimy Sculpin, Swamp Darter, Sauger, Bobcat, Copperhead, Rough Green Snake, and Smooth Green

Snake. No usable occurrence data was available for Nelson's Sharp-tailed Sparrow, Lesser Scaup, Greater Scaup, Canvasback, Ruffed Grouse, Dunlin, Chimney Swift, Long-tailed Duck/Old Squaw, Red-throated Loon, Red Crossbill, White-winged Scoter, Black Scoter, Surf Scoter, Northern Gannet, Scarlet Tanager, American Golden-plover, Black-bellied Plover, Buff-breasted Sandpiper, Yellow-throated Vireo, Bowfin, Lake Whitefish, Logperch/Chesapeake Logperch, Disc Gyro, and Paper Pondshell

Table 9: Species of High Concern and Low Regional Responsibility. This table shows the securement status of species that met minimum criteria for regional reporting (data adequacy of sufficient (S), adequate (A), or poor (P)). Securement refers to the number of species locations on land secured for multiple uses (GAP 3) or land protected for biodiversity (GAP 1-2). Table is sorted by taxa group and total secured.

	Common Name	Standard name	Data	GAP 1-2	GAP 3	Un-Secured	Total	% GAP 1-2	% GAP 3	% Secured	Total Secured
	Marbled Salamander	Ambystoma opacum	P	13	63	199	275	5%	23%	28%	76
	Northern Leopard Frog	Rana pipiens	P	4	8	8	20	20%	40%	60%	12
	Fowler's Toad	Bufo fowleri	P	3	2	11	16	19%	13%	31%	5
	Common Mudpuppy	Necturus maculosus	P	2		7	9	22%	0%	22%	2
Amphibian Total				**22**	**73**	**225**	**320**	**7%**	**23%**	**30%**	**95**
	Osprey	Pandion haliaetus	P	41	62	197	300	14%	21%	34%	103
	Common Loon	Gavia immer	A	25	64	312	401	6%	16%	22%	89
	Cooper's Hawk	Accipiter cooperii	P	61	14	171	246	25%	6%	30%	75
	Blackpoll Warbler	Dendroica striata	P	61	2		63	97%	3%	100%	63
	Red-headed Woodpecker	Melanerpes erythrocephalus	P	46	7	118	171	27%	4%	31%	53
	Northern Parula	Parula americana	P	20	19	25	64	31%	30%	61%	39
	Great Egret	Ardea alba	A	29	7	61	97	30%	7%	37%	36
	Sora Rail	Porzana carolina	S	14	16	35	65	22%	25%	46%	30
	Cattle Egret	Bubulcus ibis	A	16	4	21	41	39%	10%	49%	20
	Marsh Wren	Cistothorus palustris	P	7	7	18	32	22%	22%	44%	14
	Blackburnian Warbler	Dendroica fusca	P	10	3	6	19	53%	16%	68%	13
	Forster's Tern	Sterna forsteri	P	11	1	25	37	30%	3%	32%	12
	Rusty Blackbird	Euphagus carolinus	P	4	7	16	27	15%	26%	41%	11
	Acadian Flycatcher	Empidonax virescens	P	6	4	3	13	46%	31%	77%	10
	Cape May Warbler	Dendroica tigrina	P	2		3	5	40%	0%	40%	2
	Chuck-will's-widow	Caprimulgus carolinensis	P		2	2	4	0%	50%	50%	2
	Royal Tern	Thalasseus maximus	P	2		1	3	67%	0%	67%	2
	Brown Pelican	Pelecanus occidentalis	P	1			1	100%	0%	100%	1
	Gray-Cheeked Thrush	Catharus minimus	P	1			1	100%	0%	100%	1
Bird Total				**357**	**219**	**1014**	**1590**	**22%**	**14%**	**36%**	**576**
	Longnose Sucker	Catostomus catostomus	P	4	7	125	136	3%	5%	8%	11
	Burbot	Lota lota	P		2	6	8	0%	25%	25%	2
	Silver Lamprey	Ichthyomyzon unicuspis	A	1		16	17	6%	0%	6%	1
	Stonecat	Noturus flavus	P			15	15	0%	0%	0%	0
	Trout-perch	Percopsis omiscomaycus	A			2	2	0%	0%	0%	0
Fish Total				**5**	**9**	**164**	**178**	**3%**	**5%**	**8%**	**14**
	Rainbow	Villosa iris	P	2		9	11	18%	0%	18%	2
	Striped Whitelip	Webbhelix multilineata	A	1	1	1	3	33%	33%	67%	2
	Wavyrayed Lampmussel	Lampsilis fasciola	A		2	7	9	0%	22%	22%	2
	Creek heelsplitter	Lasmigona compressa	P		1	3	4	0%	25%	25%	1
	Fragile Papershell	Leptodea fragilis	P	1		16	17	6%	0%	6%	1
	Mossy Valvata/Boreal Tur	Valvata sincera	P		1	3	4	0%	25%	25%	1
	Cylindrical Papershell	Anodontoides ferussacianus	P			1	1	0%	0%	0%	0
Inverts Total				**4**	**5**	**40**	**49**	**8%**	**10%**	**18%**	**9**
Reptile	**Northern Map Turtle**	Graptemys geographica	A	3	1	9	13	23%	8%	31%	4
Reptile Total				**3**	**1**	**9**	**13**	**23%**	**8%**	**31%**	**4**
Grand Total				**391**	**307**	**1452**	**2150**	**18%**	**14%**	**32%**	**698**

Summary Across the Concern and Responsibility Groups: Across the seven reporting groups, the region had the highest level of inventory and securement for species of widespread concern and low responsibility (12,727 locations, 36 percent secured), this was also the group with the highest level of usable data (Figure 1, Table 10). The next highest group was the widespread concern and high responsibility (7,360 locations, 25 percent secured). This suggests that concern has been a primary motivation for conservation. Limited distribution species also had high levels of securement but much fewer locations (36 percent of 232 locations).

Securement levels were greater for species in the low responsibility group than the high responsibility group. For example, in the widespread concern group, securement was 25 percent high and 36 percent for low. Likewise in the high concern group securement was 28 percent for high but 32 percent for low. The species with restricted distributions (two or three states only) were the exception as they had 36 percent securement (Figure 1). Additionally there was a noticeable lack of inventory and useable data from our data sources for high responsibility species of moderate to low concern, where in some case over 75 percent of these species didn't have adequate data sufficiency to be included in the analysis.

Across the taxonomic groups, birds had the highest levels of inventory and the most locations secured (36 percent secured out of 11,849 locations, Table 10, Figure 2). Next were reptiles (26 percent out of 5,825 locations) and amphibians (40 percent out of 2,099). Mammals had the highest percentage of secured locations (42 percent out of 899 locations, Table 10)

Figure 1. Secured lands by concern and responsibility groups. The chart shows the percentage of all species occurrences within each combination of concern and responsibility that are located on secured or protected land in the Northeast and Mid-Atlantic states. The number of individual species per group is given in parenthesis.

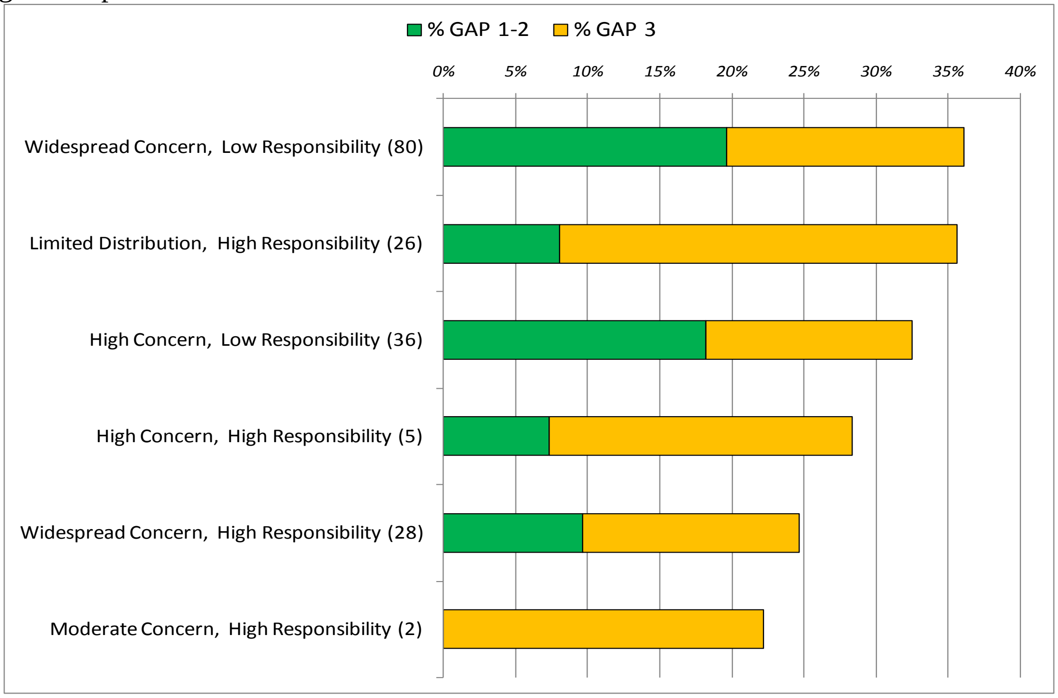
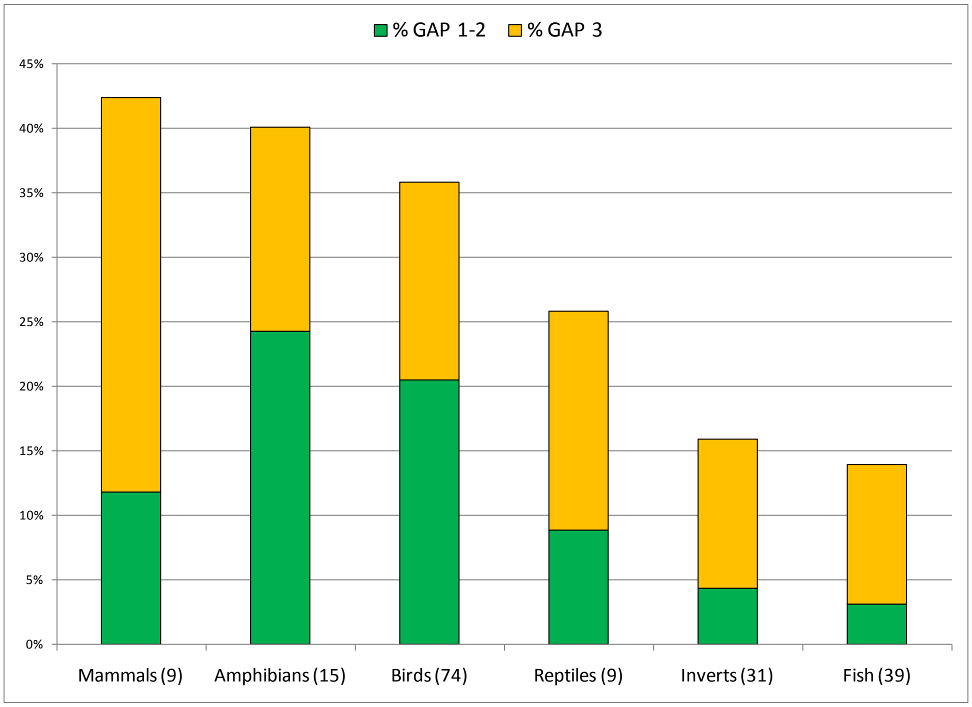


Table 10: Summary of species by taxonomic group, global rank, and securement status. Species with sufficient precise element occurrences in the northeast were used to calculate the percent of occurrences falling in securement (GAP 1-3) or protected (GAP1-2) lands. Global conservation ranks (G-rank) are defined as follows: G1= Critically Imperiled, G2 = Imperiled, G3 = Vulnerable, G4 Apparently Secure, G5 = Secure, common, widespread.

TAXA	Group	# of Species	G1	G2	G3	G4	G5	Total	GAP 1-2	GAP 3	Un-Secured	Total	% GAP 1-2	% GAP 3	% Secured	Total secured
Amphibian Total	WC:HR	3				300	668	968	120	168	680	968	12%	17%	30%	288
Bird Total	WC:HR	7				273	188	461	148	66	247	461	32%	14%	46%	214
Fish Total	WC:HR	5			31	3	18	52	3	4	45	52	6%	8%	13%	7
Inverts Total	WC:HR	7	77		748	248		1,073	31	90	952	1,073	3%	8%	11%	121
Mammal Total	WC:HR	3			664			664	69	212	383	664	10%	32%	42%	281
Reptile Total	WC:HR	3			440	2,208	1,504	4,152	340	568	3,244	4,152	8%	14%	22%	908
Widespread Concern, High Responsibility Total			**77**		**1,883**	**3,032**	**2,378**	**7,370**	**711**	**1,108**	**5,551**	**7,370**	**10%**	**15%**	**25%**	**1,819**
Fish Total	HC:HR	1				10		10		4	6	10	0%	40%	40%	4
Inverts Total	HC:HR	3			4	428		432	29	80	323	432	7%	19%	25%	109
Mammal Total	HC:HR	1				38		38	6	17	15	38	16%	45%	61%	23
High Concern, High Responsibility Total					**4**	**476**		**480**	**35**	**101**	**344**	**480**	**7%**	**21%**	**28%**	**136**
Fish Total	MC:HR	2				2	7	9		2	7	9		22%	22%	2
Moderate Concern, High Responsibility Total						**2**	**7**	**9**		**2**	**7**	**9**		**22%**	**22%**	**2**
Amphibian Total	LD:HR	2			23	12		35	10	15	10	35	29%	43%	71%	25
Bird Total	LD:HR	2					10	10	5	1	4	10	50%	10%	60%	6
Fish Total	LD:HR	13	7	3	29	51	23	113	2	37	74	113	2%	33%	35%	39
Inverts Total	LD:HR	9	20	42	14		2	78	2	12	64	78	3%	15%	18%	14
Limited Distribution, High Responsibility Total			**27**	**45**	**66**	**63**	**35**	**236**	**19**	**65**	**152**	**236**	**8%**	**28%**	**36%**	**84**
Amphibian Total	WC:LR	6			113		663	776	357	77	342	776	46%	10%	56%	434
Bird Total	WC:LR	46			651	1,550	7,587	9,788	1,921	1,531	6,336	9,788	20%	16%	35%	3,452
Fish Total	WC:LR	13			27	138	48	213	8	6	199	213	4%	3%	7%	14
Inverts Total	WC:LR	5				32	61	93	9	13	71	93	10%	14%	24%	22
Mammal Total	WC:LR	5		125		15	57	197	31	46	120	197	16%	23%	39%	77
Reptile Total	WC:LR	5				1,569	91	1,660	173	417	1,070	1,660	10%	25%	36%	590
Widespread Concern, Low Responsibility Total				**125**	**791**	**3,304**	**8,507**	**12,727**	**2,499**	**2,090**	**8,138**	**12,727**	**20%**	**16%**	**36%**	**4,589**
Amphibian Total	HC:LR	4					320	320	22	73	225	320	7%	23%	30%	95
Bird Total	HC:LR	19				28	1,562	1,590	357	219	1,014	1,590	22%	14%	36%	576
Fish Total	HC:LR	5					178	178	5	9	164	178	3%	5%	8%	14
Inverts Total	HC:LR	7					49	49	4	5	40	49	8%	10%	18%	9
Reptile Total	HC:LR	1					13	13	3	1	9	13	23%	8%	31%	4
High Concern, Low Responsibility Total						**28**	**2,122**	**2,150**	**391**	**307**	**1,452**	**2,150**	**18%**	**14%**	**32%**	**698**
Grand Total		**177**	**104**	**170**	**2,744**	**6,905**	**13,049**	**22,972**	**3,655**	**3,673**	**15,644**	**22,972**	**16%**	**16%**	**32%**	**7328**
Amphibian Total	All	15			136	312	1,651	2,099	509	333	1,257	2,099	24%	16%	40%	842
Bird Total	All	74			651	1,851	9,347	11,849	2,431	1,817	7,601	11,849	21%	15%	36%	4,248
Fish Total	All	39	7	3	87	204	274	575	18	62	495	575	3%	11%	14%	80
Inverts Total	All	31	97	42	766	708	112	1,725	75	200	1,450	1,725	4%	12%	16%	275
Mammal Total	All	9		125	664	53	57	899	106	275	518	899	12%	31%	42%	381
Reptile Total	All	9			440	3,777	1,608	5,825	516	986	4,323	5,825	9%	17%	26%	1,502
Grand Total		**177**	**104**	**170**	**2,744**	**6,905**	**13,049**	**22,972**	**3,655**	**3,673**	**15,644**	**22,972**	**16%**	**16%**	**32%**	**7,328**

Lastly, there appears to be a difference of intent between the species for which the states list as high or widespread concern and the global ranks assigned by NatureServe as the majority of the widespread concern species were ranked by NatureServe as G5 (secure, common, widespread abundant) or G4 (apparently secure, uncommon but not rare; some cause for long-term concern). Only one percent of the species with useable data were ranked as G1 (critically imperiled—at very high risk of extinction due to extreme rarity) or G2 (imperiled—at high risk of extinction due to very restricted range, very few populations or other factors) but this might reflect the criteria we used to filter the data. The group ranked G3 (vulnerable—at moderate risk of extinction due to a restricted range, relatively few populations, recent and widespread declines, or other factors) made up 13 percent of the inventoried locations.

Figure 2. Secured lands by taxonomic groups. The chart shows the percentage of all species occurrences within each taxonomic group that are located on secured or protected land in the Northeast and Mid-Atlantic states. The number of individual species per group is given in parenthesis.



References

Please see the data sources (appendix A) and detailed methods (appendix B) sections of the main report for more information on the data sources and analysis methods used in this chapter.

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Appendix 9-1. Regionally significant species: their global conservation rank, scientific name, common name, US Endangered Species rank, distribution, and secured lands regional summary metrics.

				Rank and Distribution Summary from NatureServe							Summary of Precise Occurrences by Secured Land Status						Northeast Current Distribution. L=listed in SWAP, P= Current presence in the state and unlisted in SWAP													
Taxa	Scientific Name	Common Name	Conservation Concern and Regional Responsibility Group	Rounded Global Conservation Rank	Endangered Species Act Status (Interpreted Status): C: Candidate; SC: Species of Concern; LT: Listed threatened; LE: Listed Endangered; (PS): Partial Status, status in only a portion of the species' range; See http://www.natureserve.org/explorer/statusus.htm#status	# of U.S. states currently present within	# of northeast (13) states currently present within	# of northeast state (13) SWAP for which the species is listed	# of northeast states (13) with precise level occurrences available	Data sufficiency for regional reporting; S = Sufficient, A = Adequate, P = Poor, NU = Not Usable (See chapter for definitions)	% Protected	% Secured	# of occurrences on GAP 1 & 2	# of occurrences on GAP 3	# of occurrences on unsecured land	Total # of precise occurrences	CT	DE	ME	MD	MA	NH	NJ	NY	PA	RI	VT	VA	WV	DC
Amphibian	Ambystoma jeffersonianum	Jefferson Salamander	Widespread Concern, High Responsibility	G4		14	10	10	6	A	12	28	37	47	216	300	L			L	L	L	L	L	L		L	L	L	
Amphibian	Ambystoma laterale	Blue-spotted Salamander	Widespread Concern, High Responsibility	G5		14	7	7	4	A	11	30	73	118	453	644	L		L		L	L	L	L			L			
Amphibian	Ambystoma opacum	Marbled Salamander	High Concern, Low Responsibility	G5		27	11	7	4	P	5	28	13	63	199	275	L	P		P	L	L	L	L	L	L		P	P	L
Amphibian	Ambystoma tigrinum	Eastern/Tiger Salamander	Widespread Concern, Low Responsibility	G5	(PS)	37	5	5	4	S	15	25	21	14	104	139		L		L			L	L				L		
Amphibian	Aneides aeneus	Green Salamander	Widespread Concern, Low Responsibility	G3		13	4	4	2	A	16	52	10	23	30	63				L					L			L	L	
Amphibian	Bufo fowleri	Fowler's Toad	High Concern, Low Responsibility	G5		29	12	7	3	P	19	31	3	2	11	16	L	P		P	P	L	L	L	L	L	L	P	P	L
Amphibian	Cryptobranchus alleganiensis	Eastern Hellbender	Widespread Concern, Low Responsibility	G3	(PS)	16	5	5	4	S	4	22	2	9	39	50				L				L	L			L	L	
Amphibian	Desmognathus fuscus	Northern Dusky Salamander	Low Concern, High Responsibility	G5		25	13	2	0	NU							L	P	P	P	P	P	P	P	P	L	P	P	P	L
Amphibian	Desmognathus ochrophaeus	Mountain Dusky Salamander	Low Concern, High Responsibility	G5		8	5	1	0	NU										L				P	P			P	P	
Amphibian	Desmognathus welteri	Black Mountain Salamander	Limited	G4		4	2	1	1	A	0	25		3	9	12												P	L	
Amphibian	Eurycea bislineata	Northern Two-lined Salamander	Low Concern, High Responsibility	G5		14	13	0	0	NU							P	P	P	P	P	P	P	P	P	P	P	P	P	L
Amphibian	Eurycea longicauda	Longtail Salamander	High Concern, Low Responsibility	G5		20	7	4	1	NU	0	19		4	17	21		L		L			L	L	P			P	P	P
Amphibian	Necturus maculosus	Common Mudpuppy	High Concern, Low Responsibility	G5		25	7	4	2	P	22	22	2		7	9	P			L				L	P		L	L	P	
Amphibian	Plethodon cinereus	Northern Red-backed Salamander	Low Concern, High Responsibility	G5		22	13	0	0	NU							P	P	P	P	P	P	P	P	P	P	P	P	P	L
Amphibian	Plethodon kentucki	Cumberland Plateau Salamander	Limited	G4		4	2	1	0	NU																		L	P	
Amphibian	Plethodon punctatus	Cow Knob Salamander	Limited	G3		2	2	2	2	S	43	96	10	12	1	23												L	L	
Amphibian	Plethodon virginia	Shenandoah Mountain Salamander	Limited	G2		2	2	2	0	NU																		L	L	
Amphibian	Plethodon wehrlei	Wehrle's Salamander	Low Concern, High Responsibility	G4		8	5	1	1	NU	0	0			6	6				L				P	P			P	P	
Amphibian	Pseudacris brachyphona	Mountain Chorus Frog	Widespread Concern, Low Responsibility	G5		11	4	3	1	P	0	75		3	1	4				L					L			L	P	
Amphibian	Pseudacris feriarum	Upland//Southeastern Chorus Frog	Widespread Concern, Low Responsibility	G5		14	4	3	1	P	0	50		4	4	8				P					L			L	L	L
Amphibian	Pseudacris kalmi	New Jersey Chorus Frog	Moderate Concern, High Responsibility	G4		5	5	2	0	NU								P		L			P		L			P		
Amphibian	Rana pipiens	Northern Leopard Frog	High Concern, Low Responsibility	G5		35	11	6	4	P	20	60	4	8	8	20	L		P	P	L	L	P	P	L	L	P		L	
Amphibian	Rana septentrionalis	Mink Frog	Moderate Concern, High Responsibility	G5		7	4	1	0	NU									P			L		P			P			
Amphibian	Rana virgatipes	Carpenter Frog	Widespread Concern, High Responsibility	G5		8	4	4	2	A	42	54	10	3	11	24		L		L			L					L		
Amphibian	Scaphiopus holbrookii	Eastern Spadefoot Toad	Widespread Concern, Low Responsibility	G5		23	10	9	5	A	63	68	324	24	164	512	L	L		L	L		P	L	L	L		L	L	
Bird	Accipiter cooperii	Cooper's Hawk	High Concern, Low Responsibility	G5		47	13	7	5	P	25	30	61	14	171	246	L	L	P	P	P	L	L	L	P	P	L	P	L	P
Bird	Accipiter gentilis	Northern Goshawk	Widespread Concern, Low Responsibility	G5		33	11	9	5	P	30	59	17	16	23	56	L		P	L	P	L	L	L	L	L	L		L	
Bird	Accipiter striatus	Sharp-Shinned Hawk	Widespread Concern, Low Responsibility	G5	(PS)	48	12	9	4	P	26	63	12	17	17	46	L	L	P	L	L	P	L	L	L	L	P	P	L	P
Bird	Alca torda	Razorbill	Limited	G5		3	3	3	1	P	50	67	3	1	2	6			L		P		L	L						
Bird	Ammodramus caudacutus	Saltmarsh Sharp-tailed Sparrow	Widespread Concern, High Responsibility	G4		15	10	10	4	P	27	41	12	6	26	44	L	L	L	L	L	L	L	L		L		L		
Bird	Ammodramus henslowii	Henslow's Sparrow	Widespread Concern, Low Responsibility	G4		29	8	9	7	S	12	29	6	9	37	52		L		L	L		L	L	L		L	L	L	P
Bird	Ammodramus maritimus	Seaside Sparrow	Widespread Concern, High Responsibility	G4	(PS)	18	10	9	3	P	28	60	7	8	10	25	L	L	P	L	L	L	L	L		L		L		
Bird	Ammodramus nelsoni	Nelson's Sharp-tailed Sparrow	High Concern, Low Responsibility	G5		23	6	4	0	NU								P	L		P	L	L					L		
Bird	Ammodramus savannarum	Grasshopper Sparrow	Widespread Concern, Low Responsibility	G5	(PS)	47	13	13	8	A	3	26	10	76	243	329	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Bird	Anas rubripes	American Black Duck	Widespread Concern, Low Responsibility	G5		31	13	13	0	NU							L	L	L	L	L	L	L	L	L	L	L	L	L	L
Bird	Aquila chrysaetos	Golden Eagle	Widespread Concern, Low Responsibility	G5		34	6	5	2	P	14	36	2	3	9	14			L	L	P	L	P	L	L		P		P	
Bird	Ardea alba	Great Egret	High Concern, Low Responsibility	G5		42	12	8	6	A	30	37	29	7	61	97	L	L	L	L	P		L	L	L	L	P	P	P	P
Bird	Ardea herodias	Great Blue Heron	Widespread Concern, Low Responsibility	G5		49	13	10	9	A	12	30	51	77	305	433	L	L	L	L	P	L	L	P	L	L	L	P	L	P
Bird	Arenaria interpres	Ruddy Turnstone	Widespread Concern, Low Responsibility	G5		29	9	8	0	NU							L	L	L	L	L		L	L		L	P	P		P
Bird	Asio flammeus	Short-eared Owl	Widespread Concern, Low Responsibility	G5		45	9	11	7	S	16	31	28	26	120	174	L	L	L	L	L		L	L	L	L	L	P	L	P
Bird	Asio otus	Long-eared Owl	Widespread Concern, Low Responsibility	G5		39	10	11	5	A	16	30	7	6	30	43	L	L	L	L	L	P	L	L	L	L	L	P	L	
Bird	Aythya affinis	Lesser Scaup	High Concern, Low Responsibility	G5		41	8	4	0	NU							L	L	P	P	P		L	L	P		P	P	P	P
Bird	Aythya marila	Greater Scaup	High Concern, Low Responsibility	G5		36	9	6	0	NU							L	L	L	P	P		L	L	P		P	L	P	P
Bird	Aythya valisineria	Canvasback	High Concern, Low Responsibility	G5		42	8	4	0	NU							L	L		L	P		L	P	P		P	P	P	P
Bird	Bartramia longicauda	Upland Sandpiper	Widespread Concern, Low Responsibility	G5		35	11	13	11	S	2	5	5	9	290	304	L	L	L	L	L	L	L	L	L	L	L	L	L	P
Bird	Bonasa umbellus	Ruffed Grouse	High Concern, Low Responsibility	G5		39	12	8	0	NU							L	L	P	P	L	L	L	L	P	L	L	P	P	
Bird	Botaurus lentiginosus	American Bittern	Widespread Concern, Low Responsibility	G4		48	13	13	7	A	10	51	28	115	135	278	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Bird	Branta bernicla	Atlantic Brant	High Concern, High Responsibility	G5		15	8	5	0	NU								L	P	L	P		L	L			P	L		
Bird	Bubulcus ibis	Cattle Egret	High Concern, Low Responsibility	G5		36	9	5	5	A	39	49	16	4	21	41	P	L	L	P	P		L	L		L	P			
Bird	Buteo lineatus	Red-shouldered Hawk	High Concern, Low Responsibility	G5		38	13	8	2	NU	40	42	68	3	99	170	L	L	P	L	P	L	L	L	L	P	L	P	P	L
Bird	Buteo platypterus	Broad-winged Hawk	High Concern, Low Responsibility	G5	(PS)	39	13	7	2	NU	21	45	6	7	16	29	L	L	P	L	L	P	L	P	L	L	P	P	P	L
Bird	Calidris alba	Sanderling	Widespread Concern, Low Responsibility	G5		32	8	8	0	NU							L	L	L	L	L		L	L		L	P	P		P
Bird	Calidris alpina	Dunlin	High Concern, Low Responsibility	G5		33	8	5	0	NU								L	P	L	P		P	L		L	P	L		P
Bird	Calidris canutus	Red Knot	Widespread Concern, Low Responsibility	G4	(C)	26	7	9	3	P	27	30	17	2	45	64		L	L	L	L		L	L		L		L		P
Bird	Calidris maritima	Purple Sandpiper	Widespread Concern, High Responsibility	G5		13	8	8	0	NU								L	L	L	P	L	L	L		L	P	L		
Bird	Calidris pusilla	Semipalmated Sandpiper	Widespread Concern, Low Responsibility	G5		25	7	8	0	NU							L	L	L	L	P	L	L	L		L	P	P		P
Bird	Caprimulgus carolinensis	Chuck-will's-widow	High Concern, Low Responsibility	G5		26	7	4	2	P	0	50		2	2	4		P		L	P		L	P				L	L	
Bird	Caprimulgus vociferus	Whip-poor-will	Widespread Concern, Low Responsibility	G5		39	13	13	3	NU	22	33	11	5	33	49	L	L	L	L	L	L	L	L	L	L	L	L	L	P
Bird	Catharus bicknelli	Bicknell's Thrush	Widespread Concern, High Responsibility	G4		4	4	7	3	S	84	95	52	7	3	62		L	L	L		L		L			L	L		
Bird	Catharus fuscescens	Veery	High Concern, Low Responsibility	G5		37	13	7	1	NU	38	42	114	10	174	298	L	L	L	L	P	L	L	P	P	P	L	P	P	P
Bird	Catharus minimus	Gray-Cheeked Thrush	High Concern, Low Responsibility	G5		14	4	2	1	P	100	100	1			1	L		P		P	P	L		P					P
Bird	Catharus ustulatus	Swainson's Thrush	High Concern, Low Responsibility	G5		32	8	4	1	NU	19	75	3	9	4	16	L		P	L	P	P		P	L		P	P	L	P
Bird	Cepphus grylle	Black Guillemot	Moderate Concern, High Responsibility	G5		6	4	1	0	NU									P		P	L		P						
Bird	Chaetura pelagica	Chimney Swift	High Concern, Low Responsibility	G5		40	13	8	0	NU							L	L	L	P	P	P	L	P	L	L	L	L	P	L
Bird	Charadrius melodus	Piping Plover	Widespread Concern, Low Responsibility	G3	LE, LT	30	10	12	9	S	26	40	169	91	391	651	L	L	L	L	L	L	L	L	L	L		L		
Bird	Chlidonias niger	Black Tern	Widespread Concern, Low Responsibility	G4		31	5	7	4	S	9	49	4	19	24	47		L	L	L	P		L	L	L		L			P

Appendix 9-1. Regionally significant species: their global conservation rank, scientific name, common name, US Endangered Species rank, distribution, and secured lands regional summary metrics.

				Rank and Distribution Summary from NatureServe							Summary of Precise Occurrences by Secured Land Status						Northeast Current Distribution. L=listed in SWAP, P= Current presence in the state and unlisted in SWAP													
Taxa	Scientific Name	Common Name	Conservation Concern and Regional Responsibility Group	Rounded Global Conservation Rank	Endangered Species Act Status (Interpreted Status): C: Candidate; SC: Species of Concern; LT: Listed threatened; LE: Listed Endangered; (PS): Partial Status, status in only a portion of the species' range; See http://www.natureserve.org/explorer/statusus.htm#status	# of U.S. states currently present within	# of northeast (13) states currently present within	# of northeast state (13) SWAP for which the species is listed	# of northeast states (13) with precise level occurrences available	Data sufficiency for regional reporting; S = Sufficient, A = Adequate, P = Poor, NU = Not Usable (See chapter for definitions)	% Protected	% Secured	# of occurrences on GAP 1 & 2	# of occurrences on GAP 3	# of occurrences on unsecured land	Total # of precise occurrences	CT	DE	ME	MD	MA	NH	NJ	NY	PA	RI	VT	VA	WV	DC
Bird	Chordeiles minor	Common Nighthawk	Widespread Concern, Low Responsibility	G5		47	13	11	4	P	8	17	1	1	10	12	L	L	L	L	P	L	L	L	L	L	L	P	L	P
Bird	Circus cyaneus	Northern Harrier	Widespread Concern, Low Responsibility	G5		49	13	12	11	S	38	52	247	96	312	655	L	L	P	L	L	L	L	L	L	L	L	L	L	P
Bird	Cistothorus palustris	Marsh Wren	High Concern, Low Responsibility	G5		46	13	9	5	P	22	44	7	7	18	32	L	L	L	L	P	P	L	P	L	L	P	L	L	L
Bird	Cistothorus platensis	Sedge Wren	Widespread Concern, Low Responsibility	G5		36	12	12	10	S	16	39	17	24	63	104	L	L	L	L	L	L	L	L	L		L	L	L	
Bird	Clangula hyemalis	Long-tailed Duck/Old Squaw	High Concern, Low Responsibility	G5		24	8	5	0	NU							L	L	P	P	L		L	L			P	P	P	P
Bird	Coccyzus erythropthalmus	Black-billed Cuckoo	Widespread Concern, Low Responsibility	G5		35	13	10	1	NU	51	51	24		23	47	L	L	L	L	P	P	L	L	L	L	L	P	L	P
Bird	Colinus virginianus	Northen Bobwhite	Widespread Concern, Low Responsibility	G5	(PS)	36	10	10	1	NU	0	0			4	4	L	L		L	L		L	L	L	L		L	L	L
Bird	Contopus cooperi	Olive-sided Flycatcher	Widespread Concern, Low Responsibility	G4		30	6	7	1	NU	100	100	1			1	L		L	L		P		L	L		L		L	P
Bird	Coturnicops noveboracensis	Yellow Rail	Widespread Concern, Low Responsibility	G4		20	4	4	1	P	50	88	4	3	1	8		L	L		P		P	L				L		
Bird	Dendroica caerulescens	Black-throated Blue Warbler	High Concern, Low Responsibility	G5		25	12	8	2	NU	53	53	8		7	15	L		L	L	P	P	L	L	L	L	L	P	P	P
Bird	Dendroica castanea	Bay-breasted Warbler	Widespread Concern, Low Responsibility	G5		14	5	5	2	P	40	100	2	3		5	L		L		P	L		L			L			P
Bird	Dendroica cerulea	Cerulean Warbler	Widespread Concern, Low Responsibility	G4		32	12	11	5	P	58	71	30	7	15	52	L	L		L	P	L	L	L	L	L	L	L	L	L
Bird	Dendroica discolor	Prairie Warbler	Widespread Concern, Low Responsibility	G5		31	13	12	0	NU							L	L	L	L	L	P	L	L	L	L	L	L	L	P
Bird	Dendroica fusca	Blackburnian Warbler	High Concern, Low Responsibility	G5		27	12	7	4	P	53	68	10	3	6	19	L		L	L	P	P	L	P	L	L	P	P	L	P
Bird	Dendroica striata	Blackpoll Warbler	High Concern, Low Responsibility	G5		17	6	3	2	P	97	100	61	2		63			P		L	P		P	L		L			P
Bird	Dendroica tigrina	Cape May Warbler	High Concern, Low Responsibility	G5		14	5	3	2	P	40	40	2		3	5	L		L		P	P		L			P			P
Bird	Dendroica virens	Black-throated Green Warbler	High Concern, Low Responsibility	G5		28	12	6	1	NU	48	52	13	1	13	27	L		L	L	P	P	L	P	L	L	P	P	P	P
Bird	Dolichonyx oryzivorus	Bobolink	Widespread Concern, Low Responsibility	G5		41	13	10	4	P	10	21	11	11	83	105	L	L	L	L	P	P	L	L	L	L	L	P	L	L
Bird	Egretta caerulea	Little Blue Heron	Widespread Concern, Low Responsibility	G5		31	9	8	5	A	28	35	22	6	52	80	L	L	L	L	P		L	L		L		L		P
Bird	Egretta thula	Snowy Egret	Widespread Concern, Low Responsibility	G5		38	9	8	6	A	31	40	34	9	65	108	L	L	L	L	L		L	L		L		P		P
Bird	Egretta tricolor	Tricolored Heron	Widespread Concern, Low Responsibility	G5		20	8	6	3	P	34	38	17	2	31	50	P	L	L	L			L	L		P		L		P
Bird	Empidonax traillii	Willow Flycatcher	Widespread Concern, Low Responsibility	G5	(PS)	44	13	10	0	NU							L	L	L	L	L	P	L	L	L	L	P	L	P	
Bird	Empidonax virescens	Acadian Flycatcher	High Concern, Low Responsibility	G5		31	10	6	3	P	46	77	6	4	3	13	L	P		L	P		L	P	L	L		P	L	L
Bird	Eremophila alpestris	Horned Lark	High Concern, Low Responsibility	G5	(PS)	48	13	7	3	NU	0	30		3	7	10	L	P	L	P	P	L	L	L	P	L	P	P	L	P
Bird	Euphagus carolinus	Rusty Blackbird	High Concern, Low Responsibility	G4		31	10	5	3	P	15	41	4	7	16	27			L	P	P	L	P	L	P		L	L	P	P
Bird	Falcipennis canadensis	Spruce Grouse	Widespread Concern, Low Responsibility	G5		13	4	3	3	S	43	71	15	10	10	35			P			L		L			L			
Bird	Falco peregrinus	Peregrine Falcon	Widespread Concern, Low Responsibility	G4	(PS:LE)	45	13	13	10	S	21	31	64	30	207	301	L	L	L	L	L	L	L	L	L	L	L	L	L	P
Bird	Fratercula arctica	Atlantic Puffin	Limited	G5		3	3	2	1	P	50	50	2		2	4			L		P			P						
Bird	Gallinula chloropus	Common Moorhen	Widespread Concern, Low Responsibility	G5	(PS)	38	12	9	8	A	16	44	14	24	49	87	L	P	L	L	L	L	L	P	L	L	P	P	L	P
Bird	Gavia immer	Common Loon	High Concern, Low Responsibility	G5		38	10	7	5	A	6	22	25	64	312	401	L		L	L	L	L	P	L			L	P	P	
Bird	Gavia stellata	Red-throated Loon	High Concern, Low Responsibility	G5		19	7	5	0	NU							L	L	P	L	P		L	L			P	P		
Bird	Gelochelidon nilotica	Gull-billed Tern	Widespread Concern, Low Responsibility	G5		13	4	5	4	S	17	37	5	6	19	30		L		L			L	L				L		
Bird	Haematopus palliatus	American Oystercatcher	Widespread Concern, High Responsibility	G5		17	9	9	4	P	16	46	8	15	27	50	L	L	L	L	L		L	L		L		L		
Bird	Haliaeetus leucocephalus	Bald Eagle	Widespread Concern, Low Responsibility	G5	(PS:T)	49	13	13	12	S	17	32	563	470	2190	3223	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Bird	Histrionicus histrionicus	Harlequin Duck	Widespread Concern, Low Responsibility	G4		14	4	6	1	P	11	31	4	7	25	36			L	L	L		L	L		L				
Bird	Hydrocoloeus minutus	Little Gull	High Concern, High Responsibility	G5		7	4	2	0	NU								L	P		P			L			P			
Bird	Hylocichla mustelina	Wood Thrush	Widespread Concern, Low Responsibility	G5		36	13	13	1	NU	24	26	282	27	883	1192	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Bird	Icteria virens	Yellow-breasted Chat	High Concern, Low Responsibility	G5		43	10	7	2	NU	44	48	11	1	13	25	L	L		P	P		L	L	L	L		L	P	P
Bird	Ixobrychus exilis	Least Bittern	Widespread Concern, Low Responsibility	G5		42	13	13	11	S	21	54	56	91	123	270	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Bird	Lanius ludovicianus	Loggerhead Shrike	Widespread Concern, Low Responsibility	G4	(PS)	39	5	9	4	S	4	13	1	2	20	23		L	L	L			L	L	L		L	L	L	
Bird	Larus marinus	Great Black-backed Gull	Low Concern, High Responsibility	G5		20	12	2	1	NU	0	100		1		1	P	L	P	P	P	P	P	P	P	L	P	P		P
Bird	Laterallus jamaicensis	Black Rail	Widespread Concern, Low Responsibility	G4		22	6	6	4	A	23	46	6	6	14	26	L	L		L			L	L				L		
Bird	Limnodromus griseus	Short-billed Dowitcher	Widespread Concern, Low Responsibility	G5		30	5	6	0	NU								L	P	L	L		P	L		L	P	L		
Bird	Limosa fedoa	Marbled Godwit	Widespread Concern, Low Responsibility	G5		30	4	4	0	NU								L			P		L	L		P		L		
Bird	Limosa haemastica	Hudsonian Godwit	Widespread Concern, Low Responsibility	G4		16	4	4	0	NU								L	P		P		L	L		P		L		
Bird	Loxia curvirostra	Red Crossbill	High Concern, Low Responsibility	G5		35	6	3	0	NU									L		P			P	L		P	L	P	P
Bird	Melanerpes erythrocephalus	Red-headed Woodpecker	High Concern, Low Responsibility	G5		38	11	7	3	P	27	31	46	7	118	171	L	L		L	P		L	L	L	P	P	P	L	P
Bird	Melanitta fusca	White-winged Scoter	High Concern, Low Responsibility	G5		25	8	4	0	NU							L	L	P	P	P		L	L	P		P	P		P
Bird	Melanitta nigra	Black Scoter	High Concern, Low Responsibility	G5		24	7	4	0	NU							L	L	P	P	P		L	L			P	P		
Bird	Melanitta perspicillata	Surf Scoter	High Concern, Low Responsibility	G5		25	7	4	0	NU							L	L	P	P	P		L	L			P	P		
Bird	Mniotilta varia	Black-and-White Warbler	High Concern, Low Responsibility	G5		40	13	7	1	NU	92	92	12		1	13	L	L	L	L	P	P	L	P	P	L	P	L	P	P
Bird	Morus bassanus	Northern Gannet	High Concern, Low Responsibility	G5		10	4	2	0	NU									P	L	P		L	P				P		
Bird	Numenius phaeopus	Whimbrel	Widespread Concern, Low Responsibility	G5		23	5	8	0	NU								L	L	L	L		L	L		L		L		P
Bird	Nyctanassa violacea	Yellow-crowned Night-heron	Widespread Concern, Low Responsibility	G5		33	10	9	7	A	19	22	19	3	79	101	L	L		L	P		L	L	L	L		L	L	
Bird	Nycticorax nycticorax	Black-crowned Night-heron	Widespread Concern, Low Responsibility	G5		46	11	12	7	A	37	47	46	12	65	123	L	L	L	L	L		L	L	L	L	L	L	L	L
Bird	Oporornis formosus	Kentucky Warbler	Widespread Concern, Low Responsibility	G5		30	9	7	3	P	22	44	6	6	15	27	P	L		L	P		L	L	L			L	L	L
Bird	Pandion haliaetus	Osprey	High Concern, Low Responsibility	G5		48	13	9	6	P	14	34	41	62	197	300	L	L	P	P	P	L	L	L	L	L	L	P	L	P
Bird	Parula americana	Northern Parula	High Concern, Low Responsibility	G5		35	13	8	4	P	31	61	20	19	25	64	L	L	L	L	L	P	L	P	P	L	P	L	P	P
Bird	Pelecanus occidentalis	Brown Pelican	High Concern, Low Responsibility	G4	(PS:LE)	17	4	2	1	P	100	100	1			1		L		L			P					P		
Bird	Phalacrocorax carbo	Great Cormorant	Moderate Concern, High Responsibility	G5		9	7	3	1	NU	36	91	4	6	1	11	L	L	L	P	P		P	P				P		
Bird	Phalaropus lobatus	Red Necked Phalarope	Widespread Concern, Low Responsibility	G4		24	4	3	0	NU								L	L		P			L			P			P
Bird	Picoides dorsalis	American Three-toed Woodpecker	Widespread Concern, Low Responsibility	G5		19	4	3	3	S	50	70	5	2	3	10			L			L		L			P			
Bird	Pipilo erythrophthalmus	Eastern/Rufous-sided Towhee	Widespread Concern, Low Responsibility	G5		36	13	10	0	NU							L	L	L	L	L	L	L	P	P	L	L	L	P	L
Bird	Piranga olivacea	Scarlet Tanager	High Concern, Low Responsibility	G5		34	13	9	0	NU							L	L	L	L	P	P	L	L	L	L	P	L	P	L
Bird	Plegadis falcinellus	Glossy Ibis	Widespread Concern, High Responsibility	G5		16	9	8	5	A	30	36	27	6	58	91	L	L	L	L	P		L	L		L		L		
Bird	Pluvialis dominica	American Golden-plover	High Concern, Low Responsibility	G5		23	5	3	0	NU								L	P		P		L	L		P	P			P

Appendix 9-1. Regionally significant species: their global conservation rank, scientific name, common name, US Endangered Species rank, distribution, and secured lands regional summary metrics.

				Rank and Distribution Summary from NatureServe							Summary of Precise Occurrences by Secured Land Status						Northeast Current Distribution. L=listed in SWAP, P= Current presence in the state and unlisted in SWAP													
Taxa	Scientific Name	Common Name	Conservation Concern and Regional Responsibility Group	Rounded Global Conservation Rank	Endangered Species Act Status (Interpreted Status): C: Candidate; SC: Species of Concern; LT: Listed threatened; LE: Listed Endangered; (PS): Partial Status, status in only a portion of the species' range; See http://www.natureserve.org/explorer/statusus.htm#status	# of U.S. states currently present within	# of northeast (13) states currently present within	# of northeast state (13) SWAP for which the species is listed	# of northeast states (13) with precise level occurrences available	Data sufficiency for regional reporting; S = Sufficient, A = Adequate, P = Poor, NU = Not Usable (See chapter for definitions)	% Protected	% Secured	# of occurrences on GAP 1 & 2	# of occurrences on GAP 3	# of occurrences on unsecured land	Total # of precise occurrences	CT	DE	ME	MD	MA	NH	NJ	NY	PA	RI	VT	VA	WV	DC
Bird	Pluvialis squatarola	Black-bellied Plover	High Concern, Low Responsibility	G5		33	8	5	0	NU								L	P	L	P		P	L		L	P	L		P
Bird	Podiceps auritus	Horned Grebe	Widespread Concern, Low Responsibility	G5		37	8	6	0	NU							L	L	P	L	P		L	L			P	L	P	
Bird	Podilymbus podiceps	Pied-billed Grebe	Widespread Concern, Low Responsibility	G5		49	13	11	9	A	13	38	30	58	142	230	L	L	P	L	L	L	L	L	L	L	L	P	L	P
Bird	Pooecetes gramineus	Vesper Sparrow	Widespread Concern, Low Responsibility	G5	(SC)	45	12	10	4	P	15	18	19	5	107	131	L	L	L	L	L	L	L	L	P		L	P	L	P
Bird	Porzana carolina	Sora Rail	High Concern, Low Responsibility	G5		48	13	8	10	S	22	46	14	16	35	65	L	L	P	P	L	P	L	P	L	L	L	P	L	L
Bird	Protonotaria citrea	Prothonotary Warbler	Widespread Concern, Low Responsibility	G5		32	9	8	4	P	22	56	4	6	8	18		L		L	P		L	L	L	L		L	L	L
Bird	Rallus elegans	King Rail	Widespread Concern, Low Responsibility	G4		33	11	10	8	A	31	51	19	12	30	61	L	L	P	L	L		L	L	L	L		L	L	P
Bird	Rynchops niger	Black Skimmer	Widespread Concern, Low Responsibility	G5		16	7	7	5	A	33	38	36	5	67	108	L	L		L	P		L	L		L		L		
Bird	Scolopax minor	American Woodcock	Widespread Concern, Low Responsibility	G5		36	13	13	0	NU							L	L	L	L	L	L	L	L	L	L	L	L	L	L
Bird	Seiurus motacilla	Louisiana Waterthrush	Widespread Concern, Low Responsibility	G5		35	13	11	0	NU							L	L	L	L	L	P	L	L	L	L	P	L	L	L
Bird	Spiza americana	Dickcissel	Widespread Concern, Low Responsibility	G5		33	6	5	2	P	0	11		2	16	18	P			L			L	L	L			P	L	
Bird	Spizella pusilla	Field Sparrow	Widespread Concern, Low Responsibility	G5		40	13	10	2	NU	83	83	5		1	6	L	L	L	L	L	P	L	P	P	L	L	L	L	L
Bird	Sterna dougallii	Roseate Tern	Widespread Concern, High Responsibility	G4	(PS:E)	6	4	11	4	S	18	32	25	20	97	142	L	L	L	L	L	L	L	L		L		L		
Bird	Sterna forsteri	Forster's Tern	High Concern, Low Responsibility	G5		37	7	5	2	P	30	32	11	1	25	37		L		L	P		L	L		P		L		P
Bird	Sterna hirundo	Common Tern	Widespread Concern, Low Responsibility	G5		38	11	12	6	A	25	34	126	45	326	497	L	L	L	L	L	L	L	L	L	L	L	L		P
Bird	Sterna paradisaea	Arctic Tern	Widespread Concern, High Responsibility	G5		7	4	4	3	S	36	45	17	4	26	47		L	L		L	L		P						
Bird	Sternula antillarum	Least Tern	Widespread Concern, Low Responsibility	G4	(PS:LE)	33	9	10	8	S	20	36	110	84	348	542	L	L	L	L	L	L	L	L		L		L		
Bird	Sturnella magna	Eastern Meadowlark	Widespread Concern, Low Responsibility	G5		37	13	11	2	NU	8	14	6	5	65	76	L	P	L	L	L	L	L	L	L	L	L	L	P	L
Bird	Thalasseus maximus	Royal Tern	High Concern, Low Responsibility	G5		16	6	3	2	P	67	67	2		1	3				L	P		L	P		P		L		
Bird	Toxostoma rufum	Brown Thrasher	Widespread Concern, Low Responsibility	G5		42	13	11	3	NU	30	33	68	8	154	230	L	L	L	L	L	P	L	L	L	L	L	L	P	L
Bird	Tringa melanoleuca	Greater Yellowlegs	Widespread Concern, Low Responsibility	G5		33	7	6	0	NU								L	L	L	P		L	L		L	P	P		P
Bird	Tringa semipalmata	Willet	Widespread Concern, Low Responsibility	G5		36	10	8	2	NU	15	38	2	3	8	13	L	L	L	L	P	L	L	L		L		P		P
Bird	Tringa solitaria	Solitary Sandpiper	Widespread Concern, Low Responsibility	G5		25	5	4	0	NU								L	P	L	P		P	P	L	L	P			P
Bird	Tryngites subruficollis	Buff-breasted Sandpiper	High Concern, Low Responsibility	G4		18	4	2	0	NU								L			P		P	L		P				
Bird	Tyto alba	Barn Owl	Widespread Concern, Low Responsibility	G5		43	11	11	8	A	7	11	12	6	143	161	L	L		L	L		L	L	L	L	L	L	L	P
Bird	Vermivora chrysoptera	Golden-winged Warbler	Widespread Concern, Low Responsibility	G4		26	10	11	5	A	33	52	20	11	29	60	L	L		L	L	L	L	L	L		L	L	L	P
Bird	Vermivora pinus	Blue-winged Warbler	Widespread Concern, Low Responsibility	G5		30	13	11	1	NU	0	100		2		2	L	L	L	L	L	P	L	L	L	L	L	P	L	P
Bird	Vireo flavifrons	Yellow-throated Vireo	High Concern, Low Responsibility	G5		36	13	8	0	NU							L	L	L	L	P	P	L	P	L	L	P	L	P	L
Bird	Wilsonia canadensis	Canada Warbler	Widespread Concern, Low Responsibility	G5		29	12	12	1	NU	67	67	10		5	15	L	L	L	L	L	L	L	L	L	L	L	L	P	P
Bird	Wilsonia citrina	Hooded Warbler	High Concern, Low Responsibility	G5		32	9	5	2	NU	56	60	27	2	19	48	L	L		L			L	P	P	L		P	P	L
Fish	Acantharchus pomotis	Mud Sunfish	Widespread Concern, High Responsibility	G5		7	4	4	1	P	0	0			2	2		L		L			P	L				L		
Fish	Acipenser brevirostrum	Shortnose Sturgeon	Widespread Concern, High Responsibility	G3	LE	11	7	11	4	A	0	0			22	22	L	L	L	L	L	L	L	L	L	L		L		L
Fish	Acipenser oxyrinchus	Atlantic Sturgeon	Widespread Concern, High Responsibility	G3	(LT,C)	17	10	11	4	P	11	22	1	1	7	9	L	L	L	L	L	L	L	L	L	L		L		L
Fish	Alosa aestivalis	Blueback Herring	High Concern, High Responsibility	G5	SC	16	12	6	1	NU	0	0			2	2	L	P	P	P	L	L	P	L	P	L	L	P		L
Fish	Alosa mediocris	Hickory Shad	High Concern, High Responsibility	G5		13	9	5	0	NU							L	L	P	L			L	P	L	P		P		L
Fish	Alosa pseudoharengus	Alewife	High Concern, High Responsibility	G5	SC	12	11	7	0	NU							L	P	P	P	L	L	P	L	L	L		L		L
Fish	Alosa sapidissima	American Shad	Widespread Concern, High Responsibility	G5		16	12	9	0	NU							L	P	L	L	L	L	P	L	P	L	L	L		L
Fish	Ameiurus catus	White Catfish	Moderate Concern, High Responsibility	G5		11	6	2	0	NU								P		L			P	P	L			P		P
Fish	Amia calva	Bowfin	High Concern, Low Responsibility	G5		24	5	3	0	NU										L				P	L		P	P		L
Fish	Ammocrypta pellucida	Eastern Sand Darter	Widespread Concern, Low Responsibility	G4		9	4	4	3	S	0	0			20	20								L	L		L		L	
Fish	Anguilla rostrata	American Eel	Widespread Concern, Low Responsibility	G4		33	13	10	1	NU	0	0			2	2	L	P	L	P	L	L	P	L	L	L	L	L	L	L
Fish	Apeltes quadracus	Fourspine Stickleback	Moderate Concern, High Responsibility	G5		12	11	3	0	NU							L	L	P	P	P	P	P	L	P	P		P		P
Fish	Catostomus catostomus	Longnose Sucker	High Concern, Low Responsibility	G5		23	7	5	2	P	3	8	4	7	125	136	L		L	L	L	P		P	L		P			
Fish	Coregonus clupeaformis	Lake Whitefish	High Concern, Low Responsibility	G5		15	5	3	0	NU									L			L		P	P		L			
Fish	Cottus caeruleomentum	Blue Ridge Sculpin	Low Concern, High Responsibility	G4		6	5	1	1	NU	0	0			1	1		L		P					P			P	P	
Fish	Cottus cognatus	Slimy Sculpin	High Concern, Low Responsibility	G5		21	10	6	1	NU	0	0			1	1	L		P		L	L	L	P	P		P	L	L	
Fish	Cottus girardi	Potomac Sculpin	Moderate Concern, High Responsibility	G4		4	4	1	1	P	0	0			2	2				P					P			P	L	
Fish	Cottus sp. 1	Bluestone Sculpin	Limited	G2		2	2	2	0	NU																		L	L	
Fish	Cottus sp. 7	Checkered Sculpin	Limited	G4		2	2	2	1	A	0	50		1	1	2				L					L					
Fish	Cyprinella analostana	Satinfin Shiner	Low Concern, High Responsibility	G5		9	7	1	0	NU								P		P			P	P	P			P	L	P
Fish	Cyprinodon variegatus	Sheepshead Minnow	Low Concern, High Responsibility	G5		16	8	1	0	NU							L	P		P	P		P	P		P		P		
Fish	Enneacanthus chaetodon	Blackbanded Sunfish	Widespread Concern, High Responsibility	G4		8	4	4	1	P	0	0			3	3		L		L			L					L		
Fish	Enneacanthus gloriosus	Bluespotted Sunfish	Low Concern, High Responsibility	G5		12	6	1	0	NU								P		L			P	P	P			P		P
Fish	Enneacanthus obesus	Banded Sunfish	Widespread Concern, High Responsibility	G5		16	11	10	2	NU	10	16	3	2	26	31	L	L	P	L	L	L	L	L	L	L		L		
Fish	Erimystax dissimilis	Streamline Chub	Widespread Concern, Low Responsibility	G4		9	4	3	1	P	0	0			1	1								L	L			L	P	
Fish	Esox niger	Chain Pickerel	Low Concern, High Responsibility	G5		24	13	1	0	NU							L	P	P	P	P	P	P	P	P	P	P	P	P	P
Fish	Etheostoma camurum	Bluebreast Darter	Widespread Concern, Low Responsibility	G4		10	4	4	2	A	0	0			23	23								L	L			L	L	
Fish	Etheostoma fusiforme	Swamp Darter	High Concern, Low Responsibility	G5		22	10	6	2	NU	25	50	2	2	4	8	L	P	L	L	L	L	P	L		P		P		
Fish	Etheostoma longimanum	Longfin Darter	Limited	G4		2	2	1	0	NU																		P	L	
Fish	Etheostoma maculatum	Spotted Darter	Limited	G2		6	3	3	2	A	0	33		1	2	3								L	L				L	
Fish	Etheostoma olmstedi	Tessellated Darter	Moderate Concern, High Responsibility	G5		16	12	3	1	NU	0	0			5	5	P	P		P	L	L	P	P	P	P	P	P	L	P
Fish	Etheostoma osburni	Candy Darter	Limited	G3		2	2	2	1	A	0	27		4	11	15												L	L	
Fish	Etheostoma variatum	Variegate Darter	Moderate Concern, High Responsibility	G5		7	4	1	1	P	0	29		2	5	7								P	P			L	P	
Fish	Etheostoma vitreum	Glassy Darter	Limited	G4		4	3	2	1	P	8	54	1	6	6	13		L		L								P		P
Fish	Exoglossum laurae	Tonguetied Minnow	High Concern, High Responsibility	G4		6	4	2	2	A	0	40		4	6	10								P	L			P	L	
Fish	Exoglossum maxillingua	Cutlips Minnow	Low Concern, High Responsibility	G5		10	9	2	0	NU							L	P		P			L	P	P		P	P	P	

Appendix 9-1. Regionally significant species: their global conservation rank, scientific name, common name, US Endangered Species rank, distribution, and secured lands regional summary metrics.

				Rank and Distribution Summary from NatureServe							Summary of Precise Occurrences by Secured Land Status						Northeast Current Distribution. L=listed in SWAP, P= Current presence in the state and unlisted in SWAP													
Taxa	Scientific Name	Common Name	Conservation Concern and Regional Responsibility Group	Rounded Global Conservation Rank	Endangered Species Act Status (Interpreted Status): C: Candidate; SC: Species of Concern; LT: Listed threatened; LE: Listed Endangered; (PS): Partial Status, status in only a portion of the species' range; See http://www.natureserve.org/explorer/statusus.htm#status	# of U.S. states currently present within	# of northeast (13) states currently present within	# of northeast state (13) SWAP for which the species is listed	# of northeast states (13) with precise level occurrences available	Data sufficiency for regional reporting: S = Sufficient, A = Adequate, P = Poor, NU = Not Usable (See chapter for definitions)	% Protected	% Secured	# of occurrences on GAP 1 & 2	# of occurrences on GAP 3	# of occurrences on unsecured land	Total # of precise occurrences	CT	DE	ME	MD	MA	NH	NJ	NY	PA	RI	VT	VA	WV	DC
Fish	Fundulus diaphanus	Banded Killifish	Low Concern, High Responsibility	G5		24	13	1	0	NU							P	P	P	P	P	P	P	P	P	P	P	P	L	P
Fish	Fundulus heteroclitus	Mummichog	Low Concern, High Responsibility	G5		14	11	2	0	NU							L	P	P	P	P	P	P	L	P	P		P		P
Fish	Fundulus luciae	Spotfin Killfish	Widespread Concern, High Responsibility	G4		7	5	4	1	NU	0	0			1	1	L	P		L	P		P	L		L				
Fish	Fundulus majalis	Striped Killfish	Limited	G5		5	3	1	0	NU								P						L		P				
Fish	Gasterosteus aculeatus	Threespine Stickleback	Moderate Concern, High Responsibility	G5	(PS)	16	11	3	1	NU	0	0			1	1	P	P	P	P	L	P	P	L	L	P		P		
Fish	Hiodon tergisus	Mooneye	Widespread Concern, Low Responsibility	G5		24	4	4	2	A	0	0			21	21								L	L		L		L	
Fish	Hybognathus regius	Eastern Silvery Minnow	Low Concern, High Responsibility	G5		12	9	2	2	NU	5	16	2	4	32	38		P		P	L		P	P	P		P	P	L	P
Fish	Ichthyomyzon bdellium	Ohio Lamprey	Widespread Concern, Low Responsibility	G3		11	4	4	2	A	5	5	1		20	21								L	L			L	L	
Fish	Ichthyomyzon fossor	Northern Brook Lamprey	Widespread Concern, Low Responsibility	G4		12	4	3	3	S	0	0			12	12								P	L		L		L	
Fish	Ichthyomyzon greeleyi	Mountain Brook Lamprey	Widespread Concern, Low Responsibility	G3		10	4	4	1	P	0	0			6	6								L	L			L	L	
Fish	Ichthyomyzon unicuspis	Silver Lamprey	High Concern, Low Responsibility	G5		17	4	2	2	A	6	6	1		16	17								P	P		L		L	
Fish	Lampetra aepyptera	Least Brook Lamprey	Widespread Concern, Low Responsibility	G5		15	5	5	1	NU	0	0			2	2		L		L					L			L	L	
Fish	Lampetra appendix	American Brook Lamprey	Widespread Concern, Low Responsibility	G4		25	12	11	5	P	10	18	4	3	33	40	L	L		L	L	L	L	P	L	L	L	L	L	
Fish	Lepomis auritus	Redbreast Sunfish	Low Concern, High Responsibility	G5		19	13	3	0	NU							L	P	P	P	P	P	P	P	P	L	L	P	P	P
Fish	Lepomis gibbosus	Pumpkinseed	Low Concern, High Responsibility	G5		26	13	1	0	NU							L	P	P	P	P	P	P	P	P	P	P	P	P	P
Fish	Lepomis gulosus	Warmouth	Widespread Concern, Low Responsibility	G5		23	4	3	1	P	0	0			2	2				L					L			P	L	L
Fish	Lota lota	Burbot	High Concern, Low Responsibility	G5		23	7	5	2	P	0	25		2	6	8	L		L		L	L		P	L		P			
Fish	Lythrurus ardens	Blueside Shiner	Limited	G5		3	2	1	0	NU																		P	L	
Fish	Margariscus margarita	Pearl Dace	Moderate Concern, High Responsibility	G5		18	9	3	1	NU	0	0			2	2	P		P	L			P	P	P		P	L	L	P
Fish	Microgadus tomcod	Atlantic Tomcod	High Concern, High Responsibility	G5		6	6	3	0	NU							L		P		P		P	L		L				
Fish	Morone saxatilis	Striped Bass	Low Concern, High Responsibility	G5		18	11	2	0	NU							L	P	L	P	P	P	P	P	P	P		P		P
Fish	Moxostoma carinatum	River Redhorse	Widespread Concern, Low Responsibility	G4		23	4	4	1	P	7	13	1	1	13	15								L	L			L	L	
Fish	Myoxocephalus octodecemspinosus	Longhorn Sculpin	Limited	G5		2	2	1	0	NU							L							P		P				
Fish	Nocomis platyrhynchus	Bigmouth Chub	Limited	G4		3	2	1	1	A	0	25		6	18	24												P	L	
Fish	Notropis amoenus	Comely Shiner	High Concern, High Responsibility	G5		8	7	5	1	NU	0	0			2	2		L		L			L	L	P			P	L	P
Fish	Notropis bifrenatus	Bridle Shiner	Widespread Concern, High Responsibility	G3		13	11	10	2	NU	1	20	2	25	108	135	L	L	P	L	L	L	L	P	L	L	L	L		
Fish	Notropis chalybaeus	Ironcolor Shiner	Widespread Concern, Low Responsibility	G4		19	6	6	2	P	0	25		1	3	4		L		L			L	L	L			L		
Fish	Notropis heterodon	Blackchin Shiner	Widespread Concern, Low Responsibility	G5		10	4	3	2	A	8	12	2	1	22	25			P					L	L		L			
Fish	Notropis procne	Swallowtail Shiner	Moderate Concern, High Responsibility	G5		9	7	2	1	NU	0	0			3	3		P		P			P	L	P			P	L	P
Fish	Notropis scabriceps	New River Shiner	Limited	G4		3	2	2	1	A	0	0			4	4												L	L	
Fish	Noturus flavus	Stonecat	High Concern, Low Responsibility	G5		26	6	3	2	P	0	0			15	15				L				P	P		L	L	P	
Fish	Noturus insignis	Spotted/Margined Madtom	Moderate Concern, High Responsibility	G5		10	7	3	0	NU								L		P			L	P	P			L	P	P
Fish	Osmerus mordax	Rainbow Smelt	Widespread Concern, High Responsibility	G5	(PS:SC)	13	8	7	0	NU							L		L		P	L	L	L	L	L	P			
Fish	Pararhinichthys bowersi	Cheat Minnow	Limited	G1		2	2	3	1	A	0	14		1	6	7				L					L				L	
Fish	Percina caprodes	Logperch/Chesapeake Logperch	High Concern, Low Responsibility	G5		28	6	3	0	NU										L				P	L		P	L	P	
Fish	Percina copelandi	Channel Darter	Widespread Concern, Low Responsibility	G4		14	5	4	3	A	0	0			23	23								P	L		L	L	L	
Fish	Percina gymnocephala	Appalachia Darter	Limited	G4		3	2	2	1	A	0	33		1	2	3												L	L	
Fish	Percina macrocephala	Longhead Darter	Limited	G3		5	3	4	2	A	0	0			8	8								L	L			L	L	
Fish	Percina notogramma	Stripeback Darter	Limited	G4		3	3	2	1	P	0	0			3	3				L								P	L	
Fish	Percina oxyrhynchus	Sharpnose Darter	Limited	G4		4	2	1	0	NU																		L	P	
Fish	Percina peltata	Shield Darter	High Concern, High Responsibility	G5		7	7	4	0	NU								L		L			L	P	P			P	L	
Fish	Percopsis omiscomaycus	Trout-perch	High Concern, Low Responsibility	G5		20	4	2	2	A	0	0			2	2				L				P	P		P	L	P	
Fish	Petromyzon marinus	Sea Lamprey	Moderate Concern, High Responsibility	G5		14	12	3	0	NU							L	P	P	P	P	L	P	P	P	P	L	P		P
Fish	Phenacobius teretulus	Kanawha Minnow	Limited	G3		3	2	2	1	A	17	33	1	1	4	6												L	L	
Fish	Phoxinus oreas	Mountain Redbelly Dace	Limited	G5		3	2	1	1	A	0	65		15	8	23												P	L	
Fish	Prosopium cylindraceum	Round Whitefish	Widespread Concern, High Responsibility	G5		8	4	4	2	A	13	31	2	3	11	16			L			L		L			L			
Fish	Pungitius pungitius	Ninespine Stickleback	Low Concern, High Responsibility	G5		14	7	1	0	NU							P		P		P	P	P	L		P				
Fish	Rhinichthys atratulus	Blacknose Dace	Low Concern, High Responsibility	G5		15	13	3	0	NU							L	P	P	P	L	P	P	P	P	L	P	P	P	P
Fish	Salmo salar	Atlantic Salmon	Widespread Concern, High Responsibility	G5	(PS:E)	6	6	7	0	NU							L		L		L	L		L		L	L			
Fish	Salvelinus fontinalis	Brook Trout	Widespread Concern, High Responsibility	G5		22	12	10	0	NU							L		L	L	L	L	L	L	P	L	L	P	L	
Fish	Salvelinus namaycush	Lake Trout	Widespread Concern, High Responsibility	G5		14	4	3	0	NU									L			L		P			L			
Fish	Sander canadensis	Sauger	High Concern, Low Responsibility	G5		28	5	3	1	NU	0	0			6	6								L	P		L	L	P	
Fish	Semotilus corporalis	Fallfish	Low Concern, High Responsibility	G5		13	13	2	0	NU							L	P	P	P	L	P	P	P	P	P	P	P	P	P
Fish	Syngnathus fuscus	Pipefish	Limited	G5		4	3	2	0	NU							L				P			L		P				
Fish	Thoburnia rhothoeca	Torrent Sucker	Limited	G4		2	2	1	1	A	0	50		1	1	2												P	L	
Fish	Trinectes maculatus	Hogchoker	Low Concern, High Responsibility	G5		17	9	2	0	NU							L	P		P	P		P	P	P	L		P		P
Fish	Umbra pygmaea	Eastern Mud Minnow	Low Concern, High Responsibility	G5		10	6	1	0	NU								P		P			P	P	L			P		
Inverts	Alasmidonta heterodon	Dwarf Wedgemussel	Widespread Concern, High Responsibility	G1	LE	10	9	10	7	S	6	21	5	11	61	77	L	L		L	L	L	L	L	L		L	L		L
Inverts	Alasmidonta marginata	Elktoe	Widespread Concern, Low Responsibility	G4		22	5	4	2	P	0	8		1	12	13								L	P		L	L	L	P
Inverts	Alasmidonta undulata	Triangle Floater	High Concern, High Responsibility	G4		16	12	7	4	P	7	25	26	72	288	386	P	L	P	L	L	P	L	P	P	L	P	L	L	L
Inverts	Alasmidonta varicosa	Brook Floater	Widespread Concern, High Responsibility	G3		14	11	12	9	S	4	21	8	38	168	214	L	L	L	L	L	L	L	L	P	L	L	L	L	L
Inverts	Amnicola decisus	A Spire Snail	Limited	G1		2	2	1	0	NU									L						P					
Inverts	Anarta luteola	Yellow Bog Anarta	Limited	G5		5	3	1	1	P	50	100	1	1		2	L		P		P									
Inverts	Anguispira fergusoni	Coastal Plain Tigersnail	Low Concern, High Responsibility	G4		8	6	1	0	NU								L		P			P	P	P			P		P
Inverts	Anodonta implicata	Alewife Floater	High Concern, High Responsibility	G5		13	12	6	1	NU	0	0			3	3	P	L	P	L	P	P	P	L	P	L	L	L		L
Inverts	Anodontoides ferussacianus	Cylindrical Papershell	High Concern, Low Responsibility	G5		20	4	2	1	P	0	0			1	1								P	P		L		L	

Appendix 9-1. Regionally significant species: their global conservation rank, scientific name, common name, US Endangered Species rank, distribution, and secured lands regional summary metrics.

Taxa	Scientific Name	Common Name	Conservation Concern and Regional Responsibility Group	Rank and Distribution Summary from NatureServe: Rounded Global Conservation Rank	Endangered Species Act Status (Interpreted Status): C: Candidate; SC: Species of Concern; LT: Listed threatened; LE: Listed Endangered; (PS): Partial Status, status in only a portion of the species' range; See http://www.natureserve.org/explorer/statusus.htm#status	# of U.S. states currently present within	# of northeast (13) states currently present within	# of northeast state (13) SWAP for which the species is listed	# of northeast states (13) with precise level occurrences available	Data sufficiency for regional reporting; S = Sufficient, A = Adequate, P = Poor, NU = Not Usable (See chapter for definitions)	Summary of Precise Occurrences by Secured Land Status: % Protected	% Secured	# of occurrences on GAP 1 & 2	# of occurrences on GAP 3	# of occurrences on unsecured land	Total # of precise occurrences	Northeast Current Distribution. L=listed in SWAP, P= Current presence in the state and unlisted in SWAP: CT	DE	ME	MD	MA	NH	NJ	NY	PA	RI	VT	VA	WV	DC
Inverts	Crassostrea virginica	Oyster	Limited	G5		2	2	2	0	NU							L			P				L		P				
Inverts	Discus catskillensis	Angular Disc	Low Concern, High Responsibility	G5		18	12	2	1	NU	0	100		2		2	P	L	P	L	P	P	P	P	P	P	P	P		
Inverts	Elimia virginica	Virginia River Snail	Low Concern, High Responsibility	G5		7	6	1	1	NU	13	13	1		7	8	L			P			P	P	P			P		
Inverts	Elliptio fisheriana	Northern Lance Mussel	Widespread Concern, High Responsibility	G4		6	4	4	1	P	0	0			4	4		L		L								L	L	
Inverts	Elliptio lanceolata	Yellow Lance	Limited	G2		4	2	2	1	A	0	4		1	27	28				L								L		
Inverts	Floridobia winkleyi	New England Siltsnail	Limited	G3		3	3	1	1	P	0	25		2	6	8	P		P		L									
Inverts	Fontigens bottimeri	Appalachian Springsnail	Limited	G2		2	2	2	2	S	0	30		3	7	10				L								L		L
Inverts	Fontigens orolibas	Blue Ridge Springsnail	Limited	G3		3	3	2	1	P	100	100	1			1				L					P			L		
Inverts	Gastrodonta fonticula	Appalachia Bellytooth	Limited	G3		4	2	1	0	NU																		L	P	
Inverts	Gillia altilis	Buffalo Pebblesnail	Moderate Concern, High Responsibility	G5		9	7	2	0	NU										P			P	L	P		L	P	P	P
Inverts	Glyphyalinia picea	Rust Glyph Snail	Moderate Concern, High Responsibility	G3		4	4	1	0	NU								P		P								L	P	
Inverts	Glyphyalinia raderi	Rader's/Maryland Glyph Snail	Limited	G2		4	3	3	0	NU										L					P			L	L	
Inverts	Gyraulus circumstriatus	Disc Gyro	High Concern, Low Responsibility	G5		15	4	2	0	NU							L							P	P		L			
Inverts	Helicodiscus shimeki	Temperate Coil	Low Concern, High Responsibility	G4		15	10	1	0	NU							P		P	P	P	P		P	P		P	L	P	
Inverts	Hendersonia occulta	Cherrystone Drop Snail	Widespread Concern, Low Responsibility	G4		13	4	3	2	A	37	63	7	5	7	19				L					P			L	L	
Inverts	Lampsilis cariosa	Yellow Lampmussel	Widespread Concern, High Responsibility	G3		11	8	10	7	S	2	4	4	6	224	234	L	L	L	L	L		L	L	L			L	L	L
Inverts	Lampsilis fasciola	Wavyrayed Lampmussel	High Concern, Low Responsibility	G5		13	4	2	2	A	0	22		2	7	9								L	P			P	L	
Inverts	Lampsilis ovata	Pocketbook Mussel	Widespread Concern, Low Responsibility	G5		15	5	4	3	A	0	10		2	19	21								L	P		L	L	L	
Inverts	Lampsilis radiata	Eastern Lampmussel	Moderate Concern, High Responsibility	G5		14	12	4	2	NU	16	20	4	1	20	25	P	L	P	L	P	P	L	P	P	L	P	P		P
Inverts	Lasmigona compressa	Creek heelsplitter	High Concern, Low Responsibility	G5		15	4	2	1	P	0	25		1	3	4								P	P		L		L	
Inverts	Lasmigona subviridis	Green Floater	Widespread Concern, High Responsibility	G3		8	6	5	4	A	6	9	3	2	49	54				L			L	L	P			L	L	L
Inverts	Leptodea fragilis	Fragile Papershell	High Concern, Low Responsibility	G5		25	5	3	2	P	6	6	1		16	17								P	P		L	L	L	
Inverts	Leptodea ochracea	Tidewater Mucket	Widespread Concern, High Responsibility	G3		13	10	9	7	A	2	5	6	6	234	246	L	L	L	L	L		L	L	P	L		L		L
Inverts	Leptoxis dilatata	Seep Mudalia	Limited	G3		4	3	2	0	NU															P			L	L	
Inverts	Ligumia nasuta	Eastern Pond Mussel	Widespread Concern, High Responsibility	G4		14	10	9	6	A	2	13	5	27	212	244	L	L		L	L	L	L	L	P	L		L		L
Inverts	Ligumia recta	Black Sandshell	Widespread Concern, Low Responsibility	G5		24	5	4	3	A	7	18	2	3	23	28								L	P		L	L	L	
Inverts	Lioplax subcarinata	Ridged Lioplax	Limited	G4		5	3	1	0	NU										P								L	P	
Inverts	Littoridinops tenuipes	Coastal Marsh Snail	Low Concern, High Responsibility	G5		10	6	1	1	NU	0	25		1	3	4	P			P	L		P	P				P		
Inverts	Lyogyrus granum	Squat Duskysnail	Low Concern, High Responsibility	G5		12	7	1	0	NU							P				P		P	P	P		L	P		
Inverts	Lyogyrus pupoideus	Pupa Dusky Snail	Low Concern, High Responsibility	G5		6	6	1	0	NU							P		P		P			P	P		L			P
Inverts	Lyogyrus walkeri	Canadian Duskysnail	Limited	G3		4	3	2	0	NU														L	P		L			
Inverts	Macrocotyla hoffmasteri	Hoffmaster's Cave Planarian	Limited	G3		2	2	2	2	S	0	0			5	5				L									L	
Inverts	Margaritifera margaritifera	Eastern Pearlshell	High Concern, High Responsibility	G4		9	9	5	3	P	0	17		7	35	42	L		P		P	P	P	L	L	L	L			
Inverts	Mesodon andrewsae	Balsam Globe	Limited	G3		4	2	1	0	NU																		L	P	
Inverts	Oxyloma subeffusum	Chesapeake Ambersnail	Moderate Concern, High Responsibility	G3		4	4	1	0	NU										P			P		P			L		P
Inverts	Paravitrea lamellidens	Lamellate Supercoil	Limited	G2		6	3	1	0	NU									L					P				P		
Inverts	Paravitrea pontis	Natural Bridge Supercoil	Limited	G3		4	3	1	0	NU										P								L	P	
Inverts	Philomycus flexuolaris	Winding Mantleslug	Low Concern, High Responsibility	G5		13	9	1	0	NU								L	P	P		P	P	P	P			P	P	
Inverts	Physa ancillaria	Great Lakes Physa	Low Concern, High Responsibility	G5		14	8	1	0	NU							P		L		P			P	P	P	P	P		
Inverts	Physa vernalis	Vernal Physa	Low Concern, High Responsibility	G3		5	5	1	0	NU							P				L			P	P	P				
Inverts	Pisidium equilaterale	Round Peaclam	Limited	G4		3	2	1	0	NU											P							L		
Inverts	Pleurobema collina	James Spinymussel	Limited	G1	LE	3	2	2	1	A	0	21		4	15	19												L	L	
Inverts	Procotyla typhlops	Groundwater Planarian sp.	Limited	G1		2	2	2	1	A	0	100		1		1				L								L		
Inverts	Somatogyrus pennsylvanicus	Shale Pebblesnail	Limited	G3		3	3	1	0	NU															P			P	L	
Inverts	Stenotrema simile	Bear Creek Siltmouth	Limited	G2		2	2	1	0	NU										L									P	
Inverts	Stylodrilus beattiei	Cave Lumbriculid Worm sp.	Limited	G2		2	2	2	2	S	0	0			4	4												L	L	
Inverts	Triodopsis anteridon	Carter Three-toothed Snail	Limited	G3		4	2	1	0	NU																		L	P	
Inverts	Triodopsis burchi	Pittsylvania Three-tooth	Limited	G3		3	2	1	0	NU																		L	P	
Inverts	Triodopsis fraudulenta	Baffled Three-tooth	Moderate Concern, High Responsibility	G4		6	4	1	0	NU										P					P			L	P	
Inverts	Triodopsis picea	Spruce Knob Three-tooth	High Concern, High Responsibility	G3		4	4	2	1	P	75	100	3	1		4				L					P			L	P	
Inverts	Truncilla truncata	Deertoe	Widespread Concern, Low Responsibility	G5		23	4	3	2	A	0	17		2	10	12								L	P			L	L	
Inverts	Utterbackia imbecillis	Paper Pondshell	High Concern, Low Responsibility	G5		27	4	2	0	NU										L				L	P			P	P	P
Inverts	Valvata sincera	Mossy Valvata/Boreal Turret Snail	High Concern, Low Responsibility	G5		20	6	4	2	P	0	25		1	3	4	L		P		L			L	P		P			
Inverts	Vertigo bollesiana	Snail sp.	Low Concern, High Responsibility	G4		16	8	1	0	NU									P		P	P		P	P		P	L	P	
Inverts	Vertigo clappi	Cupped Vertigo	Limited	G1		4	2	1	0	NU																		L	P	
Inverts	Vertigo perryi	Olive Vertigo	Low Concern, High Responsibility	G3		6	5	1	0	NU							P		P		L	P				P				
Inverts	Vertigo pygmaea	Crested Vertigo	Low Concern, High Responsibility	G5		16	8	1	0	NU								L	P	P	P		P	P	P			P		
Inverts	Vertigo ventricosa	Five-tooth/Cylindrically-ornate Wood Snail	Moderate Concern, High Responsibility	G5		8	7	2	0	NU									P	L	P			P	P		P	L		
Inverts	Villosa iris	Rainbow	High Concern, Low Responsibility	G5		16	4	2	1	P	18	18	2		9	11								L	P			P	L	
Inverts	Webbhelix multilineata	Striped Whitelip	High Concern, Low Responsibility	G5		16	4	2	2	A	33	67	1	1	1	3				L				P	P				L	
Mammal	Condylura cristata	Star-nosed Mole	Low Concern, High Responsibility	G5		24	13	1	0	NU							P	P	P	P	P	P	P	P	P	P	P	P	L	P
Mammal	Cryptotis parva	Least Shrew	Widespread Concern, Low Responsibility	G5		30	7	6	3	P	29	57	2	2	3	7	L	L		L			P	L	L			P	L	P
Mammal	Lasionycteris noctivagans	Silver-haired Bat	Widespread Concern, Low Responsibility	G5		46	12	11	2	NU	4	70	1	18	8	27	L	L	P	L	L	L	L	L	L	L	L	P	L	P
Mammal	Lasiurus borealis	Eastern Red Bat	Widespread Concern, Low Responsibility	G5		38	13	11	1	NU	33	67	2	2	2	6	L	L	P	L	L	L	L	L	L	L	L	P	L	L
Mammal	Lasiurus cinereus	Hoary Bat	Widespread Concern, Low Responsibility	G5	(PS)	47	13	11	2	NU	0	33		2	4	6	L	L	P	L	L	L	L	L	L	L	L	P	L	P
Mammal	Lynx rufus	Bobcat	High Concern, Low Responsibility	G5	(PS:LE,PDL)	47	13	7	3	NU	49	51	78	2	78	158	L	P	P	L	L	L	L	P	P	L	L	P	P	

Appendix 9-1. Regionally significant species: their global conservation rank, scientific name, common name, US Endangered Species rank, distribution, and secured lands regional summary metrics.

				Rank and Distribution Summary from NatureServe							Summary of Precise Occurrences by Secured Land Status						Northeast Current Distribution. L=listed in SWAP, P= Current presence in the state and unlisted in SWAP													
Taxa	Scientific Name	Common Name	Conservation Concern and Regional Responsibility Group	Rounded Global Conservation Rank	Endangered Species Act Status (Interpreted Status): C: Candidate; SC: Species of Concern; LT: Listed threatened; LE: Listed Endangered; (PS): Partial Status, status in only a portion of the species' range; See http://www.natureserve.org/explorer/statusus.htm#status	# of U.S. states currently present within	# of northeast (13) states currently present within	# of northeast state (13) SWAP for which the species is listed	# of northeast states (13) with precise level occurrences available	Data sufficiency for regional reporting; S = Sufficient, A = Adequate, P = Poor, NU = Not Usable (See chapter for definitions)	% Protected	% Secured	# of occurrences on GAP 1 & 2	# of occurrences on GAP 3	# of occurrences on unsecured land	Total # of precise occurrences	CT	DE	ME	MD	MA	NH	NJ	NY	PA	RI	VT	VA	WV	DC
Mammal	Martes americana	Pine Marten	Widespread Concern, Low Responsibility	G5		20	4	4	0	NU									P	L		L		L			L			
Mammal	Martes pennanti	Fisher	Moderate Concern, High Responsibility	G5	(PS:C)	21	11	3	2	NU	60	80	3	1	1	5	P		P	P	P	P		P	L	P	P	L	L	
Mammal	Mustela nivalis	Least Weasel	Widespread Concern, Low Responsibility	G5		25	4	4	2	A	25	25	2		6	8				L				L	L			L	P	
Mammal	Myotis leibii	Eastern Small-footed Bat	Widespread Concern, High Responsibility	G3		19	11	13	9	S	10	35	21	51	133	205	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Mammal	Myotis sodalis	Indiana Bat	Widespread Concern, Low Responsibility	G2	LE	20	7	11	6	S	15	29	19	17	89	125	L			L	L	L	L	L	L	L	L	L	L	
Mammal	Napaeozapus insignis	Woodland Jumping Mouse	Low Concern, High Responsibility	G5		21	12	1	0	NU							L		P	P	P	P	P	P	P	P	P	P	P	
Mammal	Neotoma magister	Allegheny Woodrat	Widespread Concern, High Responsibility	G3		13	7	6	4	A	12	53	46	156	180	382	P			L			L	L	L			L	L	L
Mammal	Parascalops breweri	Hairy-tailed Mole	Low Concern, High Responsibility	G5		17	11	2	0	NU							L		P	P	P	P	P	P	P		L	P	P	
Mammal	Sorex dispar	Long-tailed or Rock Shrew	High Concern, High Responsibility	G4		14	10	7	5	A	16	61	6	17	15	38			P	L	L	P	L	P	L		L	L	L	
Mammal	Sorex fontinalis	Maryland Shrew	Limited	G4		3	3	1	0	NU								L		P					P					
Mammal	Sorex fumeus	Smoky Shrew	Moderate Concern, High Responsibility	G5		21	12	3	2	NU	22	78	2	5	2	9	P		P	L	P	P	P	P	P	L	L	P	P	
Mammal	Sylvilagus obscurus	Appalachian Cottontail	Widespread Concern, Low Responsibility	G4		10	4	3	3	S	0	80		12	3	15				P					L			L	L	
Mammal	Sylvilagus transitionalis	New England Cottontail	Widespread Concern, High Responsibility	G3	C	7	7	8	3	P	3	9	2	5	70	77	L		L	L	L	L	P	L		L	L			
Mammal	Synaptomys cooperi	Southern Bog Lemming	Widespread Concern, Low Responsibility	G5		28	12	9	5	P	19	55	8	15	19	42	L		P	L	L	P	L	P	L	L	L	L	L	L
Reptile	Agkistrodon contortrix	Copperhead	High Concern, Low Responsibility	G5		27	9	6	1	NU	2	66	2	53	28	83	L	L		P	L		L	L	L			P	P	L
Reptile	Clemmys guttata	Spotted Turtle	Widespread Concern, High Responsibility	G5		21	13	13	7	A	7	25	112	270	1122	1504	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Reptile	Crotalus horridus	Timber/Canebrake Rattlesnake	Widespread Concern, Low Responsibility	G4		30	10	11	5	A	16	57	59	152	156	367	L		L	L	L	L	L	L	L		L	L	L	L
Reptile	Emydoidea blandingii	Blanding's Turtle	Widespread Concern, Low Responsibility	G4		15	5	5	4	S	8	29	96	255	851	1202			L		L	L		L	L					
Reptile	Glyptemys insculpta	Wood Turtle	Widespread Concern, High Responsibility	G4		17	12	12	9	S	8	21	176	282	1750	2208	L		L	L	L	L	L	L	L	L	L	L	L	L
Reptile	Glyptemys muhlenbergii	Bog Turtle	Widespread Concern, High Responsibility	G3	LT, SAT	12	8	8	7	S	12	15	52	16	372	440	L	L		L	L		L	L	L			L		L
Reptile	Graptemys geographica	Northern Map Turtle	High Concern, Low Responsibility	G5		22	7	5	4	A	23	31	3	1	9	13				L			P	L	L		P	L	L	
Reptile	Heterodon platirhinos	Eastern Hognose Snake	Widespread Concern, Low Responsibility	G5		33	11	10	4	P	13	30	5	7	28	40	L	L		L	L	L	P	L	L	L		L	L	L
Reptile	Opheodrys aestivus	Rough Green Snake	High Concern, Low Responsibility	G5		22	6	3	1	NU	0	100		1		1		L		P			P		L			P	L	L
Reptile	Opheodrys vernalis	Smooth Green Snake	High Concern, Low Responsibility	G5		28	12	6	1	NU	0	25		1	3	4	L		P	P	P	L	P	L	L	P	L	L	P	
Reptile	Pantherophis guttatus	Corn Snake	Widespread Concern, Low Responsibility	G5		14	5	4	2	P	27	27	13		35	48		L		L			L					P	L	L
Reptile	Plestiodon laticeps	Broadhead Skink	Widespread Concern, Low Responsibility	G5		20	4	4	1	P	0	100		3		3		L		L					L			P	L	P
Reptile	Pseudemys rubriventris	Redbelly/Red-bellied Cooter/Turtle	High Concern, High Responsibility	G5	(PS)	8	7	5	1	NU	0	0			1	1		L		L	L		P		L			P	L	L
Reptile	Regina septemvittata	Queen Snake	Widespread Concern, Low Responsibility	G5		19	6	6	1	NU	0	0			3	3		L		L			L	L	L			L	P	L
Reptile	Terrapene carolina	Eastern Box Turtle	Widespread Concern, Low Responsibility	G5		30	12	11	2	NU	15	34	321	406	1442	2169	L	L	L	L	L	L	L	L	L	L		L	P	L
Reptile	Thamnophis brachystoma	Short-headed Garter Snake	Limited	G4		2	2	2	0	NU														L	L					

Appendix 9-2. Regionally significant species: state results of the numbers of precise element occurrences falling on secured lands for each species.

Taxa	Scientific Name	Common Name	Regional Concern, Regional Responsibility	GRANK	Data Sufficiency for Regional analysis	CT GAP 1 & 2	CT GAP 3	CT None	CT Total	DE GAP 1 & 2	DE GAP 3	DE None	DE Total	MA GAP 1 & 2	MA GAP 3	MA None	MA Total	MD GAP 1 & 2	MD GAP 3	MD None	MD Total	ME GAP 1 & 2	ME GAP 3	ME None	ME Total	NH GAP 1 & 2	NH GAP 3	NH None	NH Total	NJ GAP 1 & 2	NJ GAP 3	NJ None	NJ Total	NY GAP 1 & 2	NY GAP 3	NY None	NY Total	PA GAP 1 & 2	PA GAP 3	PA None	PA Total	RI GAP 1 & 2	RI GAP 3	RI None	RI Total	VA GAP 1 & 2	VA GAP 3	VA None	VA Total	VT GAP 1 & 2	VT GAP 3	VT None	VT Total	WV GAP 1 & 2	WV GAP 3	WV None	WV Total	Grand Total
Amphibian	Ambystoma jeffersonianum	Jefferson Salamander	Widespread Concern, High Responsibility	G4	A	3	1	21	25					23	40	159	222											1	1	10		7	17																	1	2	21	24		4	7	11	300
Amphibian	Ambystoma laterale	Blue-spotted Salamander	Widespread Concern, High Responsibility	G5	A	2	1	13	16					62	113	395	570													4		3	7																	5	4	42	51					644
Amphibian	Ambystoma opacum	Marbled Salamander	High Concern, Low Responsibility	G5	P			1	1					6	59	180	245													6	1	7	14									1	3	11	15													275
Amphibian	Ambystoma tigrinum	Eastern/Tiger Salamander	Widespread Concern, Low Responsibility	G5	S					1	2	4	7					1		7	8													16	12	92	120									3		1	4									139
Amphibian	Aneides aeneus	Green Salamander	Widespread Concern, Low Responsibility	G3	A													8	2	19	29																																	2	21	11	34	63
Amphibian	Bufo fowleri	Fowler's Toad	High Concern, Low Responsibility	G5	P																						1		1	3	1	9	13																			2	2					16
Amphibian	Cryptobranchus alleganiensis	Eastern Hellbender	Widespread Concern, Low Responsibility	G3	S													1		2	3															17	17									1	1	7	9						8	13	21	50
Amphibian	Desmognathus welteri	Black Mountain Salamander	Limited Distribution, High Responsibility	G4	A																																																		3	9	12	12
Amphibian	Eurycea longicauda	Longtail Salamander	High Concern, Low Responsibility	G5	NU																														4	17	21																					21
Amphibian	Necturus maculosus	Common Mudpuppy	High Concern, Low Responsibility	G5	P																																									1		3	4	1		4	5					9
Amphibian	Plethodon punctatus	Cow Knob Salamander	Limited Distribution, High Responsibility	G3	S																																									10	1		11						11	1	12	23
Amphibian	Plethodon wehrlei	Wehrle's Salamander	Low Concern, High Responsibility	G4	NU															6	6																																					6
Amphibian	Pseudacris brachyphona	Mountain Chorus Frog	Widespread Concern, Low Responsibility	G5	P														3	1	4																																					4
Amphibian	Pseudacris feriarum	Upland//Southeastern Chorus Frog	Widespread Concern, Low Responsibility	G5	P																																																		4	4	8	8
Amphibian	Rana pipiens	Northern Leopard Frog	High Concern, Low Responsibility	G5	P	3	4	3	10																		1		1													1	2	5	8										1		1	20
Amphibian	Rana virgatipes	Carpenter Frog	Widespread Concern, High Responsibility	G5	A						1	1	2					10	2	10	22																																					24
Amphibian	Scaphiopus holbrookii	Eastern Spadefoot Toad	Widespread Concern, Low Responsibility	G5	A			6	6					321	23	149	493																	3	1	2	6							5	5											2	2	512
Bird	Accipiter cooperii	Cooper's Hawk	High Concern, Low Responsibility	G5	P	4	1	3	8					2	8	14	24										1		1	55	4	152	211																			2	2					246
Bird	Accipiter gentilis	Northern Goshawk	Widespread Concern, Low Responsibility	G5	P															1	1									8	2	11	21					6	10	9	25		1	1	2									3	3	1	7	56
Bird	Accipiter striatus	Sharp-Shinned Hawk	Widespread Concern, Low Responsibility	G5	P	2	2	3	7					3	14	8	25	4	1	1	6									3		5	8																									46
Bird	Alca torda	Razorbill	Limited Distribution, High Responsibility	G5	P																	3	1	2	6																																	6
Bird	Ammodramus caudacutus	Saltmarsh Sharp-tailed Sparrow	Widespread Concern, High Responsibility	G4	P		4	8	12													12	2	13	27							4	4															1	1									44
Bird	Ammodramus henslowii	Henslow's Sparrow	Widespread Concern, Low Responsibility	G4	S					1			1		2	2	4	1		4	5									1		2	3	3	4	26	33										1		1						2	3	5	52
Bird	Ammodramus maritimus	Seaside Sparrow	Widespread Concern, High Responsibility	G4	P	1	6	1	8																									6	2	6	14							3	3													25
Bird	Ammodramus savannarum	Grasshopper Sparrow	Widespread Concern, Low Responsibility	G5	A		2	8	10					2	53	140	195					1	1	4	6			1	1	6	15	69	90									1	1	2	4						3	14	17		1	5	6	329
Bird	Aquila chrysaetos	Golden Eagle	Widespread Concern, Low Responsibility	G5	P																	2	2	8	12										1	1	2																					14
Bird	Ardea alba	Great Egret	High Concern, Low Responsibility	G5	A	1	1	4	6																					21		16	37	2	3	32	37	1		4	5	3	2	1	6	1	1	4	6									97
Bird	Ardea herodias	Great Blue Heron	Widespread Concern, Low Responsibility	G5	A	2	5	9	16					10	29	50	89									3	1	10	14	13	1	33	47	5	3	21	29	16	22	145	183		2	1	3					2	12	25	39		2	11	13	433
Bird	Asio flammeus	Short-eared Owl	Widespread Concern, Low Responsibility	G5	S	2	1	4	7					21	18	51	90							2	2					1		2	3	4	5	50	59		1	9	10										1	2	3					174
Bird	Asio otus	Long-eared Owl	Widespread Concern, Low Responsibility	G5	A	1		5	6						4	3	7													4	1	13	18					2	1	5	8											4	4					43
Bird	Bartramia longicauda	Upland Sandpiper	Widespread Concern, Low Responsibility	G5	S			2	2						5	41	46			3	3		1	74	75			2	2	2		19	21	1	1	57	59		1	28	29	1	1	3	5			1	1	1		60	61					304
Bird	Botaurus lentiginosus	American Bittern	Widespread Concern, Low Responsibility	G4	A	2	2	5	9					17	109	110	236	1	1	1	3							1	1	7		12	19					1	3	4	8			2	2													278
Bird	Bubulcus ibis	Cattle Egret	High Concern, Low Responsibility	G5	A	1		1	2																					10		10	20	4		10	14					1	3		4						1		1					41
Bird	Buteo lineatus	Red-shouldered Hawk	High Concern, Low Responsibility	G5	NU	1		7	8																					67	3	92	162																									170
Bird	Buteo platypterus	Broad-winged Hawk	High Concern, Low Responsibility	G5	NU		6	7	13																					6	1	9	16																									29
Bird	Calidris canutus	Red Knot	Widespread Concern, Low Responsibility	G4	P							2	2	1	1	3	5													16	1	40	57																									64
Bird	Caprimulgus carolinensis	Chuck-will's-widow	High Concern, Low Responsibility	G5	P																											1	1		2	1	3																					4
Bird	Caprimulgus vociferus	Whip-poor-will	Widespread Concern, Low Responsibility	G5	NU	2	5	25	32																					9		2	11																			6	6					49
Bird	Catharus bicknelli	Bicknell's Thrush	Widespread Concern, High Responsibility	G4	S																	1			1									44	3	1	48													7	4	2	13					62
Bird	Catharus fuscescens	Veery	High Concern, Low Responsibility	G5	NU																									114	10	174	298																									298
Bird	Catharus minimus	Gray-Cheeked Thrush	High Concern, Low Responsibility	G5	P																									1			1																									1
Bird	Catharus ustulatus	Swainson's Thrush	High Concern, Low Responsibility	G5	NU																																	3	9	4	16																	16
Bird	Charadrius melodus	Piping Plover	Widespread Concern, Low Responsibility	G3	S	4		6	10		2	3	5	125	75	231	431	1			1	6	1	12	19					10		37	47	20	12	93	125					3	1	7	11			2	2									651
Bird	Chlidonias niger	Black Tern	Widespread Concern, Low Responsibility	G4	S																	1	4	12	17									1	14	10	25	1		1	2									1	1	1	3					47
Bird	Chordeiles minor	Common Nighthawk	Widespread Concern, Low Responsibility	G5	P			1	1																			2	2	1	1	5	7											2	2													12
Bird	Circus cyaneus	Northern Harrier	Widespread Concern, Low Responsibility	G5	S	1	2	5	8			1	1	201	71	189	461	1	1	2	4									24	1	34	59	11	14	56	81		6	13	19	4		1	5			1	1	5	1	9	15			1	1	655
Bird	Cistothorus palustris	Marsh Wren	High Concern, Low Responsibility	G5	P			1	1					1	2	1	4										1		1									5	1	14	20	1	3	2	6													32
Bird	Cistothorus platensis	Sedge Wren	Widespread Concern, Low Responsibility	G5	S	1		1	2					1	9	10	20	1		2	3	2	5	9	16			1	1	5		4	9	3	10	24	37	4		6	10							2	2			4	4					104
Bird	Coccyzus erythropthalmus	Black-billed Cuckoo	Widespread Concern, Low Responsibility	G5	NU																									24		23	47																									47
Bird	Colinus virginianus	Northen Bobwhite	Widespread Concern, Low Responsibility	G5	NU																																			4	4																	4
Bird	Contopus cooperi	Olive-sided Flycatcher	Widespread Concern, Low Responsibility	G4	NU	1			1																																																	1
Bird	Coturnicops noveboracensis	Yellow Rail	Widespread Concern, Low Responsibility	G4	P																	4	3	1	8																																	8
Bird	Dendroica caerulescens	Black-throated Blue Warbler	High Concern, Low Responsibility	G5	NU																									8		6	14											1	1													15
Bird	Dendroica castanea	Bay-breasted Warbler	Widespread Concern, Low Responsibility	G5	P																													1	1		2													1	2		3					5
Bird	Dendroica cerulea	Cerulean Warbler	Widespread Concern, Low Responsibility	G4	P		1		1		1		1																	29	2	13	44										1		1					1	2	2	5					52
Bird	Dendroica fusca	Blackburnian Warbler	High Concern, Low Responsibility	G5	P													1	2		3									6		5	11										1	1	2	3			3									19
Bird	Dendroica striata	Blackpoll Warbler	High Concern, Low Responsibility	G5	P									61	1		62																						1		1																	63
Bird	Dendroica tigrina	Cape May Warbler	High Concern, Low Responsibility	G5	P																													1		1	2													1		2	3					5
Bird	Dendroica virens	Black-throated Green Warbler	High Concern, Low Responsibility	G5	NU																									13	1	13	27																									27
Bird	Dolichonyx oryzivorus	Bobolink	Widespread Concern, Low Responsibility	G5	P	1	9	18	28																					10	2	62	74															1	1							2	2	105
Bird	Egretta caerulea	Little Blue Heron	Widespread Concern, Low Responsibility	G5	A	1	1	3	5																					19		29	48		1	19	20					1	3	1	5	1	1		2									80
Bird	Egretta thula	Snowy Egret	Widespread Concern, Low Responsibility	G5	A	3	2	2	7																					25		35	60	1	2	27	30					3	3	1	7	2	1		3		1		1					108
Bird	Egretta tricolor	Tricolored Heron	Widespread Concern, Low Responsibility	G5	P																									16		21	37		1	10	11									1	1		2									50
Bird	Empidonax virescens	Acadian Flycatcher	High Concern, Low Responsibility	G5	P		1	1	2																					5		2	7									1	3		4													13
Bird	Eremophila alpestris	Horned Lark	High Concern, Low Responsibility	G5	NU		2	3	5																		1		1			4	4																									10
Bird	Euphagus carolinus	Rusty Blackbird	High Concern, Low Responsibility	G4	P																		4	13	17										2		2													4	1	3	8					27
Bird	Falcipennis canadensis	Spruce Grouse	Widespread Concern, Low Responsibility	G5	S																					2		1	3					12	10	9	31													1			1					35
Bird	Falco peregrinus	Peregrine Falcon	Widespread Concern, Low Responsibility	G4	S	1	2	9	12						4	29	33					15	4	15	34					15		23	38	20	12	63	95	1		27	28			3	3	5	1	11	17	6	6	27	39	1	1		2	301
Bird	Fratercula arctica	Atlantic Puffin	Limited Distribution, High Responsibility	G5	P																	2		2	4																																	4
Bird	Gallinula chloropus	Common Moorhen	Widespread Concern, Low Responsibility	G5	A	1	3	1	5					8	12	31	51	1		1	2		2	4	6		1		1									1	1	7	9									3	4	5	12		1		1	87
Bird	Gavia immer	Common Loon	High Concern, Low Responsibility	G5	A			2	2						17	48	65											4	4					21	33	209	263													4	14	49	67					401
Bird	Gelochelidon nilotica	Gull-billed Tern	Widespread Concern, Low Responsibility	G5	S															1	1									4		7	11			10	10									1	6	1	8									30
Bird	Haematopus palliatus	American Oystercatcher	Widespread Concern, High Responsibility	G5	P	1	6	9	16		5	3	8																	6		8	14									1	4	7	12													50
Bird	Haliaeetus leucocephalus	Bald Eagle	Widespread Concern, Low Responsibility	G5	S		4	24	28					3	54	49	106	66	102	285	453	123	122	542	787			2	2	280	11	439	730	19	45	144	208	35	50	203	288		1		1	36	76	473	585	1		4	5		5	25	30	3223
Bird	Histrionicus histrionicus	Harlequin Duck	Widespread Concern, Low Responsibility	G4	P																	4	7	25	36																																	36
Bird	Hylocichla mustelina	Wood Thrush	Widespread Concern, Low Responsibility	G5	NU																									282	27	883	1192																									1192
Bird	Icteria virens	Yellow-breasted Chat	High Concern, Low Responsibility	G5	NU	3	1	3	7																					8		10	18																									25
Bird	Ixobrychus exilis	Least Bittern	Widespread Concern, Low Responsibility	G5	S	2	8	7	17					18	27	36	81	2	4	2	8	1	6	19	26			1	1	15		15	30	9	33	29	71	3	2	7	12	2	2	2	6					4	8	5	17		1		1	270
Bird	Lanius ludovicianus	Loggerhead Shrike	Widespread Concern, Low Responsibility	G4	S											1	1		1	1	2															7	7									1	1	11	13									23
Bird	Larus marinus	Great Black-backed Gull	Low Concern, High Responsibility	G5	NU																																														1		1					1
Bird	Laterallus jamaicensis	Black Rail	Widespread Concern, Low Responsibility	G4	A			2	2									1	5	1	7									5		11	16														1		1									26
Bird	Melanerpes erythrocephalus	Red-headed Woodpecker	High Concern, Low Responsibility	G5	P		1	2	3																					44	6	107	157																	2		9	11					171
Bird	Mniotilta varia	Black-and-White Warbler	High Concern, Low Responsibility	G5	NU																									12		1	13																									13
Bird	Nyctanassa violacea	Yellow-crowned Night-heron	Widespread Concern, Low Responsibility	G5	A		2	3	5											1	1									17	1	43	61	1		15	16			15	15			1	1	1		1	2									101
Bird	Nycticorax nycticorax	Black-crowned Night-heron	Widespread Concern, Low Responsibility	G5	A	2	3	4	9													3	2	2	7			1	1	38	1	42	81					1	2	14	17	2	3	2	7						1		1					123
Bird	Oporornis formosus	Kentucky Warbler	Widespread Concern, Low Responsibility	G5	P		2	1	3																					6		8	14		4	6	10																					27
Bird	Pandion haliaetus	Osprey	High Concern, Low Responsibility	G5	P	4	8	7	19					8	29	73	110													23		33	56					1	9	53	63									5	10	28	43		6	3	9	300
Bird	Parula americana	Northern Parula	High Concern, Low Responsibility	G5	P	1		2	3					7	17	7	31													12	1	16	29										1		1													64

Appendix 9-2. Regionally significant species: state results of the numbers of precise element occurrences falling on secured lands for each species.

Taxa	Scientific Name	Common Name	Regional Concern, Regional Responsibility	GRANK	Data Sufficiency for Regional analysis	CT GAP 1 & 2	CT GAP 3	CT None	CT Total	DE GAP 1 & 2	DE GAP 3	DE None	DE Total	MA GAP 1 & 2	MA GAP 3	MA None	MA Total	MD GAP 1 & 2	MD GAP 3	MD None	MD Total	ME GAP 1 & 2	ME GAP 3	ME None	ME Total	NH GAP 1 & 2	NH GAP 3	NH None	NH Total	NJ GAP 1 & 2	NJ GAP 3	NJ None	NJ Total	NY GAP 1 & 2	NY GAP 3	NY None	NY Total	PA GAP 1 & 2	PA GAP 3	PA None	PA Total	RI GAP 1 & 2	RI GAP 3	RI None	RI Total	VA GAP 1 & 2	VA GAP 3	VA None	VA Total	VT GAP 1 & 2	VT GAP 3	VT None	VT Total	WV GAP 1 & 2	WV GAP 3	WV None	WV Total	Grand Total
Bird	Pelecanus occidentalis	Brown Pelican	High Concern, Low Responsibility	G4	P																																									1			1									1
Bird	Phalacrocorax carbo	Great Cormorant	Moderate Concern, High Responsibility	G5	NU																	4	6	1	11																																	11
Bird	Picoides dorsalis	American Three-toed Woodpecker	Widespread Concern, Low Responsibility	G5	S																					1			1					4	1	1	6														1	2	3					10
Bird	Plegadis falcinellus	Glossy Ibis	Widespread Concern, High Responsibility	G5	A	1		3	4																					23		29	52		2	25	27					2	3	1	6	1	1		2									91
Bird	Podilymbus podiceps	Pied-billed Grebe	Widespread Concern, Low Responsibility	G5	A	2	6	8	16					8	9	25	42	1	1	2	4					3	6	9	18	7		18	25	5	29	56	90	2	4	16	22			1	1					2	3	7	12					230
Bird	Pooecetes gramineus	Vesper Sparrow	Widespread Concern, Low Responsibility	G5	P			3	3					13	2	45	60											1	1	6	3	58	67																									131
Bird	Porzana carolina	Sora Rail	High Concern, Low Responsibility	G5	S		4	4	8					1	2	1	4	1		1	2							1	1	5	1	6	12					4	2	12	18		1	4	5			1	1	3	5	5	13		1		1	65
Bird	Protonotaria citrea	Prothonotary Warbler	Widespread Concern, Low Responsibility	G5	P																									1			1	1	3	1	5	2	3	6	11			1	1													18
Bird	Rallus elegans	King Rail	Widespread Concern, Low Responsibility	G4	A		3	3	6					8	5	13	26													3		6	9	2	3	2	7	2		2	4	1	1		2	2		4	6					1			1	61
Bird	Rynchops niger	Black Skimmer	Widespread Concern, Low Responsibility	G5	A									1		1	2	1		2	3									23		28	51	9	2	33	44									2	3	3	8									108
Bird	Spiza americana	Dickcissel	Widespread Concern, Low Responsibility	G5	P		1	1	2																														1	15	16																	18
Bird	Spizella pusilla	Field Sparrow	Widespread Concern, Low Responsibility	G5	NU																							1	1	5			5																									6
Bird	Sterna dougallii	Roseate Tern	Widespread Concern, High Responsibility	G4	S	1		5	6					13	10	65	88					8	6	11	25									3	4	16	23																					142
Bird	Sterna forsteri	Forster's Tern	High Concern, Low Responsibility	G5	P																									10	1	8	19	1		17	18																					37
Bird	Sterna hirundo	Common Tern	Widespread Concern, Low Responsibility	G5	A		3	20	23					44	30	122	196										1	3	4	53	2	50	105	27	9	127	163													2		4	6					497
Bird	Sterna paradisaea	Arctic Tern	Widespread Concern, High Responsibility	G5	S									9	1	16	26					8	3	9	20			1	1																													47
Bird	Sternula antillarum	Least Tern	Widespread Concern, Low Responsibility	G4	S	3	2	5	10					66	65	178	309	1	1	20	22	1	1	12	14					10	1	37	48	26	12	84	122					3	2	7	12			5	5									542
Bird	Sturnella magna	Eastern Meadowlark	Widespread Concern, Low Responsibility	G5	NU	3	1	14	18																					3	4	51	58																									76
Bird	Thalasseus maximus	Royal Tern	High Concern, Low Responsibility	G5	P													1			1																									1		1	2									3
Bird	Toxostoma rufum	Brown Thrasher	Widespread Concern, Low Responsibility	G5	NU	5	4	14	23																		1	1	2	63	3	139	205																									230
Bird	Tringa semipalmata	Willet	Widespread Concern, Low Responsibility	G5	NU	2	2	7	11																																		1	1	2													13
Bird	Tyto alba	Barn Owl	Widespread Concern, Low Responsibility	G5	A			4	4					4	2	30	36													1		1	2	1		9	10	4	4	87	95	2		2	4							1	1			9	9	161
Bird	Vermivora chrysoptera	Golden-winged Warbler	Widespread Concern, Low Responsibility	G4	A	1	2	1	4					1	8	14	23													18		12	30																			1	1		1	1	2	60
Bird	Vermivora pinus	Blue-winged Warbler	Widespread Concern, Low Responsibility	G5	NU						2		2																																													2
Bird	Wilsonia canadensis	Canada Warbler	Widespread Concern, Low Responsibility	G5	NU																									10		5	15																									15
Bird	Wilsonia citrina	Hooded Warbler	High Concern, Low Responsibility	G5	NU						1	3	4																	27	1	16	44																									48
Fish	Acantharchus pomotis	Mud Sunfish	Widespread Concern, High Responsibility	G5	P															2	2																																					2
Fish	Acipenser brevirostrum	Shortnose Sturgeon	Widespread Concern, High Responsibility	G3	A											17	17			2	2											2	2			1	1																					22
Fish	Acipenser oxyrinchus	Atlantic Sturgeon	Widespread Concern, High Responsibility	G3	P									1		3	4			2	2											2	2	1			1																					9
Fish	Alosa aestivalis	Blueback Herring	High Concern, High Responsibility	G5	NU			2	2																																																	2
Fish	Ammocrypta pellucida	Eastern Sand Darter	Widespread Concern, Low Responsibility	G4	S																															15	15															1	1			4	4	20
Fish	Anguilla rostrata	American Eel	Widespread Concern, Low Responsibility	G4	NU																																																			2	2	2
Fish	Catostomus catostomus	Longnose Sucker	High Concern, Low Responsibility	G5	P			1	1					4	7	124	135																																									136
Fish	Cottus caeruleomentum	Blue Ridge Sculpin	Low Concern, High Responsibility	G4	NU															1	1																																					1
Fish	Cottus cognatus	Slimy Sculpin	High Concern, Low Responsibility	G5	NU																																																			1	1	1
Fish	Cottus girardi	Potomac Sculpin	Moderate Concern, High Responsibility	G4	P																																																			2	2	2
Fish	Cottus sp. 7	Checkered Sculpin	Limited Distribution, High Responsibility	G4	A														1	1	2																																					2
Fish	Enneacanthus chaetodon	Blackbanded Sunfish	Widespread Concern, High Responsibility	G4	P															1	1																											2	2									3
Fish	Enneacanthus obesus	Banded Sunfish	Widespread Concern, High Responsibility	G5	NU	1	1	24	26																									2	1	2	5																					31
Fish	Erimystax dissimilis	Streamline Chub	Widespread Concern, Low Responsibility	G4	P																															1	1																					1
Fish	Etheostoma camurum	Bluebreast Darter	Widespread Concern, Low Responsibility	G4	A																															1	1											12	12							10	10	23
Fish	Etheostoma fusiforme	Swamp Darter	High Concern, Low Responsibility	G5	NU																	1	2	3	6									1		1	2																					8
Fish	Etheostoma maculatum	Spotted Darter	Limited Distribution, High Responsibility	G2	A																															1	1																		1	1	2	3
Fish	Etheostoma olmstedi	Tessellated Darter	Moderate Concern, High Responsibility	G5	NU																																																			5	5	5
Fish	Etheostoma osburni	Candy Darter	Limited Distribution, High Responsibility	G3	A																																											2	2						4	9	13	15
Fish	Etheostoma variatum	Variegate Darter	Moderate Concern, High Responsibility	G5	P																														2	5	7																					7
Fish	Etheostoma vitreum	Glassy Darter	Limited Distribution, High Responsibility	G4	P													1	6	6	13																																					13
Fish	Exoglossum laurae	Tonguetied Minnow	High Concern, High Responsibility	G4	A																														2	4	6																		2	2	4	10
Fish	Fundulus luciae	Spotfin Killfish	Widespread Concern, High Responsibility	G4	NU											1	1																																									1
Fish	Gasterosteus aculeatus	Threespine Stickleback	Moderate Concern, High Responsibility	G5	NU											1	1																																									1
Fish	Hiodon tergisus	Mooneye	Widespread Concern, Low Responsibility	G5	A																															4	4																			17	17	21
Fish	Hybognathus regius	Eastern Silvery Minnow	Low Concern, High Responsibility	G5	NU											3	3																																	2	4	29	35					38
Fish	Ichthyomyzon bdellium	Ohio Lamprey	Widespread Concern, Low Responsibility	G3	A																															10	10									1		7	8							3	3	21
Fish	Ichthyomyzon fossor	Northern Brook Lamprey	Widespread Concern, Low Responsibility	G4	S																															9	9															2	2			1	1	12
Fish	Ichthyomyzon greeleyi	Mountain Brook Lamprey	Widespread Concern, Low Responsibility	G3	P																															6	6																					6
Fish	Ichthyomyzon unicuspis	Silver Lamprey	High Concern, Low Responsibility	G5	A																																													1		10	11			6	6	17
Fish	Lampetra aepyptera	Least Brook Lamprey	Widespread Concern, Low Responsibility	G5	NU																																																			2	2	2
Fish	Lampetra appendix	American Brook Lamprey	Widespread Concern, Low Responsibility	G4	P			2	2					4	3	21	28																											1	1							6	6			3	3	40
Fish	Lepomis gulosus	Warmouth	Widespread Concern, Low Responsibility	G5	P																																																			2	2	2
Fish	Lota lota	Burbot	High Concern, Low Responsibility	G5	P			3	3						2	3	5																																									8
Fish	Margariscus margarita	Pearl Dace	Moderate Concern, High Responsibility	G5	NU																																																			2	2	2
Fish	Moxostoma carinatum	River Redhorse	Widespread Concern, Low Responsibility	G4	P																														1		1									1		13	14									15
Fish	Nocomis platyrhynchus	Bigmouth Chub	Limited Distribution, High Responsibility	G4	A																																																		6	18	24	24
Fish	Notropis amoenus	Comely Shiner	High Concern, High Responsibility	G5	NU																																																			2	2	2
Fish	Notropis bifrenatus	Bridle Shiner	Widespread Concern, High Responsibility	G3	NU									2	24	102	128																																		1	6	7					135
Fish	Notropis chalybaeus	Ironcolor Shiner	Widespread Concern, Low Responsibility	G4	P														1	2	3											1	1																									4
Fish	Notropis heterodon	Blackchin Shiner	Widespread Concern, Low Responsibility	G5	A																													1	1	16	18													1		6	7					25
Fish	Notropis procne	Swallowtail Shiner	Moderate Concern, High Responsibility	G5	NU																																																			3	3	3
Fish	Notropis scabriceps	New River Shiner	Limited Distribution, High Responsibility	G4	A																																																			4	4	4
Fish	Noturus flavus	Stonecat	High Concern, Low Responsibility	G5	P															3	3																											8	8			4	4					15
Fish	Pararhinichthys bowersi	Cheat Minnow	Limited Distribution, High Responsibility	G1	A																																																		1	6	7	7
Fish	Percina copelandi	Channel Darter	Widespread Concern, Low Responsibility	G4	A																															5	5											5	5			2	2			11	11	23
Fish	Percina gymnocephala	Appalachia Darter	Limited Distribution, High Responsibility	G4	A																																																		1	2	3	3
Fish	Percina macrocephala	Longhead Darter	Limited Distribution, High Responsibility	G3	A																															3	3																			5	5	8
Fish	Percina notogramma	Stripeback Darter	Limited Distribution, High Responsibility	G4	P															3	3																																					3
Fish	Percopsis omiscomaycus	Trout-perch	High Concern, Low Responsibility	G5	A											1	1																																			1	1					2
Fish	Phenacobius teretulus	Kanawha Minnow	Limited Distribution, High Responsibility	G3	A																																									1		2	3						1	2	3	6
Fish	Phoxinus oreas	Mountain Redbelly Dace	Limited Distribution, High Responsibility	G5	A																																																		15	8	23	23
Fish	Prosopium cylindraceum	Round Whitefish	Widespread Concern, High Responsibility	G5	A																													2	3	9	14															2	2					16
Fish	Sander canadensis	Sauger	High Concern, Low Responsibility	G5	NU																																											6	6									6
Fish	Thoburnia rhothoeca	Torrent Sucker	Limited Distribution, High Responsibility	G4	A																																																		1	1	2	2
Inverts	Alasmidonta heterodon	Dwarf Wedgemussel	Widespread Concern, High Responsibility	G1	S			5	5						11	23	34	1		8	9					1		7	8	2		6	8	1		2	3											7	7			3	3					77
Inverts	Alasmidonta marginata	Elktoe	Widespread Concern, Low Responsibility	G4	P																																											6	6			1	1		1	5	6	13
Inverts	Alasmidonta undulata	Triangle Floater	High Concern, High Responsibility	G4	P									12	70	259	341			3	3									14	2	25	41																							1	1	386
Inverts	Alasmidonta varicosa	Brook Floater	Widespread Concern, High Responsibility	G3	S	1	1	5	7						11	32	43	1		9	10		12	76	88		11	14	25	5	2	6	13	1	1	16	18											2	2			1	1			7	7	214
Inverts	Anarta luteola	Yellow Bog Anarta	Limited Distribution, High Responsibility	G5	P	1	1		2																																																	2
Inverts	Anodonta implicata	Alewife Floater	High Concern, High Responsibility	G5	NU																															3	3																					3
Inverts	Anodontoides ferussacianus	Cylindrical Papershell	High Concern, Low Responsibility	G5	P																																															1	1					1

Appendix 9-2. Regionally significant species: state results of the numbers of precise element occurrences falling on secured lands for each species.

Taxa	Scientific Name	Common Name	Regional Concern, Regional Responsibility	GRANK	Data Sufficiency for Regional analysis	CT GAP 1 & 2	CT GAP 3	CT None	CT Total	DE GAP 1 & 2	DE GAP 3	DE None	DE Total	MA GAP 1 & 2	MA GAP 3	MA None	MA Total	MD GAP 1 & 2	MD GAP 3	MD None	MD Total	ME GAP 1 & 2	ME GAP 3	ME None	ME Total	NH GAP 1 & 2	NH GAP 3	NH None	NH Total	NJ GAP 1 & 2	NJ GAP 3	NJ None	NJ Total	NY GAP 1 & 2	NY GAP 3	NY None	NY Total	PA GAP 1 & 2	PA GAP 3	PA None	PA Total	RI GAP 1 & 2	RI GAP 3	RI None	RI Total	VA GAP 1 & 2	VA GAP 3	VA None	VA Total	VT GAP 1 & 2	VT GAP 3	VT None	VT Total	WV GAP 1 & 2	WV GAP 3	WV None	WV Total	Grand Total
Inverts	Discus catskillensis	Angular Disc	Low Concern, High Responsibility	G5	NU														2		2																																					2
Inverts	Elimia virginica	Virginia River Snail	Low Concern, High Responsibility	G5	NU	1		7	8																																																	8
Inverts	Elliptio fisheriana	Northern Lance Mussel	Widespread Concern, High Responsibility	G4	P																																																			4	4	4
Inverts	Elliptio lanceolata	Yellow Lance	Limited Distribution, High Responsibility	G2	A															1	1																										1	26	27									28
Inverts	Floridobia winkleyi	New England Siltsnail	Limited Distribution, High Responsibility	G3	P										2	6	8																																									8
Inverts	Fontigens bottimeri	Appalachian Springsnail	Limited Distribution, High Responsibility	G2	S														2	2	4																										1	5	6									10
Inverts	Fontigens orolibas	Blue Ridge Springsnail	Limited Distribution, High Responsibility	G3	P													1			1																																					1
Inverts	Hendersonia occulta	Cherrystone Drop Snail	Widespread Concern, Low Responsibility	G4	A													6	1	4	11																																	1	4	3	8	19
Inverts	Lampsilis cariosa	Yellow Lampmussel	Widespread Concern, High Responsibility	G3	S			6	6						1	84	85			2	2		3	64	67					4		7	11		2	42	44											18	18							1	1	234
Inverts	Lampsilis fasciola	Wavyrayed Lampmussel	High Concern, Low Responsibility	G5	A																														1	3	4																		1	4	5	9
Inverts	Lampsilis ovata	Pocketbook Mussel	Widespread Concern, Low Responsibility	G5	A																														1	12	13															2	2		1	5	6	21
Inverts	Lampsilis radiata	Eastern Lampmussel	Moderate Concern, High Responsibility	G5	NU													2		7	9									1	1	3	5													1		10	11									25
Inverts	Lasmigona compressa	Creek heelsplitter	High Concern, Low Responsibility	G5	P																																														1	3	4					4
Inverts	Lasmigona subviridis	Green Floater	Widespread Concern, High Responsibility	G3	A													3		4	7											1	1			15	15											24	24						2	5	7	54
Inverts	Leptodea fragilis	Fragile Papershell	High Concern, Low Responsibility	G5	P																															10	10									1		4	5			2	2					17
Inverts	Leptodea ochracea	Tidewater Mucket	Widespread Concern, High Responsibility	G3	A		1	12	13			2	2	3	4	168	175			1	1		1	43	44					3		7	10			1	1																					246
Inverts	Ligumia nasuta	Eastern Pond Mussel	Widespread Concern, High Responsibility	G4	A	2		15	17						26	178	204			1	1							2	2	3	1	6	10			10	10																					244
Inverts	Ligumia recta	Black Sandshell	Widespread Concern, Low Responsibility	G5	A																													1	1	8	10									1		5	6			2	2		2	8	10	28
Inverts	Littoridinops tenuipes	Coastal Marsh Snail	Low Concern, High Responsibility	G5	NU										1	3	4																																									4
Inverts	Macrocotyla hoffmasteri	Hoffmaster's Cave Planarian	Limited Distribution, High Responsibility	G3	S															1	1																																			4	4	5
Inverts	Margaritifera margaritifera	Eastern Pearlshell	High Concern, High Responsibility	G4	P		6	13	19																											7	7														1	15	16					42
Inverts	Pleurobema collina	James Spinymussel	Limited Distribution, High Responsibility	G1	A																																										4	14	18							1	1	19
Inverts	Procotyla typhlops	Groundwater Planarian sp.	Limited Distribution, High Responsibility	G1	A														1		1																																					1
Inverts	Stylodrilus beattiei	Cave Lumbriculid Worm sp.	Limited Distribution, High Responsibility	G2	S																																											1	1							3	3	4
Inverts	Triodopsis picea	Spruce Knob Three-tooth	High Concern, High Responsibility	G3	P													3	1		4																																					4
Inverts	Truncilla truncata	Deertoe	Widespread Concern, Low Responsibility	G5	A																															1	1											4	4						2	5	7	12
Inverts	Valvata sincera	Mossy Valvata/Boreal Turret Snail	High Concern, Low Responsibility	G5	P			1	1						1	2	3																																									4
Inverts	Villosa iris	Rainbow	High Concern, Low Responsibility	G5	P																													2		9	11																					11
Inverts	Webbhelix multilineata	Striped Whitelip	High Concern, Low Responsibility	G5	A															1	1																																	1	1		2	3
Mammal	Cryptotis parva	Least Shrew	Widespread Concern, Low Responsibility	G5	P		1		1																													2		3	5														1		1	7
Mammal	Lasionycteris noctivagans	Silver-haired Bat	Widespread Concern, Low Responsibility	G5	NU																																	1	16	4	21														2	4	6	27
Mammal	Lasiurus borealis	Eastern Red Bat	Widespread Concern, Low Responsibility	G5	NU	2	2	2	6																																																	6
Mammal	Lasiurus cinereus	Hoary Bat	Widespread Concern, Low Responsibility	G5	NU		1	2	3						1	2	3																																									6
Mammal	Lynx rufus	Bobcat	High Concern, Low Responsibility	G5	NU																									77	1	77	155					1		1	2		1		1													158
Mammal	Martes pennanti	Fisher	Moderate Concern, High Responsibility	G5	NU																									3		1	4														1		1									5
Mammal	Mustela nivalis	Least Weasel	Widespread Concern, Low Responsibility	G5	A													2		5	7																			1	1																	8
Mammal	Myotis leibii	Eastern Small-footed Bat	Widespread Concern, High Responsibility	G3	S									1	2		3	1	1	4	6		1		1							1	1	4	16	22	42	6	7	52	65					6	4	14	24	3	4	17	24		16	23	39	205
Mammal	Myotis sodalis	Indiana Bat	Widespread Concern, Low Responsibility	G2	S													1		4	5									1		6	7	4	6	23	33									7		7	14	4		21	25	2	11	28	41	125
Mammal	Neotoma magister	Allegheny Woodrat	Widespread Concern, High Responsibility	G3	A													1	6	4	11													10	13	9	32	33	88	85	206													2	49	82	133	382
Mammal	Sorex dispar	Long-tailed or Rock Shrew	High Concern, High Responsibility	G4	A									1		1	2	1	8	3	12																	3	1	2	6									1		1	2		8	8	16	38
Mammal	Sorex fumeus	Smoky Shrew	Moderate Concern, High Responsibility	G5	NU													2	4	1	7																						1	1	2													9
Mammal	Sylvilagus obscurus	Appalachian Cottontail	Widespread Concern, Low Responsibility	G4	S														6	1	7																		1	2	3														5		5	15
Mammal	Sylvilagus transitionalis	New England Cottontail	Widespread Concern, High Responsibility	G3	P	2	3	11	16														1	53	54										1	6	7																					77
Mammal	Synaptomys cooperi	Southern Bog Lemming	Widespread Concern, Low Responsibility	G5	P		1		1						8	1	9													8		1	9																		2		2		4	17	21	42
Reptile	Agkistrodon contortrix	Copperhead	High Concern, Low Responsibility	G5	NU									2	53	28	83																																									83
Reptile	Clemmys guttata	Spotted Turtle	Widespread Concern, High Responsibility	G5	A		2	3	5					86	227	834	1147					17	36	250	303		2	14	16	7	1	18	26																		1	2	3	2	1	1	4	1504
Reptile	Crotalus horridus	Timber/Canebrake Rattlesnake	Widespread Concern, Low Responsibility	G4	A	2	4	6	12					21	78	33	132																	35	69	101	205													1	1	2	4			14	14	367
Reptile	Emydoidea blandingii	Blanding's Turtle	Widespread Concern, Low Responsibility	G4	S									73	199	586	858					21	53	202	276			4	4					2	3	59	64																					1202
Reptile	Glyptemys insculpta	Wood Turtle	Widespread Concern, High Responsibility	G4	S	10	7	62	79					47	220	1098	1365					13	17	122	152		3	8	11	103	27	401	531										1	4	5	1	6	27	34			6	6	2	1	22	25	2208
Reptile	Glyptemys muhlenbergii	Bog Turtle	Widespread Concern, High Responsibility	G3	S	2		6	8			2	2	7	2	3	12		6	139	145									32	3	141	176	4	5	44	53									7		37	44									440
Reptile	Graptemys geographica	Northern Map Turtle	High Concern, Low Responsibility	G5	A															3	3									3		3	6																		1	2	3			1	1	13
Reptile	Heterodon platirhinos	Eastern Hognose Snake	Widespread Concern, Low Responsibility	G5	P	5	6	20	31																			3	3														1	3	4											2	2	40
Reptile	Opheodrys aestivus	Rough Green Snake	High Concern, Low Responsibility	G5	NU																																																		1		1	1
Reptile	Opheodrys vernalis	Smooth Green Snake	High Concern, Low Responsibility	G5	NU		1	3	4																																																	4
Reptile	Pantherophis guttatus	Corn Snake	Widespread Concern, Low Responsibility	G5	P																									13		34	47																							1	1	48
Reptile	Plestiodon laticeps	Broadhead Skink	Widespread Concern, Low Responsibility	G5	P																																																		3		3	3
Reptile	Pseudemys rubriventris	Redbelly/Red-bellied Cooter/Turtle	High Concern, High Responsibility	G5	NU																																																			1	1	1
Reptile	Regina septemvittata	Queen Snake	Widespread Concern, Low Responsibility	G5	NU																															3	3																					3
Reptile	Terrapene carolina	Eastern Box Turtle	Widespread Concern, Low Responsibility	G5	NU									321	406	1439	2166											3	3																													2169

Data Sources

April 2011

Boundaries

1. **States: Tele Atlas North America, Inc., 2009. U.S. States. 1:100,000 Tele Atlas Dynamap Census Boundaries v. 11.0. ESRI® Data & Maps 2009 Data Update. Redlands, California, USA.** U.S. State Boundaries represents the boundary lines of the states of the United States

2. **Counties: Tele Atlas North America, Inc., 2009. U.S. Counties. 1:100,000 Tele Atlas StreetMap Premium v. 7.2 ESRI® Data & Maps: StreetMap. 2009 Data Update: North America. Redlands, California, USA.** U.S. Counties represents the boundary lines of the counties within the United States. Boundaries are consistent with state, tract, and block group data sets.

3. **Watersheds, HUC8: USDA/NRCS - National Cartography & Geospatial Center. 1994. (Data Access from NRCS 3/31/2009) 8-Digit HUC Hydrologic Units 1:250,000. Fort Worth, TXOnline http://datagateway.nrcs.usda.gov/**

   Watersheds, HUC12: USDA/NRCS, National Cartography & Geospatial Center. 1999-2009 (Data Access from NRCS Data 3/31/2009) 12-Digit Watershed Boundary Data 1:24,000. Fort Worth, TX. http://datagateway.nrcs.usda.gov/

   Hydrologic Unit Codes (HUC) data describe watersheds as polygons. Hydrologic units are subdivisions of watersheds nested from largest to smallest areas and are used to organize hydrologic data. HUC basins decrease in size with an increase in levels. For example, HUC6 watersheds are major river basins, while HUC12 watersheds are for 2nd and 3rd order streams. The HUC codes are constructed as follows: the first two digits identify the region (HUC2), the first four digits identify subregions (HUC4), the first six digits identify accounting units (HUC6), the first eight digits identify cataloging units (HUC8), the first ten digits identify watershed units (HUC10), and the full twelve digits identify subwatershed units (HUC12).

Conservation Land

1. **Secured Lands: The Nature Conservancy. 2009. Eastern U.S. Secured Lands. Various scales. Compiled from multiple sources.** https://lfa.tnc.org/t/Eastern_Division_Secured_Lands_2009_External. A spatial dataset of public and private lands and waters secured by a conservation situation that includes an explicit level of security from future conversion and current incompatible uses. For more information on sources, please see the detailed secured lands source metadata in the secured lands chapter.
   - ME: The Maine Conservation Lands Geodatabase, TNC Maine March 2010.
   - NH: New Hampshire Conservation Lands, GRANIT, April 2010. US Forest Service Management Areas, US Forest Service, 2009.

- VT: Vermont Conservation Lands Database, Spatial Analysis Lab University of Vermont, 2010. Vermont Land Trust Conservation Land Database, 2010. The Nature Conservancy of Vermont, 2010.
- MA: Protected and Recreational Openspace Database, MassGIS, February 2010.
- RI: Local and NGO Conservation Park Layer, RI State Department of Environmental Management, April 2010. State Conservation and Parks Layer, , RI State Department of Environmental Management, April 2010.
- CT: Protected Open Space Phase 1, CT Department of Environmental Protection, 2005. Protected Open Space Phase 2, CT Department of Environmental Protection, 2010. TNC Connecticut, 2008. Municipal and Private Open Space, Connecticut Office of Policy and Management 1997. DEP Property, Connecticut Department of Environmental Protection, 2010.
- NY: NYS Parks and Historic Sites Boundaries, NY OPRHP, 2008, NYSDEC Division of Lands & Forests, 2008. NYC DEP Property - Division of Lands & Forests, GIS 2008. NYC DEP, 2008, NYC DEP propert . Open Space Institute. Albany County Land Conservancy. Agricultural Stewardship Association. Finger Lakes Land Trust. Lake George Land Conservancy. Hudson Highlands Land Trust. Rondout Esopus Land Conservancy. Wallkill Valley Land Trust, Inc. Shawangunk Conservancy. Genesee Land Trust. Scenic Hudson, Inc. Tug Hill Tomorrow Land Trust. Mohonk Preserve. Saratoga PLAN.
- PA: Protected Lands Inventory: Federal Lands, Nonprofit, and Private Lands, The Conservation Fund, 2004. Pennsylvania State Game Lands, PA Game Commission, July 2009. PA State Forests and State Parks, PA Bureau of Forestry, July 2009. Boundaries of State Parks in PA, Pennsylvania Department of Conservation and Natural Resources, 2008. County Parcel Data: Chester County (2001), Clinton County (2003), Elk County (2005), Juniata County (2007), Lancaster County (2001), Monroe County (2009), Northampton County (2007), Pike County (2005), Venango County (2004), Wayne County (2003). Lands owned by Western Pennsylvania Conservancy, Western Pennsylvania Conservancy, October 2009. Northeast Pennsylvania Protected Lands, Natural Lands Trust, July 2009. Lands owned by Fish and Boat Commission, Pennsylvania Fish and Boat Commission, July 2009.
- NJ: New Jersey State owned Conservation Easements, State Owned Land, and Green Acres Tracts, New Jersey Department of Environmental Protection, January 2010. Power Company TNC Land, PSEG, May 2007. Farmland Preservation File, New Jersey Department of Agriculture (NJDA) and State Agriculture Development Committee (SADC), July 2007.
- DE: Conservation Easements, DNREC Division of Parks and Recreation, 2008. Nature Preserves, DNREC Division of Parks and Recreation, 2008. Outdoor Recreation Inventory, DNREC Division of Parks and Recreation, 2008. Forest Easements, Delaware Forest Service, 2010. State Agriculture Easements, Delaware Department of Agriculture, 2010.
- MD: Agriculture Land Preservation Foundation Easements/Districts, Maryland Department of Agriculture, October 2006. County Parks, MD DNR, October 2007. MD DNR Lands, MD DNR, October 2009. Environmental Trust Easements, Maryland Environmental Trust, November 2009. Maryland Federal Lands, MD DNR, 2006. Forest Legacy Easements, MD DNR, October 2009. Private Conservation Properties, MD DNR, February 2009. Rural Legacy Properties, MD DRN, October 2009.
- West Virginia: WMA Property Boundaries, West Virginia Department of Natural Resource, October 2010. West Virginia Public Lands, West Virginia Department of

Natural Resources, October 2010. The Nature Conservancy West Virginia Field Office Layer, TNC West Virginia, 2010.

- Virginia: Conservation Lands Database, Virginia Department of Conservation and Recreation, March 2010.

Roads and Railroads

1. **Roads: Tele Atlas North America, Inc., 2009. U.S. and Canada Streets Cartographic. 1:100,000 Tele Atlas StreetMap Premium v. 7.2 ESRI® Data & Maps: StreetMap. 2009 Data Update: North America. Redlands, California, USA.** U.S. and Canada Streets Cartographic represents streets, highways, interstate highways, roads with and without limited access, secondary and connecting roads, local and rural roads, roads with special characteristics, access ramps, and ferries within the United States and Canada.

2. **Railroads: Tele Atlas North America, Inc. 2009. U.S. and Canada Railroads. 1:100,000. ESRI® Data & Maps: StreetMap. 2009 Data Update: North America. Redlands, California, USA.** U.S. and Canada Railroads represent the railroads of the United States and Canada.

Land Cover and Related Derivates

1. **Land Cover: U.S. Geological Survey (USGS). National Land Cover Dataset 2001. Version 1. U.S. 30m cell. Sioux Falls, SD. http://www.epa.gov/mrlc/nlcd-2001.html Homer, C., C. Huang, L. Yang, B. Wylie and M. Coan, 2004. Development of a 2001 national land cover database for the United States. Photogrammetric Engineering and Remote Sensing.** The National Land Cover Database 2001 land cover dataset was produced through a cooperative project conducted by the Multi-Resolution Land Characteristics (MRLC) Consortium, a partnership of federal agencies (www.mrlc.gov). The goal was to generate a current, consistent, seamless, and accurate National Land Cover Database (NLCD) circa 2001 for the United States at medium spatial resolution. The resultant product for the northeast distinguishes 15 land cover classes: Open Water, Developed Open Space, Developed Low Intensity, Developed Medium Intensity, Developed High Intensity, Barren Land (Rock/Sand/Clay), Deciduous Forest, Evergreen Forest, Mixed Forest, Shrub/Scrub, Grassland/Herbaceous, Pasture/Hay, Cultivated Crops, Woody Wetlands, and Emergent Herbaceous Wetlands.

2. **Imperviousness: U.S. Geological Survey (USGS). National Land Cover Dataset 2001 Imperviousness. Version 1. 30m cell. Sioux Falls, SD. http://www.epa.gov/mrlc/nlcd-2001.html Yang, L, C. Huang, C. Homer, B. Wylie, and M. Coan, 2002. An approach for mapping large-area impervious surfaces: Synergistic use of Landsat 7 ETM+ and high spatial resolution imagery. Canadian Journal of Remote Sensing, 29: 2, 230-240.** The National Land Cover Database 2001 land cover dataset was produced through a cooperative project conducted by the Multi-Resolution Land Characteristics (MRLC) Consortium, a partnership of federal agencies (www.mrlc.gov). The impervious surface data classifies each 30m pixel into 101 possible values (0% - 100%).

3. **Canopy Cover: U.S. Geological Survey (USGS). National Land Cover Dataset 2001 Canopy Cover. Version 1. 30m cell. Sioux Falls, SD. http://www.epa.gov/mrlc/nlcd-2001.html Huang, C., L. Yang, B. Wylie, and C. Homer, 2001. A strategy for estimating tree canopy**

density using Landsat 7 ETM+ and high resolution images over large areas. In: Third International Conference on Geospatial Information in Agriculture and Forestry; November 5-7, 2001; Denver, Colorado. CD-ROM, 1 disk. The National Land Cover Database 2001 land cover dataset was produced through a cooperative project conducted by the Multi-Resolution Land Characteristics (MRLC) Consortium, a partnership of federal agencies (www.mrlc.gov). The canopy density database classifies each 30m pixel into 101 possible values (0% - 100%). The canopy density estimates apply only to the forest cover.

4. **Land Cover Change: U.S. Geological Survey (USGS). National Land Cover Database (NLCD) 1992–2001 Land Cover Change Retrofit Product. 30m cell. Sioux Falls, SD. http://www.mrlc.gov/multizone.php Fry, J.A., Coan, M.J., Homer, C.G., Meyer, D.K., and Wickham, J.D., 2009, Completion of the National Land Cover Database (NLCD) 1992 - 2001 Land Cover Change Retrofit product: U.S. Geological Survey Open-File Report 2008: 1379, 18 p.** New developments in mapping methodology, new sources of input data, and changes in the mapping legend for the 2001 National Land Cover Database (NLCD 2001) will confound any direct comparison between NLCD 2001 and the 1992 National Land Cover Dataset (NLCD 1992). Users are cautioned that direct comparison of these two independently created land cover products is not recommended. This NLCD 1992/2001 Retrofit Land Cover Change Product was developed to offer users more accurate direct change analysis between the two products. The NLCD 1992/2001 Retrofit Land Cover Change Product uses a specially developed methodology to provide land cover change information at the Anderson Level I classification scale relying on decision tree classification of Landsat imagery from 1992 and 2001. Unchanged pixels between the two dates are coded with the NLCD 2001 Anderson Level I class code, while changed pixels are labeled with a "from-to" land cover change value. This product is designed for regional application only and is not recommended for local scales.

5. **Local Connectivity: Brad Compton. 2010. Resistant Kernal. 90m cell. University of Massachusetts. 2010.** The connectivity metric is derived from a resistant kernel analysis. A resistance value is assigned to each cover type in a land-cover map. For land cover we used classified data from the NLCD2001. The NLCD was supplemented with road information from ESRI. The resistant kernel provides a measure of how connected each grid cell is versus an “ideal” kernel with no resistance (ie completely natural). We used a 3km radius for the distance of the kernel to define local connectivity. Please see the methods section for more information on development of this dataset.

6. **Forest Types: U.S. Geological Survey. 2006. LANDFIRE 1.1.0: Existing Vegetation Type layer. 30m. http://landfire.cr.usgs.gov/viewer/** The LANDFIRE existing vegetation layers represents the current distribution of the terrestrial ecological systems classification developed by NatureServe for the western Hemisphere. A terrestrial ecological system is defined as a group of plant community types (associations) that tend to co-occur within landscapes with similar ecological processes, substrates, and/or environmental gradients. Existing vegetation is mapped using predictive landscape models based on extensive field reference data, satellite imagery, biophysical gradient layers, and classification and regression trees.

Rivers and Streams

1. **Streams and Lakes: U.S. Geological Survey (USGS) and Environmental Protection Agency (USEPA). 2006. National Hydrography Dataset Plus (NHD-Plus). 100,000. http://www.horizonsystems.com/nhdplus/** The NHDPlus consists of nine components:

a greatly improved line and polygon 1:100K National Hydrography Dataset (NHD), a set of value added attributes to enhance stream network navigation, an elevation-based catchment polygon for each flowline in the stream network, catchment characteristics, headwater node areas, cumulative drainage area characteristics, a flow direction grid, a flow accumulation grid, a elevation grid, flowline min/max elevations and slopes, and flow volume & velocity estimates for each flowline in the stream network.

2. **Stream Classification Types: Olivero and Anderson. 2008. Northeast Aquatic Habitat Classification System. The Nature Conservancy. Boston, MA.** http://rcngrants.org/node/38 This project developed a standard Northeastern Aquatic Habitat Classification (NAHCS) and GIS map for 13 northeastern states (ME, NH, VT, MA, RI, CT, NY, PA, NJ, DE, MD, VA, WV, and DC.) that are part of the Northeast Association of Fish and Wildlife Agencies (NEAFWA). This classification and a GIS dataset linked to the NHD-Plus 1:100,000 hydrography was designed to consistently represent the natural aquatic habitat types across this region in a manner deemed appropriate and useful for conservation planning by the participating states. This product was not intended to override state classifications, but is meant to unify state classifications and allow for looking at aquatic biodiversity patterns across the region. The NAHCS habitat classification is based on a biophysical aquatic classification approach (Higgins et al. 2005) and uses four primary classification attributes to define habitat types. These variables include size, gradient, geology, and temperature. Ecologically meaningful class breaks within each of the four variables were developed and the resultant variables and classes combined to yield a regional taxonomy with 259 stream types. The full types can be simplified using recommended prioritization and collapsing rules.

3. **Brook Trout Distribution: Thieling, T.M. 2006. Assessment and predictive model for brook trout (*Salvelinus fontinalis*) population status in the eastern United States. Masters Thesis. James Madison University http://128.118.47.58/EBTJV/Thieling_Thesis.pdf** Over the last 200 years, brook trout (*Salvelinus fontinalis*) have been subjected to numerous anthropogenic physical, chemical, and biological perturbations that threaten the long term viability of brook trout throughout their historic native range. The study area included the historic native range of brook trout in the eastern United States, covering 17 states stretching from Maine to northern Georgia. The author developed numerous predictive models using known brook trout subwatershed population status (Extirpated/Reduced/Intact) and subwatershed metrics derived from GIS data. The purpose of the models was to predict subwatershed status for the subwatersheds where the status was either unknown or only qualitative data were available. Six core subwatershed and subwatershed water corridor metrics (percentage of forested land, combined sulfate and nitrate deposition, percentage of mixed forest in the water corridor, percentage of agriculture, road density, and latitude) were useful as predictors of brook trout distribution and status. The most successful model, model 3, was used for NEAFWA reporting brook trout distributions.

4. **Active River Area: Sheldon, A. O. 2009. Active River Area. 30m. The Nature Conservancy Eastern Conservation Science. Boston, MA.** The Active River Area conservation framework provides a conceptual and spatially explicit basis for the assessment, protection, management, and restoration of freshwater floodplain and riparian ecosystems. GIS techniques allow the floodplain and riparian active river area components to be identified over a range of spatial scales. At the regional scale, as of 8/10/2009, the floodplain and riparian component of the Active River Area has been mapped using a 30m DEM and 1:100,000 hydrography. The Riparian Active River Area model delineates an ARA Riparian Base Zone using cost distance modeling and a moisture index (wet flat) analysis. We expect the meander belts, riparian wetlands, ~100 year floodplains,

and lower terraces to be primarily within the ARA Riparian Base Zone, however these features could not be separately distinguished within the regional scale model.

5. **Dams. The Nature Conservancy. 2011. Northeast Regional Dam Dataset Version 3/1/2011. The Nature Conservancy Eastern Conservation Science Office. Boston, MA.** This dataset represents the result of a project to compile a dataset of dam barriers in the northeast states (ME, NH, VT, MA, CT, RI, NY, PA, NJ, DE, MD, VA, WV, DC) and spatially link the dams to the correct stream flowline in the USGS National Hydrography Plus (NHD-Plus) 1:100,000 stream dataset. A standardized, repeatable, feasible, and most accurate dam snapping method was developed and implemented to create this dataset. Primary steps included 1) snapping each state's dams to the 1:100,000 NHD flowlines, using a 100m snapping tolerance, 2) coding the dams for prioritization for manual review, 3) manual error checking of the prioritized dams, 4) returning the data to the states for expert review, and 5) re-incorporated the state edits into the final snapped dataset. Detailed data sources include
   - CT: Connecticut DEP, Inland Water Resources Div. Publication date 1996. Retrieved April 2009.
   - DE: Delaware Dams: DNREC; 2007
   - MA: MA Division of Ecological Restoration April 2009
   - MD: MD Department of Natural Resources 2/12/2007, publication date 2009
   - ME: Army Corp of Engineers (USACE), Maine Emergency Management Agency (MEMA), Maine Department of Environmental Protection (MEDEP)(comp., ed.), Maine Office of Geographic Information Systems (comp., ed.). Publication date 2006
   - NH: NH Department of Environmental Services 4/2009
   - NJ: NJDEP - Bureau of Dam Safety and Flood Control Publication Date: 2001
   - NY: NYS Department of Environmental Conservation 2007; USGS Great Lakes Science Center Retrieved 4/15/2009
   - PA: Division of Dam Safety, Department of Environmental Protection 01/28/2010; PA Fish and Boat Commission Retrieved 7/20/2009
   - RI: RI Department of Environmental Management 6/2009
   - VA: VA Dept. of Game & Inland Fisheries 6/2009
   - VT: Vermont Agency of Natural Resources, Department of Environmental Conservation 4/2009 & 11/2009
   - WV: WV DNR: Wildlife Diversity and Technical Support Units 9/2009; WV Non-coal dams 6/2002, DMR Dams 6/2009, NID dams 10/2000: WV State GIS Data Clearinghouse: http://wvgis.wvu.edu/data/data.php
   - US Army Corps' National Inventory of Dams Retrieved 4/29/2008
   - USGS Geographic Names Information System (GNIS) 1/2009

6. **Waterfall: U.S. Geological Survey. 2009. Geographic Names Information System (GNIS) 1.2009. http://nhd.usgs.gov/gnis.html** Waterfall features were extracted from the Geographic Names Information System (GNIS) system. The GNIS was developed by the U.S. Geological Survey in cooperation with the U.S. Board on Geographic Names, and contains information about physical and cultural geographic features in the United States and associated areas, both current and historical. The database holds the Federally recognized name of each feature and defines the location of the feature by state, county, USGS topographic map, and geographic coordinates.

7. **Flow: Carlisle, D.M. 2010. Linkages of Streamflow Alteration to Fish and Macroinvertebrate Communities: Alteration of streamflow magnitudes and potential**

ecological consequences: a multiregional assessment. Front Ecol Environ 2010; doi:10.1890/100053 http://www.esajournals.org/doi/abs/10.1890/100053?journalCode=fron
Human impacts on watershed hydrology are widespread in the US, but the prevalence and severity of stream-flow alteration and its potential ecological consequences have not been quantified on a national scale. We assessed streamflow alteration at 2888 streamflow monitoring sites throughout the conterminous US. The magnitudes of mean annual (1980–2007) minimum and maximum streamflows were found to have been altered in 86% of assessed streams. The occurrence, type, and severity of streamflow alteration differed markedly between arid and wet climates. Biological assessments conducted on a subset of these streams showed that, relative to eight chemical and physical covariates, diminished flow magnitudes were the primary predictors of biological integrity for fish and macroinvertebrate communities.

7. **National Lake Assessment: U.S. Environmental Protection Agency (USEPA). 2009. *National Lakes Assessment*: *A Collaborative Survey of the Nation's Lakes.* EPA 841-R-09-001. U.S. Environmental Protection Agency, Office of Water and Office of Research and Development, Washington, D.C. http://water.epa.gov/type/lakes/lakessurvey_index.cfm**
EPA and its state and tribal partners have conducted a survey of the nation's lakes, ponds and reservoirs. This National Lakes Assessment is designed to provide statistically valid regional and national estimates of the condition of lakes. It uses a probability-based sampling design to represent the condition of all lakes in similar regions sharing similar ecological characteristics. Consistent sampling and analytical procedures ensure that the results can be compared across the country.

8. **Wadeable Stream Assessment: U.S. Environmental Protection Agency (USEPA). 2006. Wadeable Streams Assessment: A Collaborative Survey of the Nation's Streams. EPA 841-B-06-002 U.S. Environmental Protection Agency, Office of Water and Office of Research and Development, Washington, D.C. http://water.epa.gov/type/rsl/monitoring/streamsurvey/index.cfm** The Wadeable Streams Assessment (WSA) is a first-ever statistically-valid survey of the biological condition of small streams throughout the U.S. EPA worked with the states to conduct the assessment in 2004-2005. 1,392 sites were selected at random to represent the condition of all streams in regions that share similar ecological characteristics. Wadeable streams were chosen for study because they are a critical natural resource and because we have a well-established set of methods for monitoring them. Participants used the same standardized methods at all sites, to ensure results that are comparable across the nation.

Species or Inventory Related Datasets

1. **Forest Inventory and Analysis: USDA Forest Service. 2009. FIA Forest Inventory and Analysis National Program. http:///www.fia.fs.fed.us/** The Forest Inventory and Analysis (FIA) Program of the U.S. Forest Service provides the information needed to assess America's forests. FIA reports on status and trends in forest area and location; in the species, size, and health of trees; in total tree growth, mortality, and removals by harvest; in wood production and utilization rates by various products; and in forest land ownership. The Forest Service has significantly enhanced the FIA program by changing from a periodic survey to an annual survey, by increasing our capacity to analyze and publish data, and by expanding the scope of our data collection to include soil, under story vegetation, tree crown conditions, coarse woody debris, and lichen community composition on a subsample of our plots. FIA is managed by the Research and Development organization within the USDA Forest Service in cooperation with State and Private Forestry and National Forest Systems.

2. **Breeding Bird Survey: Sauer, J. R., J. E. Hines, and J. Fallon. 2008. *The North American Breeding Bird Survey, Results and Analysis 1966 - 2007. Version 5.15.2008. USGS Patuxent Wildlife Research Center, Laurel, MD* http://www.pwrc.usgs.gov/BBS/** The BBS is a cooperative effort between the U.S. Geological Survey's Patuxent Wildlife Research Center and Environment Canada's Canadian Wildlife Service to monitor the status and trends of North American bird populations. Following a rigorous protocol, BBS data are collected by thousands of dedicated participants along thousands of randomly established roadside routes throughout the continent. Professional BBS coordinators and data managers work closely with researchers and statisticians to compile and deliver these population data and population trend analyses on more than 400 bird species, for use by conservation managers, scientists, and the general public.

3. **Loons: Vogel, H. 2010. Northeast Loon Population and Reproductive Success. Northeast Loon Study Working Group.** State surveys of the loon population and reproductive success have been compiled by the Northeast Loon Study Working Group for the last 6 years.

4. **Freshwater Fish Distributions: NatureServe. 2008. Watershed Distribution Maps of Freshwater Fishes in the Conterminous United States. Version 2. Arlington, VA. U.S.A.** For each USGS-defined 8-digit Hydrologic Cataloging Unit (HUC), the current or historical status of each fish species is listed. The origin status field indicates whether the species is native, exotic, or cryptogenic in the watershed. The source of the distribution information includes literature, element occurrences, and expert review.

5. **Nonindigenous Aquatic Species: Fuller, P. 2011. Nonindigenous Aquatic Species Northeast Summary. USGS Nonindigenous Aquatic Species Program, Gainesville, FL http://nas.er.usgs.gov/queries/** The USGS Nonindigenous Aquatic Species (NAS) website has been established as a central repository for accurate and spatially referenced biogeographic accounts of NAS. Reports of NAS are obtained from a variety of sources such as researchers, field biologists, fishermen, and others involved in activities in the aquatic environment. Freshwater, or primarily freshwater species that may go into estuarine areas, were included. Species identified only to genus were included if they were the only collection in that genus or are known to be a different species than the other known species introduced in that area. The major pathways used by species were summarized; unknown and pathways with very few records were not included. The categories were based on the best available evidence taking into account the species, its biology, and the location of the introduction. Because this is a compilation of a species at a place and time, a species can fall in more than one category. It may have been introduced via one pathway in one area and another in another area**.**

6. **Locations of Regionally Significant Species of Greatest Conservation Need:**

   A. **NatureServe 2011 NatureServe Central Databases. Arlington, Virginia. U.S.A. Precise locational (Element Occurrence) data polygons for all species in the following states: Connecticut, Delaware, District of Columbia, Maryland, Maine, New Hampshire, New Jersey, New York, Rhode Island, Virginia, Vermont, and West Virginia. Data Source: NatureServe (www.natureserve.org) and its Natural Heritage member programs.** NatureServe and its Natural Heritage member programs have developed a Multi-Jurisdictional Dataset (MJD). The creation of the MJD is aimed at improving conservation planning and actions by providing access to a comprehensive dataset of U.S. and Canadian species and ecological communities. These data are dependent on the research and observations of many scientists and institutions, and reflect our current state of knowledge. Many areas have never been thoroughly surveyed, however, and the absence of data in any particular geographic area does not necessarily mean that species or ecological communities of concern are not present. The data was exported from NatureServe 2/2011.

   B. **Pennsylvania Natural Heritage Program, Pittsburg, PA. U.S.A.** The Pennsylvania Natural Heritage Program (PNHP) is a partnership of the Department of Conservation and Natural Resources, the Western Pennsylvania Conservancy, the Pennsylvania Fish and Boat Commission, and the Pennsylvania Game Commission. The Pennsylvania Natural Heritage Program (PNHP) provided The Nature Conservancy (TNC) with GIS shapefiles and tabular data for Element Occurrences for non-Federally listed tracked birds, mammals, terrestrial invertebrates, plants, and natural communities contained in the PNHP database for the entire state of Pennsylvania. For amphibians, reptiles, fish, aquatic invertebrates (e.g., mussels, odonates) and species listed under the US Endangered Species Act, PNHP was only able to provide Environmental Review polygons. The data was exported from the Pennsylvania Natural Herigate Program 2/2011.

   C. **Massachusetts Natural Heritage & Endangered Species Program. Westborough, Massachusetts. U.S.A.** The Massachusetts Natural Heritage & Endangered Species Program is part of the Massachusetts Division of Fisheries and Wildlife. The Massachusetts Natural Heritage and Endangered Species Program provided The Nature Conservancy with GIS shapefiles and tabular data for all Element Occurrences contained in the NHESP database for species and natural communities within the state. The data was exported from the Massachusetts Natural Heritage & Endangered Species Program 1/2011.

D. Delaware Natural Heritage and Endangered Species Program. Smyrna, Delaware. U.S.A. The Delaware Natural Heritage and Endangered Species Program is part of the Delaware Division of Fish and Wildlife. The Delaware Natural Heritage and Endangered Species Program provided The Nature Conservancy with GIS shapefiles and tabular data for all Element Occurrences contained in the NHESP database for species and natural communities within the state. The data was exported from the Delaware Natural Heritage and Endangered Species Program 2005.

Biophysical: Elevation, Geology, Landforms

Ferree, C. 2008. Ecological Land Units. Version 11/2008. The Nature Conservancy Eastern Conservation Science Office. Boston, MA. The Ecological Land Unit (ELU) dataset is a composite of several layers of abiotic information that critically influence the form, function, and distribution of ecosystems - elevation zone, bedrock geology, and landforms. Each 30m grid cell is assigned a given elevation, bedrock or surficial geology, and landform class. The three components can be viewed or queried separately or in combination. Elevation has been shown to be a powerful predictor of the distribution of forest communities in the Northeast. Temperature, precipitation, and exposure commonly vary with changing altitude. Bedrock geology strongly influences area soil and water chemistry. Bedrock types also differ in how they weather and in the physical characteristics of the residual soil type. Rowe (1998) contends that landform is "the anchor and control of terrestrial ecosystems." Landforms are largely responsible for local variation in solar radiation, moisture availability, soil development, and susceptibility to wind and other disturbance. We adopted the Fels and Matson (1997) system for landform modeling, in which combinations of slope and landscape position are used to define topographic units such as ridges, sideslopes, coves, and flats on the landscape. Six ecologically relevant elevation zones were defined; over 250 bedrock and surficial geology classes were collapsed into 9 ecologically distinct geology classes; and GIS modeling gave us 13 ecologically significant landform classes. Combination of these resource grids resulted in over 700 unique ELUs in the region.

Detailed Methods

April 2011

In the following appendix, we provide additional background on certain source datasets and analyses that were used in this report. This information was too detailed for the main body of the report, but is provided here for reference.

Forests

How did we map forest types? We used the LANDFIRE 1.1.0, 2006: Existing Vegetation Type layer. 30m. http://landfire.cr.usgs.gov/viewer/ from the U.S. Geological Survey to map the forest types in the region. The LANDFIRE existing vegetation layer represents the current distribution of the terrestrial ecological system classification developed by NatureServe for the western Hemisphere. The existing vegetation was mapped using predictive landscape models based on extensive field reference data, satellite imagery, biophysical gradient layers, and classification and regression trees. The 37 forest types included in the LANDFIRE data for our region were collapsed into our 4 major forest types for reporting. This collapsing was done using the NatureServe Macrogroup assignment which links the source forest types to the coarser forest macrogroup classification level. Please see the table below for the details of this linkage.

MACROGROUP	LANDFIRE FOREST TYPE LABEL	Acres in Region
Boreal Upland Forest	Acadian Low-Elevation Spruce-Fir-Hardwood Forest	7,122,027
Boreal Upland Forest	Acadian-Appalachian Montane Spruce-Fir Forest	2,736,858
Boreal Upland Forest	Central and Southern Appalachian Spruce-Fir Forest	75,493
Central Oak-Pine	Central Appalachian Dry Oak-Pine Forest	9,531,941
Central Oak-Pine	Northeastern Interior Dry-Mesic Oak Forest	8,105,540
Central Oak-Pine	Southern Piedmont Dry Oak-(Pine) Forest	3,589,753
Central Oak-Pine	Allegheny-Cumberland Dry Oak Forest and Woodland	2,996,071
Central Oak-Pine	Northern Atlantic Coastal Plain Hardwood Forest	1,841,680
Central Oak-Pine	Central Appalachian Pine-Oak Rocky Woodland	1,130,834
Central Oak-Pine	Atlantic Coastal Plain Mesic Hardwood Forest	1,072,042
Central Oak-Pine	Atlantic Coastal Plain Dry and Dry-Mesic Oak Forest	694,404
Central Oak-Pine	Southern Appalachian Oak Forest	651,199
Central Oak-Pine	Southern Ridge and Valley / Cumberland Dry Calcareous Forest	543,027
Central Oak-Pine	Central and Southern Appalachian Montane Oak Forest	251,970
Central Oak-Pine	Appalachian Shale Barrens	148,503
Central Oak-Pine	Northern Atlantic Coastal Plain Pitch Pine Barrens	139,488
Central Oak-Pine	Northern Atlantic Coastal Plain Maritime Forest	104,342
Central Oak-Pine	Southern Appalachian Montane Pine Forest and Woodland	54,250
Central Oak-Pine	Southern Appalachian Low-Elevation Pine Forest	50,837
Central Oak-Pine	Northeastern Interior Pine Barrens	31,476
Central Oak-Pine	Eastern Serpentine Woodland	1,882
Central Oak-Pine	North-Central Interior Dry-Mesic Oak Forest and Woodland	99
Longleaf Pine	Atlantic Coastal Plain Upland Longleaf Pine Woodland	5,002

Northern Hardwood & Conifer	Laurentian-Acadian Northern Hardwoods Forest	21,422,424
Northern Hardwood & Conifer	Appalachian (Hemlock)-Northern Hardwood Forest	16,681,414
Northern Hardwood & Conifer	South-Central Interior Mesophytic Forest	3,421,850
Northern Hardwood & Conifer	Southern and Central Appalachian Cove Forest	3,310,083
Northern Hardwood & Conifer	Laurentian-Acadian Pine-Hemlock-Hardwood Forest	3,165,107
Northern Hardwood & Conifer	Southern Piedmont Mesic Forest	456,051
Northern Hardwood & Conifer	Laurentian-Acadian Northern Pine-(Oak) Forest	453,694
Northern Hardwood & Conifer	North-Central Interior Beech-Maple Forest	301,017
Northern Hardwood & Conifer	Southern Appalachian Northern Hardwood Forest	5,720
Plantation and Ruderal Forest	Ruderal Forest	3,939,127
Plantation and Ruderal Forest	Managed Tree Plantation	2,523,115
Plantation and Ruderal Forest	Harvested forest-herbaceous regeneration	175,047
Plantation and Ruderal Forest	Recently Logged Timberland	1,589
Plantation and Ruderal Forest	Recently Logged Timberland-Herbaceous Cover	95

How did we build blocks? To evaluate the impact of major roads on forests in the region, major roads were used as the bounding features in a block analysis. The major roads included Class 1-4 roads, including Primary Limited Access Highways/Interstates, Primary U.S. State Highways, Secondary State or County Highways, and Freeway Ramps. The major roads for all NEWFWA states + all adjacent counties touching NEAFWA states were extracted from the road source data, Tele Atlas North America, Inc., 2009. U.S. and Canada Streets Cartographic. 1:100,000 Tele Atlas StreetMap Premium v. 7.2 ESRI® Data & Maps: StreetMap. 2009 Data Update: North America. Redlands, California, USA. To create closure features for the blocks along the ocean and great lakes edge of the region, the coastline was extracted from the U.S. States Boundary 1:100,000 shapefile from ESRI® Data & Maps 2009 Data Update, Tele Atlas North America, Inc., 2009. The major road and coastline linework was built into polygon "block" topology using the clean command (0 dangle length, 0.0001m fuzzy tolerance) in ArcGIS 9.3 Environmental Systems Research Institute, Inc.

How did we map local connectivity? A Resistant Kernal Analysis was done to assess the local connectivity of each 90m pixel in the region. The Resistant Kernel analysis was run by Brad Compton at University of Massachusetts as part of a larger study called CAPS, Conservation Assessment and Prioritization System. "CAPS is an ecological community-based approach for assessing the ecological integrity of lands and waters and prioritizing land for habitat and biodiversity conservation." http://www.umass.edu/landeco/research/caps/caps.html

From the CAPS study we used the connectivity metric, which is one of a suite ecological integrity metrics used in their larger study. The connectivity metric is derived from a resistant kernel analysis. For this analysis, a resistance value is assigned to each cover type in a land-cover map, representing the expected dispersal or migration distance of animals moving through that cover type. For Landcover we used classified data from the National Land Cover Dataset 2001 (Homer et al. 2004). The NLCD was supplemented road information from ESRI. The Major and Minor roads were burned into the 30 meter dataset. Having a road overlap a grid cell made the resistance one point harder than the corresponding non-road landuse.

Cover type	Resistance Value
Open Water	1
Deciduous Forest	1

Conifer Forest	1
Mixed Forest	1
Shrub Scrub	1
Wetlands	1
Open Water road	2
Deciduous Forest road	2
Conifer Forest road	2
Mixed Forest road	2
Shrub Scrub road	2
Wetlands road	2
Barren Land	8
Agriculture	8
Barren Land road	9
Agriculture road	9
Low Density Developed	9
High Density developed	10
Railroad	10
Major Road	10
Major Road and Rail	10
Minor Rd nothing	10
Low Density Developed road	10
High Density developed road	10

The resulting landcover and road dataset was resampled to 90m cell size due to computer processing limitations. Using the cell values as a resistance grid, for each natural gridcell in the landscape, a resistant kernel was then calculated. The resistant kernel provides a measure of how connected each gridcell is versus an "ideal" kernel with no resistance (ie completely natural). We used a 3km radius for the distance of the kernel to define local connectivity. The results were a grid with values ranging from 0 to 1 with 0 being completely developed and 1 being the ideal natural kernel with 3km radius of connectedness/no barriers. These grid values were rescaled to a 0 -100 grid to allow for easier analysis (0 –highly developed to 100 – Natural Completely).

A more detail explanation follows for how the resistant kernel is calculated is as follows: from Compton, B.W., K. McGarigal, S.A. Cushman, and L.R. Gamble. 2007. A resistant-kernel model of connectivity for amphibians that breed in vernal pools. Conservation Biology 21(3):788-799. "The resistant-kernel estimator is a hybrid between two existing approaches, the kernel estimator and least-cost paths with resistant surfaces. …This least-cost path approach can be extended to a multidirectional approach that measures the functional distance from a focal cell to every other cell in the landscape within a maximum dispersal or migration distance. Such a least-cost "kernel" is a surface that can be scaled to represent the probability of an individual dispersing from the focal cell arriving at any other point in the landscape."

Wetlands

How did we map wetlands? We used the most recent 2001 National Land Cover Dataset (Homer et al. 2004) to map wetlands. Emergent and woody wetland cover pixels were extracted and those wetland pixels that were adjacent to each other were joined together to form polygon wetland system occurrences. The resultant wetland system occurrences can contain a single wetland cover type (woody or emergent) or contain a mixture of woody and emergent cover, however they are defined by being spatially isolated from other wetland pixels. Wetland occurrences which were over 50% within the NEAFWA states region were extracted for further analysis. The size of the wetland occurrences was calculated and the polygons were overlapped with other datasets for further classification and reporting. For example, the wetland system occurrences were classified into alluvial, basin, and tidal system types. Tidal wetlands were defined as those occurrences having half or more of their occurrence located in the <= 6 meter elevation zone (Anderson et al, 2006). Alluvial wetlands were defined as those occurrences with half or more of their occurrence located in the floodplain of rivers >100 sq.km in drainage area. The floodplain of these rivers was modeled using the NHD-Plus stream network, FEMA 100 year floodplain, and a 30m Digital Elevation Model (Olivero, 2009). Basin wetland identified non-tidal wetlands that were isolated or associated with only streams < 100 sq.km in drainage area. These were defined as those wetland polygons not meeting the above two criteria for alluvial or tidal occurrences. For the size analysis of emergent wetland occurrences, a similar process to the wetland system occurrence delineation process was used. Pixels of emergent wetland were extracted from the NLCD 2001 land cover and pixels that were adjacent to each other were joined together to form polygon emergent wetland system occurrences. The resultant emergent wetland system occurrences contained only emergent cover and their size and overlap with other datasets could be measured.

Anderson, M. G., Lombard, K., Lundgren, J., Allen, B., Antenen, S., Bechtel, D., Bowden, A., Carabetta, M., Ferree, C., Jordan, M., Khanna, S., Morse, D., Olivero, A., Sferra, N., Upmeyer, A. 2006. The North Atlantic Coast: Ecoregional Assessment, Conservation Status Report and Resource CD. The Nature Conservancy, Eastern Conservation Science, Boston, MA.

Olivero, A. 2009. Active River Area Model Datset for the Northeastern U.S. The Nature Conservancy. Eastern Conservation Science. Boston, MA

How did we map wetland change? We estimated the amount of historical wetland loss by using a flow accumulation and moisture index model to delineate the wettest areas of the landscape (Ferree, 2008; landform model). These wet flat landforms containing 100% of the current wetlands and some additional areas that we expect historically contained wetlands. We then overlaid our NLCD 2001 landcover data (Homer et al. 2004) on these areas to determine what type of cover were currently present. By assuming that the current ratio of upland to wetland communities was similar in the past, we could then estimate the proportion of the converted lands (developed or agricultural land covers) that were most likely to have been wetland or upland.

We estimated the amount of wetland gain or loss in the 1992-2001 time period using the The National Land Cover Database (NLCD) 1992–2001 Land Cover Change Retrofit Product (Fry et al. 2009). Given the source imagery was at a resolution of 30m pixels and the inherent difficulty in mapping wetland boundaries using satellite data, we were concerned that any reported grain or loss of wetlands within the 1 pixel edge of 1992 wetland occurrence boundaries might represent mapping error rather than real change. We thus report our change statistics in categories by what amount of change is within the 1 pixel edge of existing 1992 wetlands (margin of error) and what amount of change is outside this border region.

How did we map road density around wetlands? We created a wall-to-wall map of road density for the region. We compiled roads from the following sources: 1) Roads: Tele Atlas North America, Inc., 2009. U.S. and Canada Streets Cartographic. 1:100,000 Tele Atlas StreetMap Premium v. 7.2 ESRI® Data & Maps: StreetMap. 2009 Data Update: North America. Redlands, California, USA. U.S. 2) Railroads: Tele Atlas North America, Inc. 2009. U.S. and Canada Railroads. 1:100,000. ESRI® Data & Maps: StreetMap. 2009 Data Update: North America. Redlands, California, USA. From this dataset we excluded 4-wheel drive trails, walking trails, and ferry lines because these features were not consistently mapped across states. Using the remaining class 1-8 roads and all railroads, we calculated the density of line features using the ESRI ArcGIS 9.3 Workstation GRID command LINEDENSITY (<lines>, {item}, {cellsize}, <SIMPLE | KERNEL>,{unit_scale_factor}, {radius}) with the parameters linedensity (mrg_rd18rr.shp, none, 30, simple, 10000, 1000). We had to divide the region into 8 tiles for analysis and create integer outputs due to the large file sizes involved. Each of the 8 tile areas was also buffered out by 10km prior to running through the linedensity command to make sure the border section of each tile was accurately calculated. These 10km buffer area results were then clipped off before combining the 8 tiles into a resultant regional dataset. For each wetland occurrence polygon, the zonal statistics function was used on the output road density grid to calculate the mean of the road density pixels falling within that wetland occurrence. We developed road impact index thresholds for placing each wetland occurrence into a road density impact class following Findlay and Houlahan (1997).

Findlay, C.S and J. Houlahan. 1997. Anthropogenic Correlates of Species Richness in Southeastern Ontario Wetlands. Conservation Biology. V.11 N.4 1000-1009

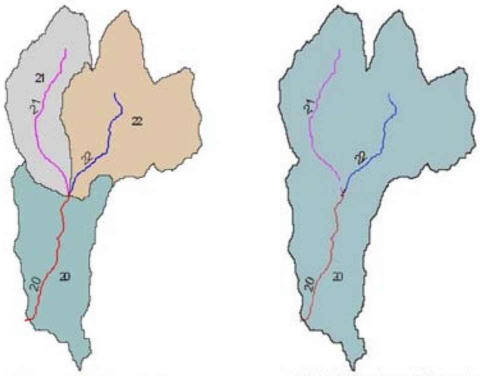
<u>Rivers</u>

How did we map rivers and streams? The 2006 National Hydrography Dataset (NHD-Plus), a widely available 1:100,000 GIS dataset, was used as the base hydrology dataset for this project. This dataset provides greatly improved hydrographic features compared to all previous USGS 1:100,000 hydrology products. The NHD-Plus linework has been geometrically corrected, augmented with improved names, and the dataset provides line (stream), polygon (lake, wide river), and local catchment watersheds for each flowline. Current limitations in the 2006 NHD-Plus include occasional stream segments that lack directionality codes and unevenness in headwater stream densities.

A single centerline flowline network was developed from the NHDPlus 1:100,000 scale hydrography through a series of attribute queries and manual edits. This dataset was used in both stream mile reporting and in the related stream connected network analysis. Loops and divergences were removed using the NHDPLus Flow Direction attribute and the NHDPlus Value Added Attribute (VAA) “Divergence” attribute selecting mainstem arcs that satisfy the query (“Divergence” <>2 AND “FlowDir” = ‘with Digitized’). Arcs listed as “artificial pathways” were separated into those centerlines going through lakes vs. those going through sections of wide river polygons. Those artificial pathway centerlines going through wide river polygons were maintained to allow calculation of the linear miles of these types of rivers, while the artificial pathway linework going through lakes were removed for the calculation of river and stream miles in the region. Other extraneous arcs including coastlines and pipelines were also removed from the network. Finally, streams with a drainage <1 square mile were excluded from the analysis using the cumulative drainage (CUMDRAINAG) attribute available in the NHDPlus. This was done to ameliorate the variation with which hydrography was digitized in the NHD. These small headwater streams are digitized for some USGS quads and not for others. These were all excluded to “level the playing field” across the region and make the calculation of miles of streams and rivers comparable from one quad or area to the next.

How did we summarize the upstream watershed impervious surface for each stream or river? We used the USGS 2001 National Land Cover Impervious Surface Dataset (Yang et al. 2002) summarized for the upstream watershed of each NHD-Plus reach by the National Fish Habitat Human Disturbance Assessment Project, Dana Infante and Arthur Cooper, Michigan State University, 8/11/2009. The Human Disturbance project used the NHD-Plus dataset catchments to summarize the amount of impervious surface in each reach’s local catchment using the U.S. Geological Survey (USGS). 2004. National Land Cover Dataset 2001 Imperviousness Dataset. Version 1. 30m cell. Sioux Falls, SD. This local catchment impervious information was then accumulated for all the upstream catchments to obtain a total upstream watershed percent impervious for each reach (Figure 1.) The NHD-Plus provided flow relationship tables define how reaches flow together and these flow relationships are used in the USGS provided Catchment Attribute Allocation and Accumulation Tool (CA3T) http://www.horizon-systems.com/nhdplus/tools.php to accumulate upstream characteristics for each reach.

Figure 1: Example of Local Catchments and Total Upstream Watershed



A. Local Catchments for Reaches 20, 21, and 22

B. Total Upstream Watershed for Reach 20

<u>How did we create funcationally connected stream networks between dams?</u> Functionally connected stream networks were calculated in a GIS using the Barrier Analysis Tool (BAT), a custom ArcGIS 9.3 toolbar that was developed for The Nature Conservancy by Duncan Hornby of the GeoData Institute at the University of Southampton, England. Inputs for the BAT include a single-flowline drendritic hydrography network and point locations representing barriers.

A single flowline network was developed from the NHDPlus 1:100,000 scale hydrography through a series of attribute queries and manual edits. Please see the above section "how did we map streams and rivers" for more information. This network was run through the BAT which produced a list of outstanding errors. These errors included loops created from digitizing errors in the NHDPlus (e.g. streams that cross ridgelines thus connecting two networks) as well as other special circumstances (e.g. canals which cut across the natural topography thereby creating loops). Manual editing was done to fix these segments and terminated when the BAT no longer produced error lists.

Dam location points were "snapped" to the hydrography network. Topological concurrence between the point locations and the hydrography lines was necessary for the subsequent analysis in BAT. Dams within 100m of the hydrography were snapped using the free ArcGIS Hawth's tools. After dams were snapped, several error checks were run. These include reviewing: 1) that river names match in dam dataset and stream dataset 2) large dams that snapped to small streams 3) all dams on larger rivers 4) all large dams. These error checking fields were used to prioritize dams for manual review. After TNC performed internal manual review, snapped dam data was returned to the state contacts who had provided the data or other regional experts for their review.

The snapped dams and edited hydrography were entered into the BAT which used the dams to "fracture" the network, thus creating connected networks bounded by dams.

Barrier Analysis Tool (Version 1.0) [Software]. 2010. The Nature Conservancy and Northeast Association of Fish and Wildlife Agencies. Software Developer: Duncan Hornby

Lakes

How did we map lakes and ponds? The mapped lakes and ponds are based on the 2006 version NHD-Plus 1:100,000 lake and pond polygons (USGS, 2006). These source pond and lake polygons provided a good representation of lakes and ponds in the region, however they contained artificial polygon boundaries at quad boundaries. The source dataset was thus dissolved across quad boundaries to yield a final regional lake and pond polygons dataset where each polygon represented a "whole" lake or pond, rather than a lake sometimes split by a quad line into two separate polygons. We eliminated ponds less than 2 acres because these overlapped with the wetland assessment and had in most cases already been assessed as wetland communities.

How did we determine the upstream watershed percent impervious surface for each lake? To determine the upstream catchment of each lake, we used the NHD-Plus flow network and its related catchments. We began by intersecting the NHD-Plus flowline centroids with our whole lake and pond polygons. With the results of this intersectionl, we identified the flowline in each lake that had the highest upstream drainage size and thus was the flowline exiting the lake. For each of these outflow flowlines, we linked over the upstream impervious surface information from the previously described USGS 2001 National Land Cover Impervious Surface Dataset summarized for the upstream watershed of each NHD-Plus flowline by the National Fish Habitat Human Disturbance Assessment Project, Dana Infante and Arthur Cooper, Michigan State University, 8/11/2009. For headwater lakes with no inflow/flow through centerline within them, we assigned the lake impervious surface from the stream exiting the lake which we identified using a 100m buffer to select the stream exiting the lake with the highest drainage area. For isolated lakes that were unconnected to the 1:100,000 NHD-Plus stream networks, we created a 500 m shoreline buffer and summarized the information from the National Land Cover Dataset 2001 Imperviousness Dataset in this area. We chose a 500m buffer based on guidance from Patricia A. Soranno, PhD., Department of Fisheries and Wildlife, Michigan State University, who has published extensively on linking human effects at multiple scales to lake condition.

How did we determine minimum distance to a mapped road? We created a wall-to-wall map of distance to roads and railroads for the region. We compiled roads from the following sources: 1) Roads: Tele Atlas North America, Inc., 2009. U.S. and Canada Streets Cartographic. 1:100,000 Tele Atlas StreetMap Premium v. 7.2 ESRI® Data & Maps: StreetMap. 2009 Data Update: North America. Redlands, California, USA. U.S. 2) Railroads: Tele Atlas North America, Inc. 2009. U.S. and Canada Railroads. 1:100,000. ESRI® Data & Maps: StreetMap. 2009 Data Update: North America. Redlands, California, USA. From this dataset we excluded 4-wheel drive trails, walking trails, and ferry lines because these features were not consistently mapped across states. Using the remaining class 1-8 roads and all railroads, we calculated the distance of each 30m pixel in the region to a road or railroad line features using the ESRI ArcGIS 9.3 Workstation GRID command EUCDISTANCE <source_grid>, {o_direction_grid},{o_allocate_grid}{max_distance},{value_grid}) with the parameters eucdistance (mrg_rd18rr, #, #, #,#. We had to divide the region into 8 tiles for analysis and create integer outputs due to the large file sizes involved. Each of the 8 tile areas was also buffered out by 10km prior to running through the eucdistance command to make sure the border section of each tile was accurately calculated. These 10km buffer area results were then clipped off before combining the 8 tiles into a resultant regional dataset. For each lake polygon, the zonal statistics function was used on the output distance to road to calculated the minimum distance to a road or railroad of the pixels falling under the lake.

Species

How did we do the overlay of species occurrences with secured lands? All source species occurrence datasets were converted to point features if they were not already in point format. Centroids were created by The Nature Conservancy from the following sources using the XTools extension (ver. 6.0) for ArcGIS:

- Massachusetts Natural Heritage & Endangered Species Program Element Occurrence Record Source polygons
- Massachusetts Natural Heritage & Endangered Species Program Element Occurrence Record Source lines
- NatureServe Multi-Jurisdictional Dataset polygons
- Pennsylvania Natural Heritage Program Environmental Review polygons

These were combined with data already in point format from:

- Delaware Natural Heritage and Endangered Species Program Element Occurrence Record
- Massachusetts Natural Heritage & Endangered Species Program Element Occurrence Record source points
- Pennsylvania Natural Heritage Program Element Occurrence Record point representations of polygon records

Point attribute field names were standardized to calculate equivalent point attribute values across all datasets based largely on the NatureServe MJD fields.

The following types of centroids were classified as precise enough for the secured lands centroid overly:

1) The NatureServe MJD most precise available polygon occurrences where the representational accuracy was listed as very high, high, or medium.
2) The NatureServe MJD most precise available polygon occurrences where the representational accuracy was listed as unknown or blank but the polygon was < 125 acres in size, the minimum size allowable for a procedural feature to be classified as of medium representational accuracy
3) All occurrences obtained from Massachusetts Natural Heritage Program
4) All occurrences obtained from Delaware Natural Heritage Program
5) Pennsylvania Natural Heritage Program Element Occurrence Records for non-Federally listed tracked birds, mammals, terrestrial invertebrates, plants, and natural communities

The following types of occurrences were classified as not precise enough for the centroid overlay with secured lands.

1. The NatureServe MJD most precise available polygon occurrences where the representational accuracy was listed as low or very low
2. The NatureServe MJD most precise available polygon occurrences where the representational accuracy was listed as unknown or blank and the polygon was >= 125 acres in size
3. Pennsylvania amphibians, reptiles, fish, aquatic invertebrates (e.g., mussels, odonates) and species listed under the US Endangered Species Act for which PNHP could only provide Environmental Review polygons.

With the species occurrence point data finalized, an overlay of that data with the Secured Areas polygon data was performed. This overlay attributed each occurrence to the level of protection it falls within, if any. For more information on the source datasets, please see the Data Sources appendix.

Grasslands

How did we map open habitats? We used the most recent 2001 National Land Cover Dataset (Homer et al. 2004) to map grasslands. We extracted all pixels of grassland/herbaceous (class 71), shrub/scrub (class 52), and barren lands (class 31). We then used the 2001 National Land Cover Canopy Cover Dataset (Huang et al. 2001) to extract deciduous (class 41), mixed (class 43) and evergreen (class 42) forest pixels from the land cover datset that had <= 15% canopy cover. We assume these low canopy cover forest pixels represent early successional forest areas.

Communities:

How did we map elevation zones, geology, and landforms? We mapped elevation zones, geology and landforms using the regional Ecological Land Units dataset. Please see the following supplementary information on the content and construction of the Ecological Land Unit 30M Dataset by Charles Ferree, Landscape Ecologist, The Nature Conservancy Eastern Conservation Science Office.

Background: Conservation planning at any scale—regional, landscape level, or local—requires an understanding of patterns of environmental variation and biological diversity. This dataset was developed as a tool for assessing the biophysical character of landscapes, and for mapping the distribution and composition of community assemblages across those landscapes. Informed decisions on where to focus conservation efforts require such tools.

Data on biological distributions are very often inadequate to a large-scale analysis of biodiversity. The close relationship of the physical environment to ecological process and biotic distributions underpins the ecological sciences, and in the absence of suitable biological datasets, conservation science has recognized that physical diversity could be an acceptable surrogate for biological diversity. Research has repeatedly demonstrated especially strong links between ecosystem pattern and process and climate, bedrock, soils, and topography. This recognition led to the development of the ecological land unit, or ELU.

The ELU is a composite of several layers of abiotic information: elevation, bedrock geology, distribution of deep glacial sediments that mask bedrock's geochemical effects, moisture availability, and landform. An ELU grid of 30 meter cells was developed for the region. The ELU dataset describes the "ecological potential" of the landscape, but carries no information about actual landuse or landcover in a region where human alterations to the landscape have everywhere affected the natural vegetation. A brief discussion of each of the layers of information built into the current dataset follows.

Dataset content and development

Elevation classes

Elevation has been shown to be a powerful predictor of the distribution of forest communities in the Northeast. Temperature, precipitation, and exposure commonly vary with changing altitude. We broke continuous elevation data from the National Elevation Dataset of the USGS into discrete elevation classes with relevance to the distribution of forest types region-wide. Meaningful biotic zones would be defined with quite different elevation cut-offs in the northern and southern parts of the region, so class ranges necessarily approximate critical ecological values.

Table 1. Ranges for elevation classes.

Elevzone	*(feet)*	*Characteristic forest type in Lower New England*
1000/2000	0-20ft & 20-800ft	Oak, pine-oak, pine-hemlock, maritime spruce, floodplain forest
3000	800-1700ft	Hemlock-N. hardwoods, N. hardwoods, lowland spruce-fir
4000	1700-2500ft	Northern hardwoods, spruce-hardwoods
5000, 6000	2500-3600ft, >3600ft	Krummholz, montane spruce-fir, alpine communities

Bedrock geology and deep sediments

Bedrock geology strongly influences area soil and water chemistry. Even in glaciated landscapes, studies suggest that soil parent material is commonly of local origin, rarely being ice-transported more that a few miles from its source. Bedrock types also differ in how they weather and in the physical characteristics of the residual soil type. Because of this, local lithology is usually the principle determinant of soil chemistry, texture, and nutrient availability. Many ecological community types are closely related to the chemistry and drainage of the soils or are associated with particular bedrock exposures.

We grouped bedrock units on the bedrock geology maps of the northeast 14 states into seven general classes (Table 2). We based our scheme on broad classification schemes developed by other investigators which emphasize chemistry and texture, and on bedrock settings that are important to many ecological communities, particularly to herbaceous associations.

In some settings deep sediments of glacial origin mantle the bedrock. The consolidated bedrock of valleys of pro-glacial lakes, for example, may lie under many meters of fine lacustrine sediments, and deep coarse deltaic or outwash deposits often overlay the bedrock in pine barrens and sand plains in the northeast. In these settings it is the nature of the sediments—their texture, compactness, and moisture-holding capacity, their nutrient availability, their ability to anchor overstory trees in a wind disturbance--that is ecologically relevant, and not the nature of the underlying bedrock. We used a USGS dataset of sediments of the glaciated northeast to identify such places. The USGS map was compiled at a coarse scale (1:1,000,000), but we made the data a little “smarter” by informing it with our landform map (please see landforms development section that accompanies this metadata). Our landform layer was compiled at a much finer scale (the scale of the digital elevation models from which they were shaped, 1:24,000), and we allowed the deep coarse or fine sediments of the USGS dataset to be mapped only on those landforms on which they would naturally be expected to occur. In the case of sandy, coarse sediments, this would be in broad basin and valley/toe slope settings; in the case of fine clayey lacustrine or marine sediments, in these same settings, plus low hills and lower sideslopes. The seven bedrock classes were numbered 100 through 700 (Table 2), and the coarse and fine sediments classes were numbered 800 and 900, respectively.

Table 2. Bedrock geology classes.

Geology class	*Lithotypes*	*Meta-equivalents*	*Comments*	*Some characteristic communities*
100: ACIDIC SEDIMENTARY / METASEDIMENTARY: fine- to coarse-grained, acidic sed/metased rock	Mudstone, claystone, siltstone, non-fissile shale, sandstone, conglomerate, breccia, greywacke, arenites	(Low grade:) slates, phyllites, pelites; (Mod grade:) schists, pelitic schists, granofels	Low to moderately resistant rocks typical of valleys and lowlands with subdued topography; pure sandstone and meta-sediments are more resistant and may form low to moderate hills or ridges	Many: low- and mid-elevation matrix forests, floodplains, oak-pine forest, deciduous swamps and marshes
200: ACIDIC SHALE: Fine-grained acidic sedimentary rock with fissile texture	Fissile shales		Low resistance; produces unstable slopes of fine talus	Shale cliff and talus, shale barrens
300: CALCAREOUS SEDIMENTARY / META-SEDIMENTARY: basic/alkaline, soft sed/metased rock with high calcium content	Limestone, dolomite, dolostone, other carbonate-rich clastic rocks	Marble	Lowlands and depressions, stream/river channels, ponds/lakes, groundwater discharge areas; soils are thin alkaline clays, high calcium, low potassium; rock is very susceptible to chemical weathering; often underlies prime agricultural areas	Rich fens and wetlands, rich woodlands, rich cove forests, cedar swamps, alkaline cliffs
400: MODERATELY CALCAREOUS SEDIMENTARY / METASED: Neutral to basic, moderately soft sed/metased rock with some calcium but less so than above	Calc shales, calc pelites and siltstones, calc sandstones	Lightly to mod. metamorphosed calc pelites and quartzites, calc schists and phyllites, calc-silicate granofels	Variable group depending on lithology but generally susceptible to chemical weathering; soft shales often underlie agricultural areas	Rich coves, intermediate fens

500: ACIDIC GRANITIC: Quartz-rich, resistant acidic igneous and high grade meta-sedimentary rock; weathers to thin coarse soils	Granite, granodiorite, rhyolite, felsite, pegmatite	Granitic gneiss, charnockites, migmatites, quartzose gneiss, quartzite, quartz granofels	Resistant, quartz-rich rock, underlies mts and poorly drained depressions; uplands & highlands may have little internal relief and steep slopes along borders; generally sandy nutrient-poor soils	Many: matrix forest, high elevation types, bogs and peatlands
600: MAFIC / INTERMEDIATE GRANITIC: quartz-poor alkaline to slightly acidic rock, weathers to clays	(Ultrabasic:) anorthosite (Basic:) gabbro, diabase, basalt (Intermediate, quartz-poor:) diorite/ andesite, syenite/ trachyte	Greenstone, amphibolites, epidiorite, granulite, bostonite, essexite	Moderately resistant; thin, rocky, clay soils, sl acidic to sl basic, high in magnesium, low in potassium; moderate hills or rolling topography, uplands and lowlands, depending on adjacent lithologies; quartz- poor plutonic rocks weather to thin clay soils with topographic expressions more like granite	Traprock ridges, greenstone glades, alpine areas in Adirondacks
700: ULTRAMAFIC: magnesium-rich alkaline rock	Serpentine, soapstone, pyroxenites, dunites, peridotites, talc schists		Thin rocky iron-rich soils may be toxic to many species, high magnesium to calcium ratios often contain endemic flora favoring high magnesium, low potassium, alkaline soils; upland hills, knobs or ridges	Serpentine barrens

Landforms

Stanley Rowe called landform "the anchor and control of terrestrial ecosystems." It breaks up broad landscapes into local topographic units, and in doing so provides for meso- and microclimatic expression of broader climatic character. It is largely responsible for local variation in solar radiation, soil development, moisture availability, and susceptibility to wind and other disturbance. As one of the five "genetic influences" in the process of soil formation, it is tightly tied to rates of erosion and deposition, and therefore to soil depth, texture, and nutrient availability. These are, with moisture, the primary edaphic controllers of plant productivity and species distributions. If the other four influences on soil formation (climate, time, parent material, and biota) are constant over a given space, it is variation in landform that drives variation in the distribution and composition of natural communities.

Of the environmental variables discussed here, it is landform that most resists quantification. Landform is a compound measure, which can be decomposed into the primary terrain attributes of elevation, slope, aspect, surface curvature, and upslope catchment area. The wide availability and improving quality of digital elevation data has made the quantification of primary terrain attributes a simple matter. Compound topographic indices have been derived from these primary attributes to model various ecological processes. We adopted the Fels and Matson (1997) approach to landform modeling. They described a metric that combines information on slope and landscape position to define topographic units such as ridges, sideslopes, coves, and flats on the landscape. That approach is described here: feel free to skip over the details, to the set of defined landforms that emerges from the process (Figure 1 and Table 3 below).

The parent dataset for the two grids used to construct the landforms is the 30 meter National Elevation Dataset digital elevation model (DEM) of the USGS. Step one was to derive a grid of discrete slope classes relevant to the Northern Appalachian landscape. We remapped slopes to create classes of 0-2˚ (0.0-3.5%), 2-6˚ (3.5–10.5%), 6-24˚ (10.5–44.5%), 24-35˚ (44.5-70.0%), and >35˚ (>70.0%) (vertical axes of Figure1). Ground checks have shown that, because the NED dataset averages slopes over 30 meter intervals, raster cells in the 2 steepest elevation classes contain actual terrain slopes of from about 35 to 60 degrees (in the 24-35˚ class) and 60 to 90 degrees (in the steepest class).

The next step was the calculation of a landscape position index (LPI), a unitless measure of the position of a point on the landscape surface in relation to its surroundings. It is calculated, for each elevation model point, as a distance-weighted mean of the elevation differences between that point and all other elevation model points within a user-specified radius:

$$LPI_o = [\sum_{1,n} (z_i - z_o) / d_i] / n,$$

where z_o = elevation of the focal point whose LPI is being calculated,

z_i = elevation of point i of n model points within the specified search radius of the focal point,

d_i = horizontal distance between the focal point and point i, and

n = the total number of model points within the specified search distance.

If the point being evaluated is in a valley, surrounding model points will be mostly higher than the focal point and the index will have a positive value. Negative values indicate that the focal point is close to a ridge top or summit, and values approaching zero indicate low relief or a mid-slope position (Fig. 1).

The specified search distance, sometimes referred to as the "fractal dimension" of the landscape, is half of the average ridge-to-stream distance. We used two methods to fix this distance for each subsection within the region, one digital and one analog. The "curvature" function of the ArcInfo Grid module uses the DEM to calculate change in slope ("slope of the slope") in the landscape. This grid, when displayed as a stretched grayscale image, highlights valley and ridge structure, the "bones" of the landscape, and ridge-to-stream distances can be sampled on-screen. For our analog approach we used 7.5' USGS topographic quadsheets. In each case, we averaged several measurements of ridge-to-stream distances, in landscapes representative of the subsection, to obtain the fractal dimension. This dimension can vary considerably from one subsection to another.

[There is a third approach to fixing the landscape fractal dimension that is intriguing. A semivariogram of a clip of the DEM for a typical portion of the regional landscape can be constructed— it quantifies the spatial autocorrelation of the digital elevation points by calculating the squared difference in elevation between each and every pair of points in the landscape, then plotting half that squared difference (the "semivariance") against the distance of separation. A model is then fitted to the empirical semiovariogram "cloud of points." (This model is used to guide the prediction of unknown points in a kriging interpolation.) The form of the model is typically an asymptotic curve that rises fairly steeply and evenly near the origin (high spatial autocorrelation for points near one another) and flattens out at a semivariance "sill" value, beyond which distance there is little or no correlation between points. Though the sill distance, in the subsections where we tried this approach, was 2 or 3 times the "fractal distance" as measured with the first 2 methods, the relationship between the two was fairly consistent. With a little more experimentation, the DEM semivariogram could prove to be a useful landscape analysis tool.]

The next step was to divide the grid of continuous LPI values into discrete classes of high, moderately high, moderately low, and low landscape position. Histograms of the landscape position grid values were examined, a first set of break values selected, and the resulting classes visualized and evaluated. We did this for several different types of landscapes (rolling hills, steeply cut mountainsides, kame complexes in a primarily wet landscape, broad valleys), in areas of familiar geomorphology. The process was repeated many times, until we felt that the class breaks accurately caught the structure of the land, in each of the different landscape types. Success was measured by how well the four index classes represented the following landscape features:

- High landscape position (very convex): sharp ridges, summits, knobs
- Moderately high landscape position: upper side slopes, rounded summits and ridges, low hills and kamic convexities
- Moderately low landscape position: lower sideslopes and toe slopes, gentle valleys and draws, broad flats
- Low landscape position (very concave): steeply cut stream beds and coves, and flats at the foot of steep slopes

We assigned values 1-5 to the five slope classes, and 10, 20, 30, and 40 to the four LPI classes. Following Fels and Matson (1997), we summed the grids to produce a matrix of values (Fig. 1), and gave descriptive names to landforms that corresponded to matrix values. We collapsed all units in slope classes 4 and 5 into "steep" and "cliff" units, respectively. The ecological significance of these units, which are generally small and thinly distributed, lies in their very steepness, regardless of where they occur on the landscape.

Recognizing the ecological importance of separating occurrences of “flats” (0-2˚) into primarily dry areas and areas of high moisture availability, we calculated a simple moisture index that maps variation in moisture accumulation and soil residence time. We used National Wetlands Inventory datasets to calibrate the index and set a wet/dry threshold, then applied it to the flats landform to make the split. The formula for the moisture index is:

$$Moist\_index = \ln [(flow\_accumulation + 1) /(slope + 1)]$$

Grids for both flow accumulation and slope were derived from the DEM by ArcInfo Grid functions of the same names.

For the ecoregional ELU dataset, upper and lower sideslopes are combined, and a simple ecologically relevant aspect split is embedded in the sideslope and cove slope landforms (Figure 2 and Table 3).

Last, waterbodies from the National Hydrography Dataset (NHD), which was compiled at a scale of 1:100,000 and is available for the whole region, were incorporated into the landform layer with codes 51 (broader river reaches represented as polygons) and 52 (lakes, ponds, and reservoirs). Single-line stream and river arcs from the NHD were not burned into the landforms-- only those river reaches that are mapped as polygons.

Landform units for an area of varied topography in the southeastern New Hampshire are shown in map view in Figure 2.

Fig. 1: Formulation of landform models from land position and slope classes.

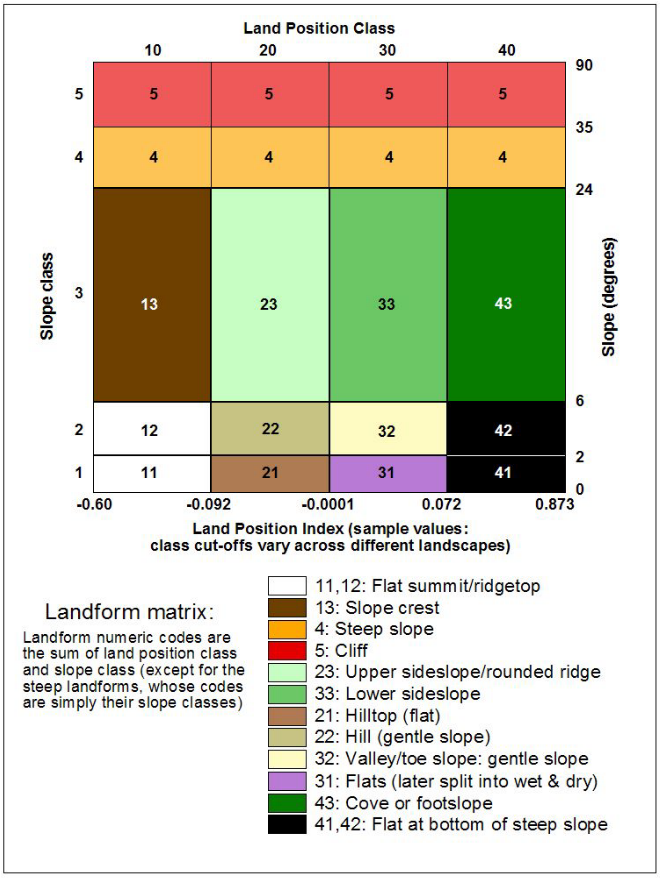
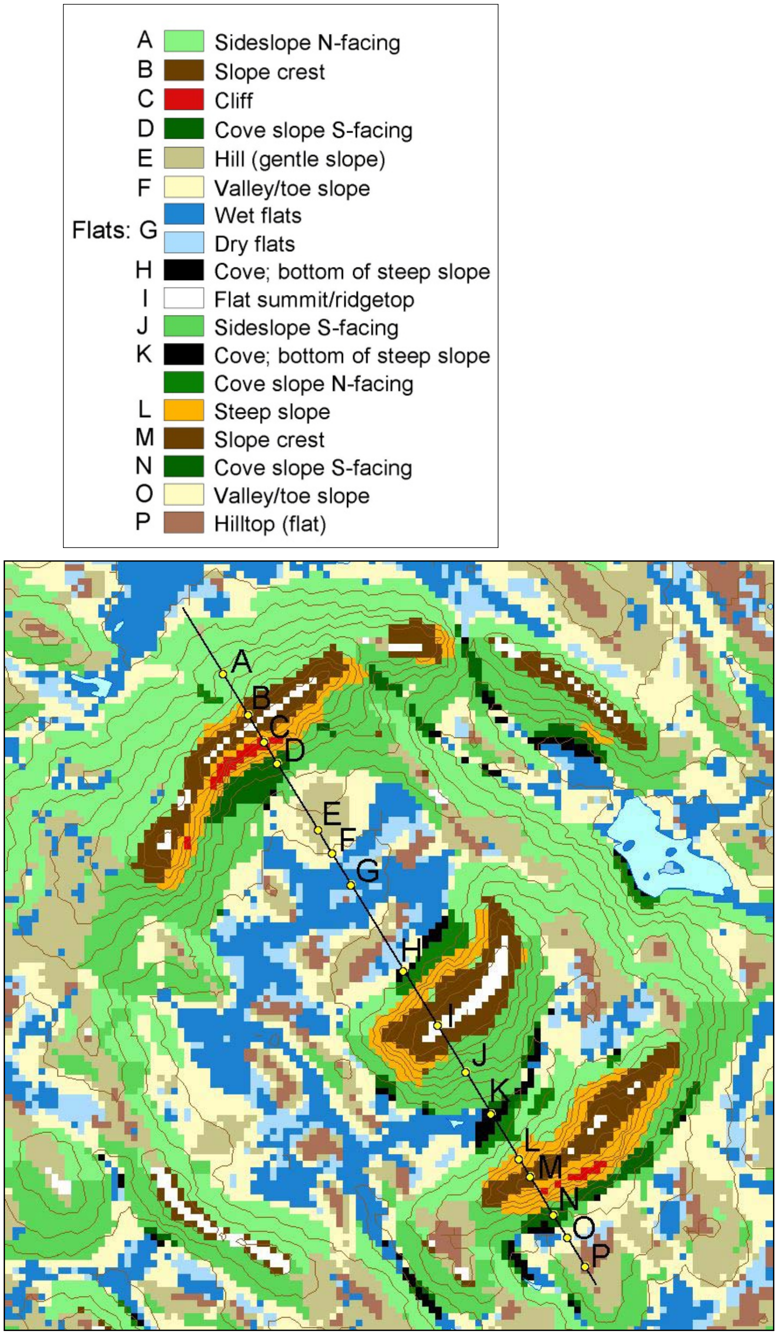


Fig. 2: Landforms in Pawtuckaway State Park, NH



For more information on landform development, please consult the full article "Fels, J, and K.C. Matson. 1997. A cognitively-based approach for hydrogeomorphic land classification using digital terrain models." which is available on the internet at:

www.ncgia.ucsb.edu/conf/SANTA_FE_CD-ROM/sf_papers/fels_john/fels_and_matson.html

The Ecological Land Unit Grid

With the elevation, substrate, and landform layers, all the elements for assembling ecological land units, or ELUs, are in place. ELU code values for each cell in the region-wide grid are simply the summed class values for elevation zone, substrate, and landform for that cell. For example, a cell in a wet flat (landform 31) at 1400 feet (elevation class 2000) on granitic bedrock (substrate class 500) would be coded 2531.

ELU_code = Elev class (ft) + Substrate class + Landform

Elev class (ft)	Substrate class	Landform
1000 (0-20)	100 Acidic sed/metased	4 Steep slope
2000 (20-800)	200 Acidic shale	5 Cliff
3000 (800-1700)	300 Calc sed/metased	11 Flat summit/ridgetop
4000 (1700-2500)	400 Mod. calc sed/metased	13 Slope crest
5000 (2500-3600)	500 Acidic granitic	21 Hilltop (flat)
600 (3600+)	600 Mafic/intermed granitic	22 Hill (gentle slope)
	700 Ultramafic	23 N-facing sideslope
	800 Coarse sediments	24 S-facing sideslope
	900 Fine sediments	30 Dry flat
		31 Wet flat
		32 Valley/toe slope
		41 Flat at bottom of steep slope
		43 N-facing cove/draw
		44 S-facing cove/draw
		51 River
		52 Lake/pond/reservoir

Grassland and Shrubland C

First Approximation April 2011

M. Anderson and A. Olivero Sheldon

The report Monitoring the Conservation of Fish and Wildlife in the Northeast (Tomajer et al. 2008) makes no recommendations for measures or indicators of grassland conservation. Moreover, grasslands are notoriously difficult to map at the scale of the region, and existing data on their distribution is very poor. Because of these limitations, and time constraints, we did not make any attempt to correct this situation. However, for those interested in this habitat, we prepared this brief summary of the distribution and securement of open habitats based on the National Land Cover dataset (USGS 2004), and a short overview of trends in grassland birds based on the Breeding Bird Survey. Please be aware that due to the problems in mapping this habitat, the acreages and percents should be considered a very rough approximation of the actual situation.

Background: Historically most of the Northeast and Mid-Atlantic region was forested. Permanent, natural, grasslands were uncommon, probably occurring only as scattered openings on bedrock pavements, rocky summits, or other soils too undeveloped to support trees. Sections of the coastal sandplain appear to have supported a mosaic of grasslands, heathlands and barrens opened periodically due to fires set by lightning strikes, and burning and clearing by Native Americans.

Open habitats expanded dramatically with European colonization as forests were cleared for agriculture, and by the 1800s, grasslands were widespread in the Northeast. Many species, especially grassland dependent birds, such as bobolink and eastern meadowlark, benefited from this expanded habitat (Figure 1). However, by the early 20th century, as farming moved west and the population grew, the quantity and quality of open habitat was already in decline. Currently, much of the idle farmland has reverted to forest and active agricultural lands are fragmented by roads and development. As remaining grasslands become smaller and more isolated, they no longer provide suitable habitat for species requiring large tracts of grassland. Moreover, extensive hayfields that were traditionally harvested late in the season, creating ideal breeding habitat, are now mowed earlier and more frequently, or have been converted to monoculture crop fields.

An introduction to grassland, shrubland and young forest conservation may be found at http://www.wildlife.state.nh.us/Wildlife/Northeast_Hab_Mgt_Guide.htm and the following source offer a comprehensive discussion of one or many issues:

Litvaitis, J.A., D.L.Wagner, J.L. Confer, M.D. Tarr, and E.J. Snyder. 1999. Early-successional forests and shrub-dominated habitats: land-use artifacts or critical community in the northeastern United States. Northeast Wildlife 54:101-118.

Lorimer, C.G. and A.S. White. 2003. Scale and frequency of natural disturbances in the northeastern United States: implications for early-successional forest habitat and regional age distributions. Forest Ecology and Management 185:41-64.

Trani, M.K., R. T. Brooks, T. L. Schmidt, V. A. Rudis, and C.M. Gabbard. 2001. Patterns and trends of early successional forests in the eastern United States. Wildlife Society Bulletin 29:413-424.

Vickery, P.D., and P.W. Dunwiddie. 1997. Grasslands of northeastern North America. Massachusetts Audubon Society: ecology and conservation of native and agricultural landscapes. 297 pp.

Open Habitats and their Fauna

Permanently open habitats are uncommon in this forested landscape and are mostly restricted to barrens or sparse grasslands where edaphic factors such as thin, poor, rocky soils, or very steep slopes, restrict the growth of trees. Non-permanent open habitats, however, are much more common and include pastures, hayfields, abandoned agricultural lands, and young forest. The latter habitat, often called early successional forest, develops after natural disturbances such as hurricanes or fires, after heavy forest cutting, or after agricultural land is abandoned. Although it is not a permanent feature of any specific place, early successional forest is a permanent feature of the region.

Grasslands: are dominated by herbaceous vegetation. Native species, such as little bluestem, may be common but often these are a mixture of native, exotic, and cultivated species. Recently abandoned agricultural or residential lands are characterized by a mix of grasses and shrubs, especially those that are good colonizers (e.g. dispersed by birds or wind such as rose and buckthorn). Collectively, over 22 species of birds are associated with grassland habitats (see below). Reptiles like black racer and wood turtle, prefer these habitats as do some mammals such as the New England cottontail. They also support a variety of butterflies such as the karner blue and persius duskywing that are both declining in the region.

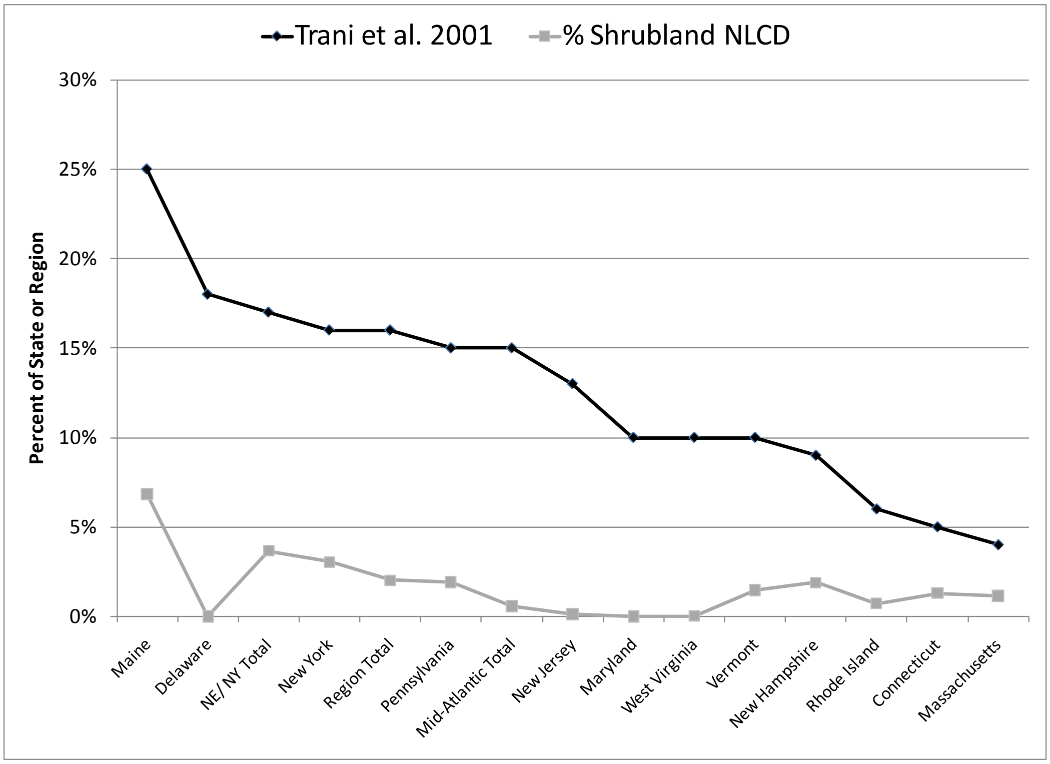
Young Forest and Shrublands: are temporary forest openings caused by natural disturbances or anthropogenic practices, or older abandoned land that have reverted to forest, but do not yet have mature trees and a closed canopy. Typical birds of young forest habitat include chestnut-sided warbler and blue-winged warbler.

Estimates of Distribution and Conservation Status

The amount of open shrubland and young forest habitat in the Northeast has fluctuated widely through history averaging an estimated 13 percent for the region but ranging widely depending on the forest type and geography (Lorimer and White 2003). Current amounts of early successional forest have been estimated by Trani et al. 2001. To get an idea of the accuracy of the National Land Cover dataset (Homer et al. 2004) we compared the Trani et al. (2001) estimates of percent young forest per state with the percentage derived for the NLCD data for shrubland, grassland, open forest, barrens and various combinations of these habitats. We found that found that Trani et al (2001) estimates were most closely correlated with the NLCD shrubland class (r = 0.61), although the estimates of early successional forest were 3 to 18 percent higher than those for shrublands (Figure 1).

With the previous relationship in mind, and with the caveats discussed above, the NLCD (Homer et al. 2004) may provide a rough ballpark estimate of the current extent of natural open habitats. Across the whole region these data show an average of 4 percent open habitat, not including the 18 percent of agricultural lands, and a range from 1 percent to 8 percent of each state (Table 1, Map 1).

Figure 2. Estimates of early successional forest. This chart compares estimates from Trani et al (2001) with the amount of land mapped as shrubland (the most closely correlated cover type) the National Land cover data set (USGS 2006).



Map 1. Open habitat by type.

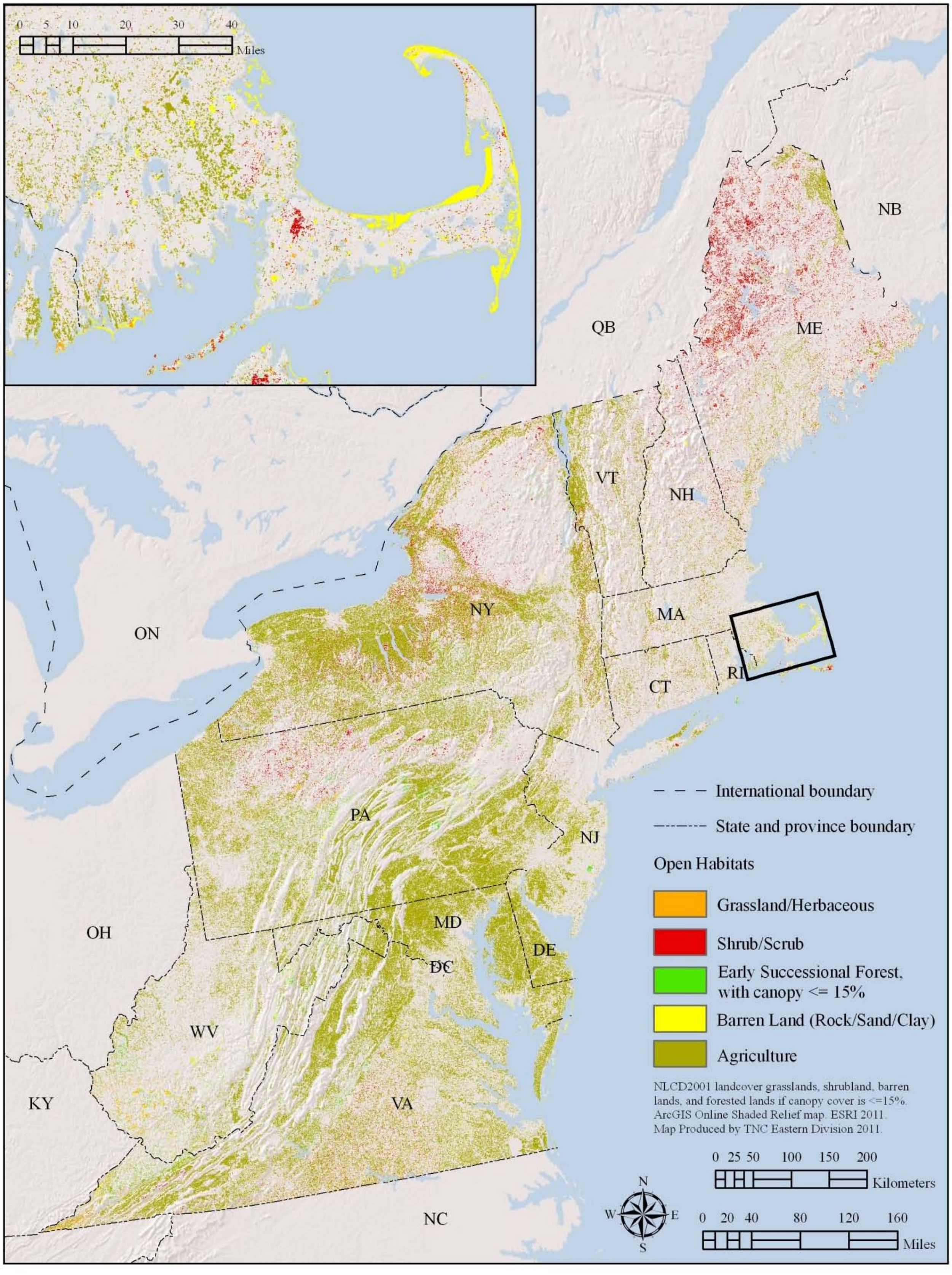
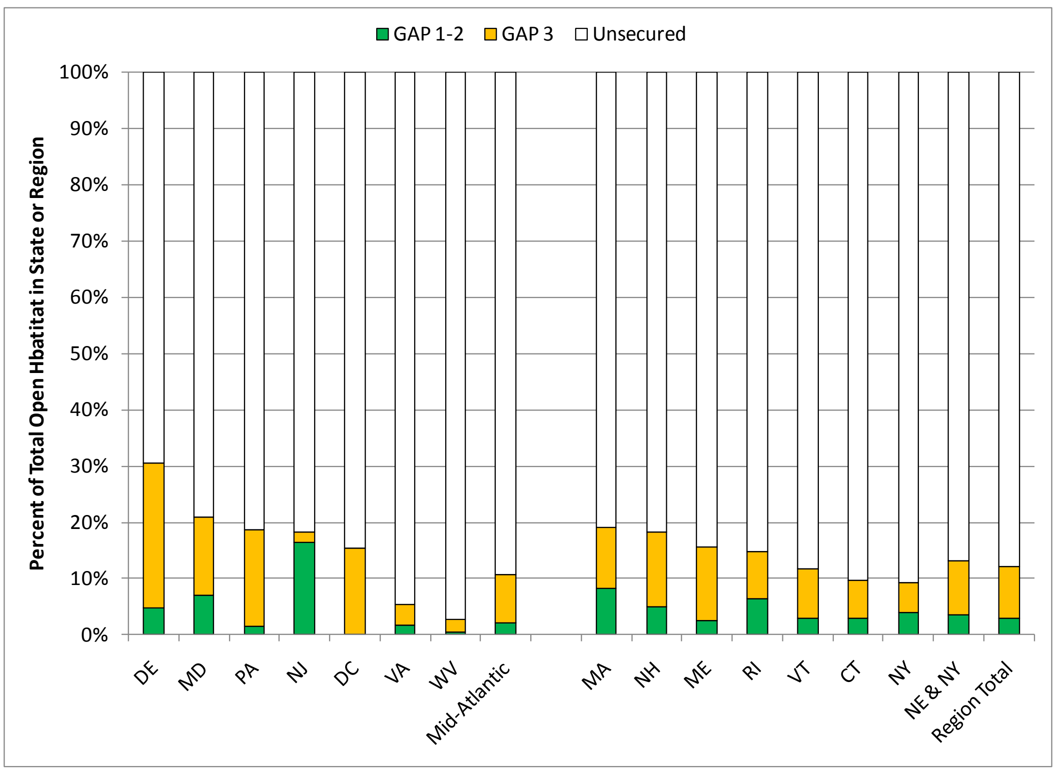


Table 1. Estimates of grassland, shrubland, barren, open forest, and agricultural lands for each state and region. The data source is the National Land Cover data set (Homer et al. 2004). Open forests were defined and canopy cover less than 15%. Trani et al (2001) is an independent estimate of the percent of shrubland and young forest in the state.

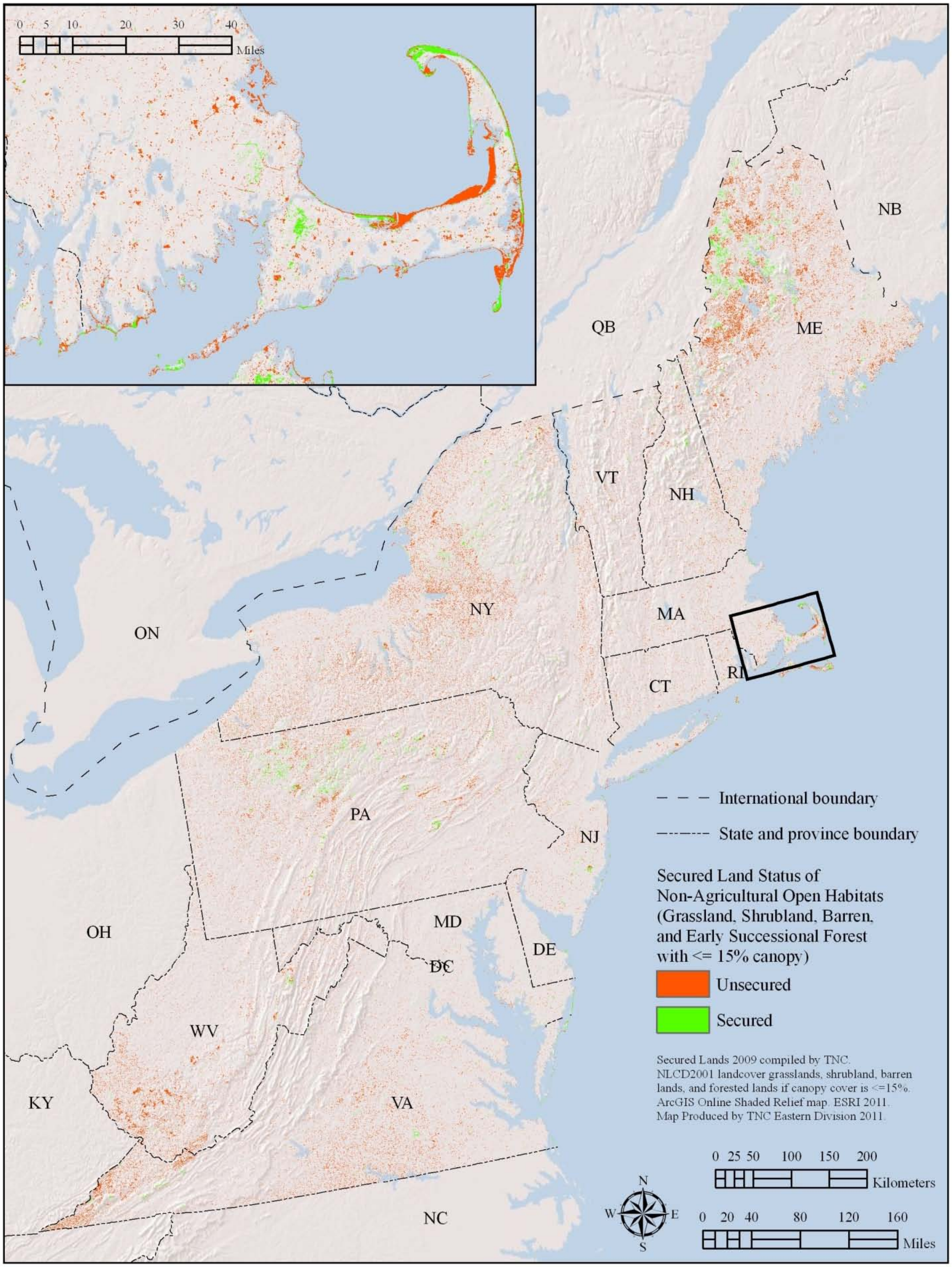
STATE	Grassland	%G	Shrub	%S	Barrens	%B	Open Forest	%F	Total	Total Acres	% of State /Region in Open Non-Agriculture Habitats	Trani et al. 2001	Acres Agriculture	% Agriculture in Region
District of Columbia		0%		0%	236	91%	22	9%	259	43,686	1%		952	2%
Delaware		0%		0%	17,098	94%	1,022	6%	18,119	1,287,144	1%	18%	651,590	51%
Maryland		0%		0%	79,825	82%	18,062	18%	97,887	4,827,542	2%	10%	2,541,953	40%
New Jersey	1,979	2%	8,014	2%	89,308	75%	19,880	17%	119,181	6,395,350	2%	13%	934,592	19%
Pennsylvania	151,813	15%	296,360	15%	123,999	13%	414,702	42%	986,874	15,506,769	6%	15%	7,158,129	25%
Virginia	375,212	40%	170,618	40%	195,835	21%	206,903	22%	948,567	25,584,807	4%		6,223,031	24%
West Virginia	220,093	37%	3,222	37%	89,089	15%	278,199	47%	590,604	28,991,659	2%	10%	1,441,744	9%
Mid-Atlantic Total	**749,098**	**27%**	**478,214**	**27%**	**595,390**	**22%**	**938,789**	**34%**	**2,761,492**	**82,636,957**	**3%**	**15%**	**18,951,991**	**23%**
Connecticut	8,605	11%	41,456	55%	9,349	12%	15,750	21%	75,159	3,183,870	2%	5%	278,500	9%
Maine	171,247	10%	1,423,872	81%	123,240	7%	30,365	2%	1,748,725	20,807,110	8%	25%	822,410	4%
Massachusetts	33,426	16%	59,471	28%	82,900	40%	33,474	16%	209,270	5,194,591	4%	4%	376,532	7%
New Hampshire	17,773	11%	112,273	67%	21,349	13%	16,992	10%	168,387	5,930,347	3%	9%	265,355	4%
New York	307,921	20%	947,775	60%	67,574	4%	250,151	16%	1,573,421	31,114,781	5%	16%	6,960,684	22%
Rhode Island	7,462	27%	5,071	19%	7,281	27%	7,435	27%	27,248	695,850	4%	6%	43,593	6%
Vermont	14,799	11%	90,641	69%	7,207	5%	19,490	15%	132,138	6,152,926	2%	10%	872,547	14%
NE/ NY Total	**561,233**	**14%**	**2,680,559**	**68%**	**318,901**	**8%**	**373,657**	**9%**	**3,934,348**	**73,079,473**	**5%**	**17%**	**9,619,620**	**13%**
Region Total	**1,310,331**	**20%**	**3,158,772**	**47%**	**914,291**	**14%**	**1,312,446**	**20%**	**6,695,840**	**155,716,430**	**4%**	**16%**	**28,571,611**	**18%**

Conservation Status of Non-Agricultural Open Habitats: We overlaid the NLCD land cover estimate of open habitats with the TNC secured land data set to evaluate how much open habitat fell on secured lands (Huang et al. 2001). Results show 12 percent were secured from conversion, most of that on multiple use land (9 percent) with a small amount (3 percent) and land protected for biodiversity (Figure 3, Map 2).

Figure 3. Secured land status of NLCD open habitats.



Map 2. Secured land status of non-agricultural open habitats.



Because many species that breed in open habitat species may persist, or even thrive in agricultural lands, we do not mean to imply that securing land is the best strategy for the conservation of these species. However, land securement may slow down the rate of fragmentation of these areas and a substantial amount of rare plants and invertebrates occur in open barren habitat.

Trends in Grassland Bird Abundance

Grassland breeding birds appear to have declined substantially in the Northeast and Mid-Atlantic and we used a two-step process to examine these trends. First, we identified a set of breeding species associated with grasslands or old fields using DeGraaf and Yamasaki's (2001) list of preferred habitat during the breeding season for northeast wildlife. Second, we used breeding bird survey data to examine each species' regional and state abundance patterns over the last four decades. The data are most telling if they show consistent trends across many species, many states, and many time intervals. The breeding bird survey (BBS) is a long-term, large-scale, avian monitoring program initiated in 1966 to track the status and trends of North American bird populations, and coordinated in the US by the USGS Patuxent Wildlife Research Center. More information on the program may be found here http://www.pwrc.usgs.gov/bbs/.

The BBS annually collects bird population data along roadside routes allowing users of the data to look at trends occurring within states, regions and continentally. We used only species for which there was adequate data (data categories blue or yellow), we summarized statistically significant declines and increases for each species by each state; next we looked at the data across all states to examine how consistent the trend was, as well as how consistent it was across two time intervals. In the tables below, we show whether there was a consistent trend, whether it was an increase, decrease, or mixed signal, how many states it was detected in, and whether the trend was apparent at both the 40 year time interval and a more recent 20 year time interval.

Grassland and Shrublands: Twenty-two species preferentially breed in grasslands and fields (DeGraaf and Yamasaki 2001), and the breeding bird survey had sufficient data to examine temporal trends for all 22 of them. Results indicated consistent widespread declines in 17 species: **eastern meadowlark, field sparrow, northern bobwhite, ring-necked pheasant, brown thrasher, song sparrow, common yellowthroat, grasshopper sparrow, red-winged blackbird, killdeer, savannah sparrow, golden-winged warbler, vesper sparrow, yellow-breasted chat, blue-winged warbler, prairie warbler,** and **bobolink** (Table 2). These declines were detectable over both the 40 and 20 year periods. For two species, **common yellowthroat** and **prairie warbler**, declines have spread to more states in the recent decades. Only **alder flycatcher** showed consistent increases across many states, although the increases were less widespread in the most recent decades. A few species showed mixed trends; **chestnut-sided warbler** and **northern mocking bird** appear to be declining in many states but increasing in one or two. **Horned lark** and **American goldfinch** showed conflicting trends across decades.

Table 2. Grasslands and fields: forty year trends in the abundance of associated bird species. DNS = Declining or not significant, INS = Increasing or not significant, NS = Not significant. Data quality codes: B= blue, adequate data, Y = yellow, usable but with significant gaps, R = red, data not usable.

Grasslands	40 Year Trend (1966-2007)					20 Year Trend (1980-2007)				
SPECIES	Status	Declines (# of states)	Increases (# of states)	Data Quality	Regional Trend	Status	Declines (# of states)	Increases (# of states)	Data Quality	Regional Trend
Eastern Meadowlark	DNS	11	0	Y	-4.2	DNS	12	0	Y	-3.2
Field Sparrow	DNS	11	0	Y	-3.7	DNS	10	0	Y	-3.5
Northern Bobwhite	DNS	9	0	Y	-4.8	DNS	8	0	Y	-6.2
Ring-necked Pheasant	DNS	9	0	Y	-5.6	DNS	8	0	Y	-6.8
Brown Thrasher	DNS	8	0	B	-2.4	DNS	3	0	B	-0.6
Song Sparrow	DNS	8	0	Y	-1	DNS	6	0	Y	-0.7
Common Yellowthroat	DNS	7	0	Y	-0.4	DNS	10	0	Y	-0.7
Grasshopper Sparrow	DNS	6	0	B	-5.4	DNS	5	0	B	-4.9
Red-winged Blackbird	DNS	6	0	B	-2	DNS	2	0	B	-1
Killdeer	DNS	5	0	Y	-1.1	DI	4	1	Y	-1.7
Savannah Sparrow	DNS	5	0	B	-2.6	DNS	3	0	B	-2.1
Golden-winged Warbler	DNS	4	0	Y	-8.8	DNS	1	0	Y	-6.2
Vesper Sparrow	DNS	4	0	Y	-5.5	DNS	2	0	Y	-1.9
Yellow-breasted Chat	DNS	4	0	Y	-2.4	DNS	4	0	Y	-2.1
Blue-winged Warbler	DNS	3	0	Y	-1.2	DNS	3	0	Y	-2.9
Prairie Warbler	DNS	3	0	B	-2.1	DNS	4	0	B	-1.8
Bobolink	DNS	2	0	B	-0.3	DNS	3	0	B	-0.9
Willow/Alder Flycatcher	INS	0	7	B	0.8	INS	0	1	B	0.6
Chestnut-sided Warbler	DI	5	1	B	-0.5	DI	4	2	B	-0.2
American Goldfinch	DI	3	1	Y	-0.5	DI	1	7	Y	1
Northern Mockingbird	DI	3	1	Y	-0.6	DI	5	1	Y	-0.3
Horned Lark	DI	2	1	Y	-2	INS	0	1	Y	1.6

<u>Early Successional Forest:</u> This group of species overlaps with the grassland group but, according their species profiles in Birds of North America (Gill et al. ongoing), this group prefers the shrubs and sapling habitat common when old fields revert to forest or when forests have been recently harvested. Results indicated consistent declines in three or more states for two of the ten species selected: **blue-winged warbler** and **prairie warbler.** Two species **American redstart** and **chestnut-sided warbler** were declining in 3 or more states but increasing in one or two states, and this pattern was consistent across both time intervals. No species was increasing in three or more states.

Table 3. Early successional forest: forty year trends in the abundance of associated bird species. DNS = Declining or not significant, INS = Increasing or not significant, NS = Not significant. Data quality codes: B= blue, adequate data, Y = yellow, usable but with significant gaps, R = red, data not usable.

Early Successional Forest	40 Year Trend (1966-2007)					20 Year Trend (1980-2007)				
SPECIES	Status	Declines (# of states)	Increases (# of states)	Data Quality	Regional Trend	Status	Declines (# of states)	Increases (# of states)	Data Quality	Regional Trend
Tennessee Warbler	DNS	1	0	Y	-8.4	DNS	1	0	Y	-12.7
Blue-winged Warbler	DNS	3	0	Y	-1.2	DNS	3	0	Y	-2.9
Prairie Warbler	DNS	3	0	B	-2.1	DNS	4	0	B	-1.8
Ruffed Grouse	DNS	2	0	Y	-3	DNS	1	0	Y	-7.4
American Woodcock	DNS	1	0	R	-2.6	DNS	2	0	R	-5
Mourning Warbler	INS	0	1	Y	1	NS	0	0	Y	0.5
Philadelphia Vireo	INS	0	1	Y	12.6	INS	0	1	Y	11.1
Chestnut-sided Warbler	DI	5	1	B	-0.5	DI	4	2	B	-0.2
American Redstart	DI	4	1	B	-1.2	DI	4	2	B	-1.2
Nashville Warbler	DI	1	1	Y	-0.9	DNS	2	0	Y	-2.2

References

Please see the data sources (appendix A) and detailed methods (appendix B) sections of the main report for more information on the data sources and analysis methods used in this chapter.

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