The Nature Conservancy

Protecting nature. Preserving life.™

©U.S. Fish & Wildlife

© Stephanie Koch U.S. Fish & Wildlife

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

## Implementation of the Northeast Monitoring Framework

The Nature Conservancy · Eastern Conservation Science

©Eric Aldrich/TNC

**Mark G. Anderson and Arlene Olivero Sheldon**
**The Nature Conservancy**
**Eastern Conservation Science**
**Eastern Regional Office**
**99 Bedford Street**
**Boston, MA 02111**

**Please cite as:**

**Anderson, M.G. and A. Olivero Sheldon. 2011. Conservation Status of Fish, Wildlife, and Natural Habitats in the Northeast Landscape: Implementation of the Northeast Monitoring Framework. The Nature Conservancy, Eastern Conservation Science. 289 pp.**

*This project was supported by a grant from the Northeast Association of Fish and Wildlife Agencies (#2007-05, The Conservation Status of Key Habitats and Species of Greatest Conservation Need in the Eastern Region, and 2008-05, Regional Indicators and Measures: Beyond Conservation Land), through funding from the National Fish & Wildlife Foundation, Doris Duke Charitable Trust, and U.S. Fish and Wildlife Service. In-kind support was provided by individual state fish & wildlife agencies of the Northeast Association of Fish and Wildlife Agencies, the network of Natural Heritage Programs and The Nature Conservancy.*

# Acknowledgements

This project is the result of a web of collaborations across the northeastern U.S. and beyond. The authors were charged with assembling and analyzing the information, but it would not have been possible without the expertise contributed by individuals in state agencies, federal agencies, academia, conservation organizations, and elsewhere. We offer our thanks to everyone who contributed their time and talents.

Core team members participated in conference calls and reviewed materials throughout this project. They were critical in the initial six months of the project during which we reviewed potential conservation status and condition metrics for inclusion: 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.

Federal agencies provided many of the underlying datasets used in this project, and we would like to particularly thank their staff for sharing their expertise; specifically Pam Fuller of the USGS/BRD Nonindigenous Aquatic Species Program, John R. 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, Mark Hatfield of USFS's Northern Research Station for FIA data and explanations, and Daren M. Carlisle PhD of the USGS National Water-Quality Assessment Program. We would also like to thank Harry Vogel of the Northeast Loon Study Working Group, Patricia A. Soranno, PhD., Dana Infante PhD., and Peter Esselman PhD. at Michigan State University, and Matthew Baker PhD. at the University of Maryland for their assistance with the lake and stream measures.

Without the countless hours of field work and information management conducted by Natural Heritage Programs and NatureServe this report would also not be possible. We would like to particularly thank the following individuals for the assistance with obtaining this critical data: NatureServe: Lynn Kutner, Kat Maybury, Margaret Ormes, and Adele Tomaino; CT NHP: Nancy Murray and Karen Zyko, DE NHP: Karen Bennett, NH NHP: Don Kent, NY NHP: D.J. Evans, NJ DEP Jason McNees, C. David Jenkins, Jr. , Bob Cartica, Gretchen Fowles, Elena Williams, Peter Winkler, and Kathleen Walz, PA NHP Susan Klugman and Jeff Wagner, ME NHP: Molly Docherty, MD NHP : Lynn Davidson, MA NHP: Henry Woolsey and Sarah Haggerty, RI NHP: Rick Enser and David Gregg, VT NHP: Bob Popp and Steve Parren, VA NHP: Tom Smith, and WV NHP: Barbara Sargent.

Without a spatial dataset of public and private lands secured from conversion this report would also not have been possible. We want to thank all the federal, state, local, and other NGO agencies who contributed spatial data and review to our secured lands regional dataset. We especially thank Melissa Clark who coordinated the effort, Kathy Smith for compiling the regional database and TNC state field office staff who were responsible for compiling the source datasets and quality controlling the information: Daniel Coker, Craig Cheeseman, Brad Stratton, Peter Steckler, Dan Farrell, Jessica Dyson, Kevin Ruddock, Michelle Canick, Tamara Gagnolet, Rachel Ralls, Mike Shanahan, Ellen Creveling, Chris Bruce, and Ruth Thornton.

Finally, we would like to thank members of the Conservancy team that provided assistance with data gathering, analysis, editing, and review during this project; specifically Melissa Clark, John Prince, and Charles Ferree of Eastern Conservation Science, and Colin Apse and Erik Martin of the Eastern Freshwater Program.

# Table of Contents

**Chapter 1 - Executive Summary** ..... 1-1

## General

**Chapter 2 - Introduction** ..... 2-1

**Chapter 3 - Secured Lands** ..... 3-1
Definition of Secured Land ..... 3-2
Terminology: Intent, Duration, Potential for Effective Management ..... 3-2
The Nature Conservancy's Secured Land Dataset ..... 3-3
Secured Lands and GAP Status ..... 3-3
Distribution of Secured Lands in the Northeast and Mid-Atlantic ..... 3-4
Patterns of Securement ..... 3-5
Conversion versus Securement: The Conservation Risk Index ..... 3-9
Ownership and Designation ..... 3-12
Ownership ..... 3-12
Designation ..... 3-14
Designation, GAP Status, and IUCN Management Categories ..... 3-15
Securement of Natural Features ..... 3-15

## Terrestrial and Palustrine Environments

**Chapter 4 - Eastern Forests** ..... 4-1
Forest Types ..... 4-2
Northern Hardwood and Conifer Forest ..... 4-2
Central Oak-Pine Forest ..... 4-2
Boreal Upland Forest ..... 4-2
Ruderal and Plantation Forest ..... 4-2
Distribution, Loss and Protection ..... 4-4
Forest Condition ..... 4-8
Fragmentation ..... 4-8
Connectivity ..... 4-10
Age and Size Structure ..... 4-16
Forest Disturbance ..... 4-20
Trends in Forest Bird Abundance ..... 4-22
Upland Boreal Forest ..... 4-22
Northern Hardwood and Conifer Forest ..... 4-23
Central Oak-Pine Forest ..... 4-24
Synthesis of Species Data with Forest Condition ..... 4-26

**Chapter 5 - Wetlands** ..... **5-1**
Types of Wetlands and their Fauna ..... 5-1
Marshes: Basin marshes, Alluvial marshes, Tidal marshes ..... 5-2
Forested Swamps: Basin swamps, Alluvial swamps, Tidal swamps ..... 5-2
Distribution, Loss, and Protection Status ..... 5-4
Wetland Conversion ..... 5-4
Conversion versus Securement ..... 5-5
Conservation and Wetland Size ..... 5-10
Ecological Condition ..... 5-13
Impacts in the Buffer Zone ..... 5-13
Road Density ..... 5-15
Changes in Wetland Acreage over Time ..... 5-18
Trends in Wetland Bird Abundance ..... 5-20
Freshwater Emergent Marsh ..... 5-20
Salt Marsh ..... 5-21
Alluvial and Riparian Habitat ..... 5-22
Forested and Shrub Swamp ..... 5-22
Correlations Between Species Patterns and Wetland Condition ..... 5-24

**Chapter 6 - Unique Habitats in the Northeast** ..... **6-1**
Community Types ..... 6-2
Calcareous Settings ..... 6-2
Moderately Calcareous Settings ..... 6-6
Shale Settings ..... 6-6
Acidic Sedimentary Settings ..... 6-7
Granitic Settings ..... 6-7
Mafic Settings ..... 6-8
Ultramafic Settings ..... 6-8
Fine-grained Mud and Silt Settings ..... 6-9
Coarse-grained Sand Settings ..... 6-9
Species Restrictedness Patterns ..... 6-10
Elevation and Landform-based Communities ..... 6-12
Distribution, Loss and Protection Status ..... 6-13
Ecological Condition: Fragmentation and Connectivity ..... 6-21
Fragmentation ..... 6-21
Connectivity ..... 6-21
Synthesis of Species data with Habitat condition ..... 6-23

## Aquatic Environments

**Chapter 7 - Streams and Rivers** ..... **7-1**
Stream Types and Associated Species ..... 7-2
Conversion and Securement of the Riparian Zone ..... 7-4
Secured Land in the Riparian Buffer ..... 7-6
Condition of the Riparian Buffer ..... 7-6
Conversion versus Securement ..... 7-8
Fragmentation and Flow ..... 7-12
Impervious Surfaces ..... 7-12
Stream Barriers ..... 7-14
Connected Stream Networks ..... 7-19
Flow Alteration ..... 7-24
Biotic Patterns and Trends ..... 7-29
Distribution and Population Status of Native Eastern Brook Trout ..... 7-29
Index of Biotic Integrity ..... 7-31
Relationship of IBI to Imperviousness Surfaces ..... 7-32
Non-Indigenous Aquatic Species ..... 7-33
Reduction in Native Fish Diversity ..... 7-36

**Chapter 8 - Lakes and Ponds** ..... **8-1**
Waterbody Types and Associated Species ..... 8-1
Distribution, Loss, and Protection Status ..... 8-2
Securement Status ..... 8-4
Conversion in the Shoreline Buffer Zone ..... 8-6
Conversion Versus Securement ..... 8-9
Ecological Condition ..... 8-10
Impervious Surface ..... 8-10
Isolation from Roads ..... 8-13
Presence of Dams ..... 8-15
Biological Integrity ..... 8-16
Index of Taxa Loss ..... 8-16
Correspondence between Taxa Loss and Lake Condition ..... 8-18
Trends in Loon Abundance ..... 8-19

## Species

**Chapter 9 - Regionally Significant Species of Greatest Conservation Need** ..... **9-1**
Identifying the Species of Greatest Conservation Need. ..... 9-2
Characterizing the Species ..... 9-2
Level of Regional Concern ..... 9-2
Level of Regional Responsibility ..... 9-2
Data Preparation ..... 9-3
Distribution, Rarity, and Protection Status ..... 9-4
Species of Widespread Concern and High Regional Responsibility ..... 9-4
Species of High Concern and High Regional Responsibility ..... 9-5
Species of Moderate Concern and High Regional Responsibility ..... 9-6
Species of Low Concern and High Regional Responsibility ..... 9-7
Species of Limited Distribution and High Regional Responsibility ..... 9-8
Species of Widespread Concern and Low Regional Responsibility ..... 9-9
Species of High Concern and Low Regional Responsibility ..... 9-11
Summary Across the Concern and Responsibility Groups ..... 9-13

## Appendices

**Appendix A - Data Sources** ..... **A-1**
Lists of all major data sources with brief description and web link

**Appendix B - Detailed Methods** ..... **B-1**
Detailed methods where needed, arranged by chapter
Background of the Monitoring Framework

**Appendix C - Grasslands and Shrublands** ..... **C-1**
Background ..... C-1
Open Habitats and their Fauna ..... C-2
Estimates of Distribution and Conservation Status ..... C-2
Conversion Status of Non-Agricultural Open Habitats ..... C-5
Trends in Grassland Bird Abundance ..... C-7
Grasslands and Shrublands ..... C-7
Early Successional Forest ..... C-8

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

## 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 the natural world is faring in individual states, and in the region as a whole.

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 focused 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



The Nature Conservancy • Eastern Conservation Science • Eastern Division • 99 Bedford St • Boston, MA 02111

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 "**secured primarily for nature**" 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 "**secured for multiple uses,**" meaning that they are managed for many purposes, often including forest products and recreation. Although not explicitly managed for natural diversity, the multiple-use lands provide and sustain many important functions and are an integral piece of the conservation picture.

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 total, 16 percent of the region is secured against conversion and is intended to remain permanently in natural cover, while 28 percent of the region has been converted to development or agriculture. Thus, conversion outweighs total securement 2 to1. Moreover, 5 percent of the land is secured primarily for nature, and 11 percent for multiple uses, so, on an acre-by-acre basis, five acres have been converted for every one secured for nature.

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 are secured for nature in equal proportion to conversion, but diverse, productive, limestone habitats have 51 times more conversion than securement for nature. Any way that it is measured, securement for nature is largely limited to slopes, high elevations, and granite or sedimentary bedrocks. Flats, floodplains, low elevations, limestone, sand and shale - the centers of diversity in the region - are largely converted and mostly unsecured.

## 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. Converted forest land exceeds forest land secured for nature 6 to 1, and securement is not spread evenly across forest types. Upland boreal forests are 30 percent secured with 12 percent secured for nature. Northern hardwoods are 23 percent secured with 8 percent primarily for nature. Oak-pine forests are only 17 percent secured with 5 percent primarily for nature.

**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 is a high proportion of secured land within most of the remaining big contiguous forest 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 2” to 6” in diameter. Upland boreal forests are the most heavily logged, and they differ from the other types in having fewer trees in the larger diameter size classes. Out of almost 7,000 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, 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. Changes in boreal birds appeared less extensive suggesting that logging has not had as obvious an effect on bird abundance as fragmentation, but due to data limitations this pattern needs more research to confirm.

## 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 secured for nature, 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.

## 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, with 27 percent of riparian areas converted and 14 percent 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, securement for nature was equal to, or greater than, conversion on granite settings, on summits and cliffs, and at high elevations. In stark contrast, habitat conversion exceeds securement for nature 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 attention 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 low 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 secured primarily for nature. 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 of widespread or high concern, 32 percent of their known locations are on secured land, including 16 percent on land secured primarily for nature. Species of concern include animals which are declining in many geographic regions, so actions in this region are only one part of a larger solution. Examples include: bald eagle, eastern spadefoot toad, American brook lamprey, cherrystone drop snail, Indiana bat, and Blanding's turtle.

**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.

# Introduction



## Understanding and Using this Report



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.

<u>The Indicator Concept:</u> 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<br>1b. Forest area – by reserve status<br>Forest composition and structure – by seral stage<br>Forest bird population trends | Forest fragmentation index<br>Acid deposition index |
| **2. Freshwater streams and river systems** | Distribution and population status of native eastern brook trout<br>Index of biotic integrity | % impervious surface<br>Stream connectivity (length of open river) and number of blockages<br>Distribution and population status of non-indigenous aquatic species |
| **3. Freshwater wetlands** | Size/area of freshwater wetlands<br>Buffer area and condition (buffer index)<br>3a. Hydrology – upstream surface water retention<br>3b. Hydrology – high and low stream<br>Wetland bird population trends | % impervious surface flow<br>Road density |
| **4. Highly migratory species** | Migratory raptor population index<br>Shorebird abundance<br>Bat population trends<br>Abundance of diadromous fish (indicator still under development)<br>Presence of monarch butterfly | |
| **5. Lakes and ponds** | Overall Productivity of Common Loons | % impervious surface/landscape integrity<br>% 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<br>State-listing status and heritage rank of highly imperiled wildlife<br>Population trends of endemic species | |
| **8. Unique habitats in the Northeast.** | Wildlife presence/absence<br>Wildlife population trends | Proximity to human activity/roads<br>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<br>1b. Forest Area – by Reserve Status | Areal extent of forested lands<br>How much forest in a land use category | Forest Inventory and Analysis (FIA) Program<br>FIA Program | Margin of error in can be as high as 10%<br>FIA categories for Reserve status need to be migrated to the Conservation Lands categories<br>Margin of error in can be as high as 10%<br>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<br>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<br>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

# Secured Lands

3

## In the Northeast and Mid-Atlantic

April 2011

M. Anderson & A. Olivero Sheldon

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**

**Secured primarily for nature:** a secured area intended explicitly 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 development and 5 percent of that land area is secured primarily 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, the discrepancy is greater with respect to land secured primarily for nature conservation, roughly 5 acres converted for every 1 secured for nature; 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, and conversion, has widespread and fundamental biases with direct implications for biodiversity. For example, conversion in rocky granite areas is balanced with securement for nature at almost 1:1, but in productive, diverse limestone areas, conversion exceeds securement 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.



The Nature Conservancy • Eastern Conservation Science • Eastern Division • 99 Bedford St • Boston, MA 02111

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. Thus, the typing scheme described below is a **classification** not a ranking system.

For any given parcel of land, the determination of the type 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 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, equivalent to **CMS 1: Secured Primarily for Nature**

**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, equivalent to **CMS 1: Secured Primarily for Nature**

**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, equivalent to **CMS 3: Secured for Multiple Uses.**

**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

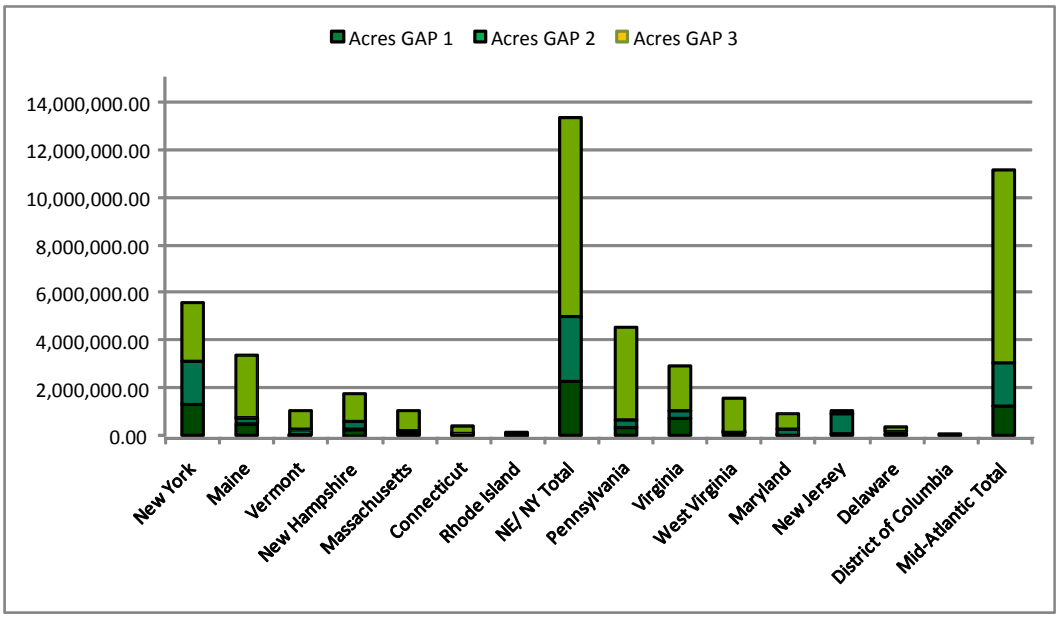
Conservationists have fought hard to secure important places, but do all those places add up to a larger conservation picture? In this report, we try to fit together the pieces of the securement puzzle, in order to take stock of our collective accomplishments, and identify where we need to put more effort. 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 secured primarily 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 (secured primarily 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).

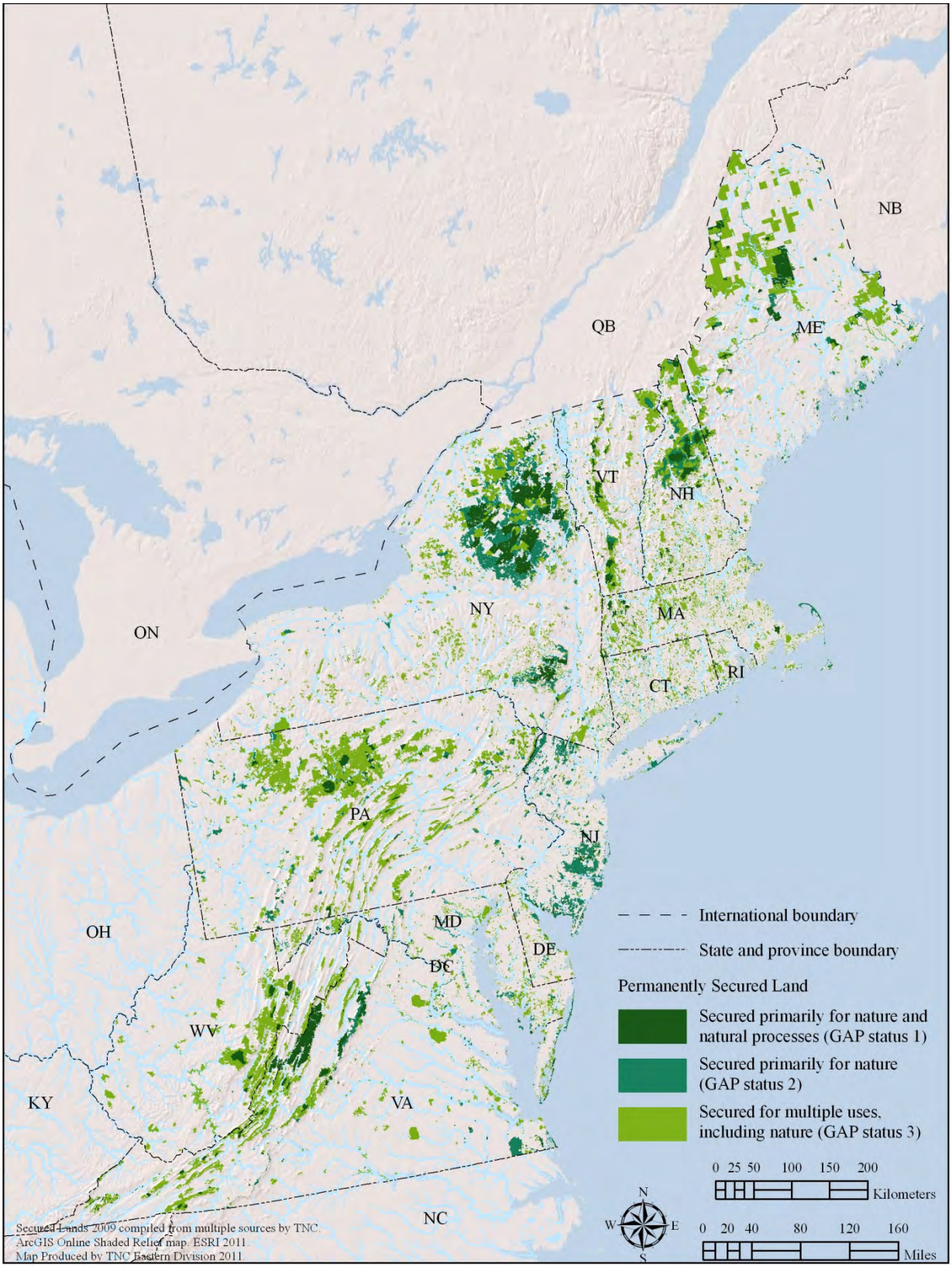
**Table 3. Acres and percentages of secured lands by GAP status.**

| 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 |

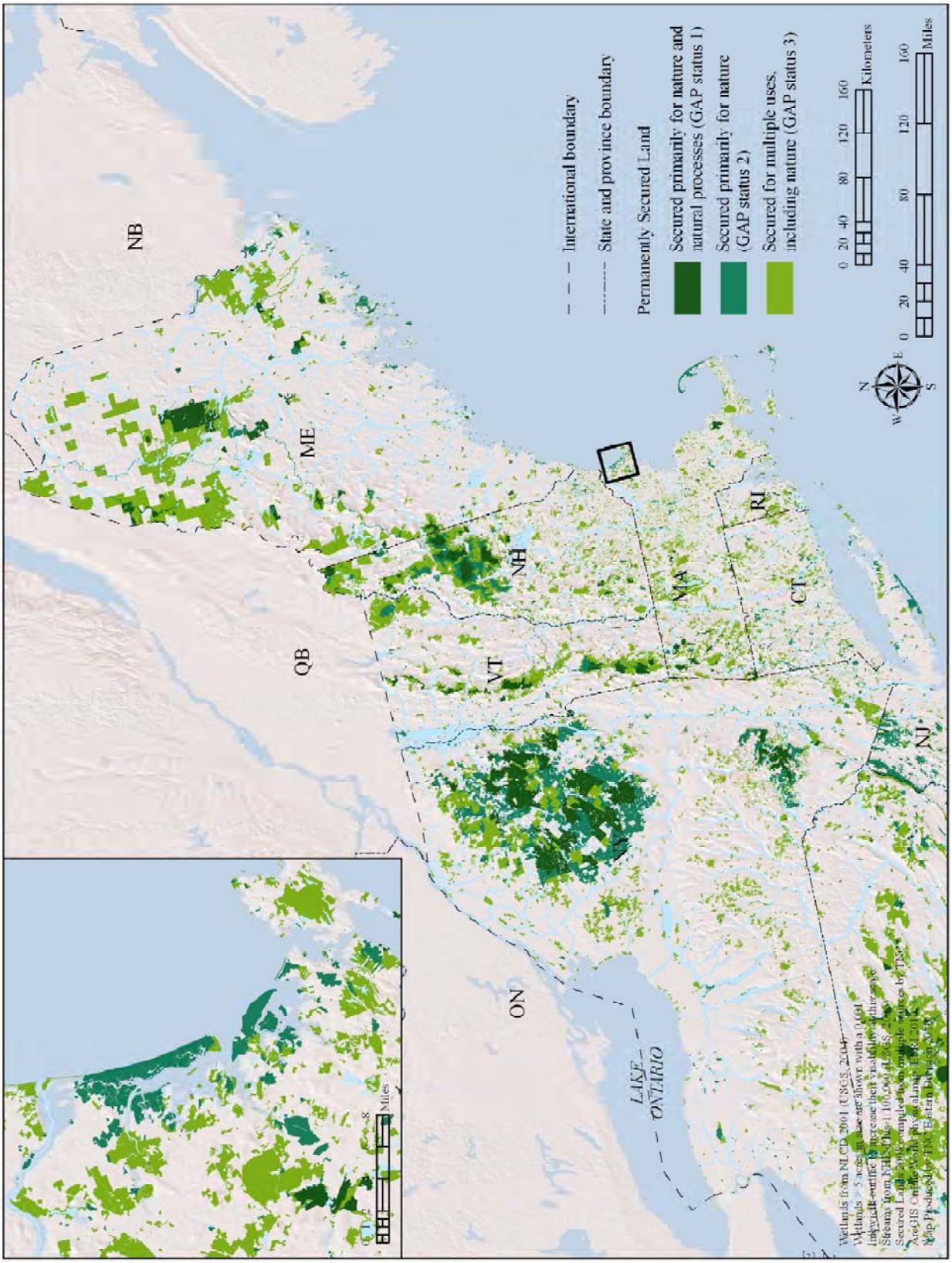
**Figure 1. The total amount of secured land by state and sub-region**. The overall acreage was closely correlated with the size of the state (r=0.91).



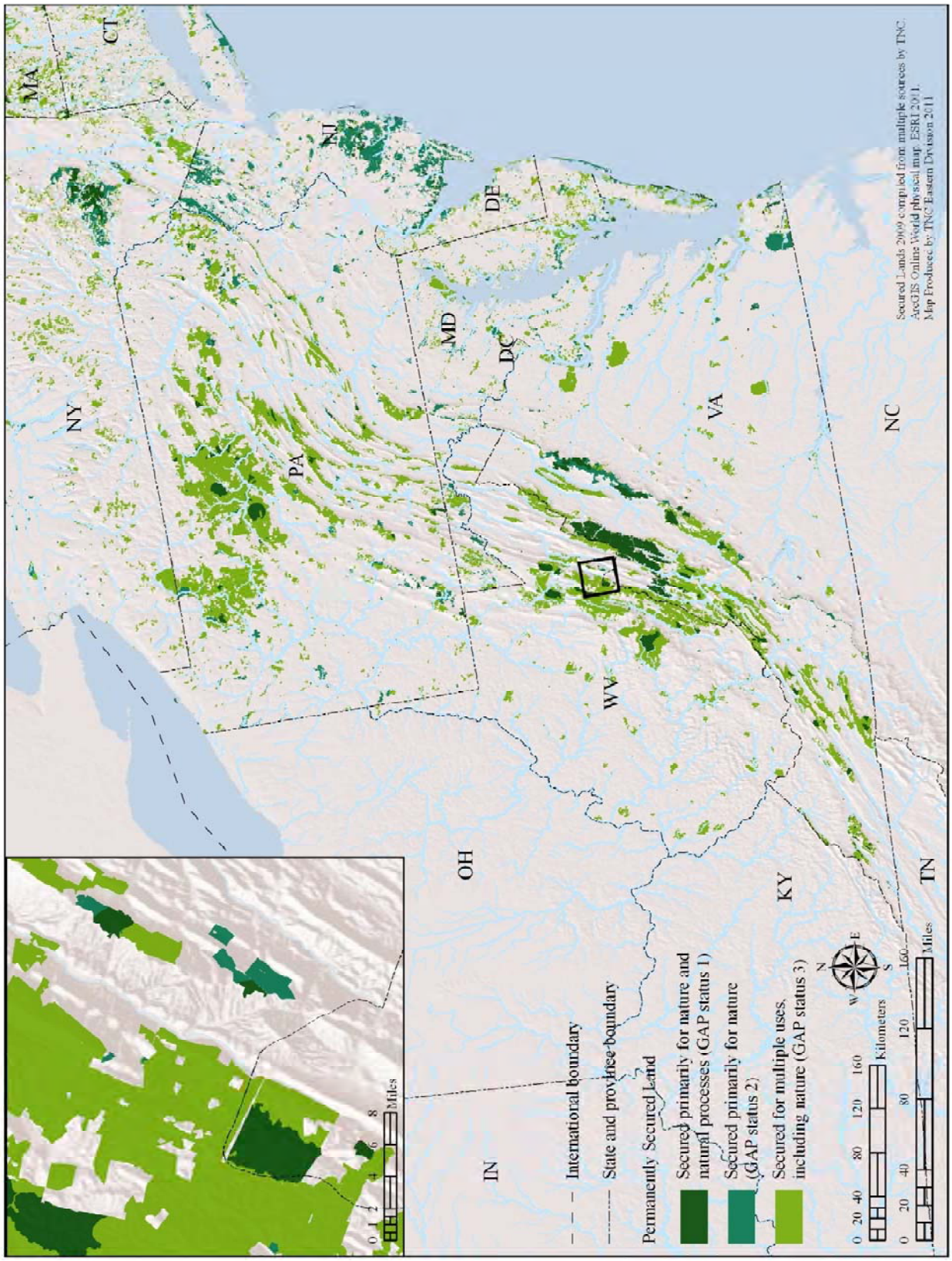
**Map 1. Secured land by GAP status.**



**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 land secured primarily for nature (GAP 1-2) and the ratio of conversion to all types of 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 land **P**rimarily for nature as CRI-**P** and conversion to all types of **S**ecurement 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 securement primarily for nature 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 secured for nature (Figure 2, Table 4). However, conversion exceeds all types of 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. Many of these lands have high biodiversity value even if biodiversity conservation 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.**

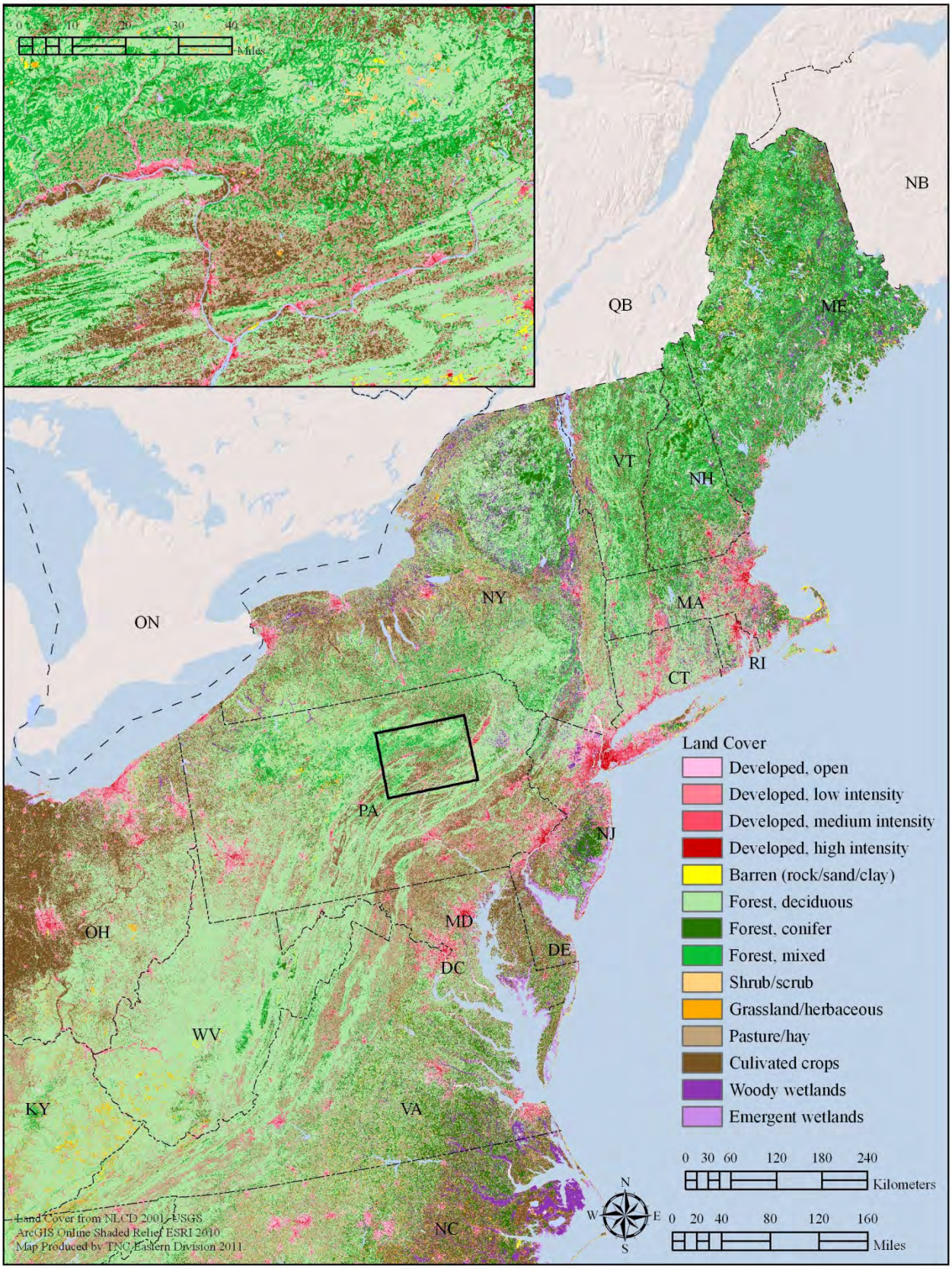


**Figure 2. The distribution of land conversion and land securement by state, sub-region, and region**. In this chart, each bar represents the total area of land in the geographic area. Land to the left of the center bar has been converted to development or agriculture; land to right of the center bar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

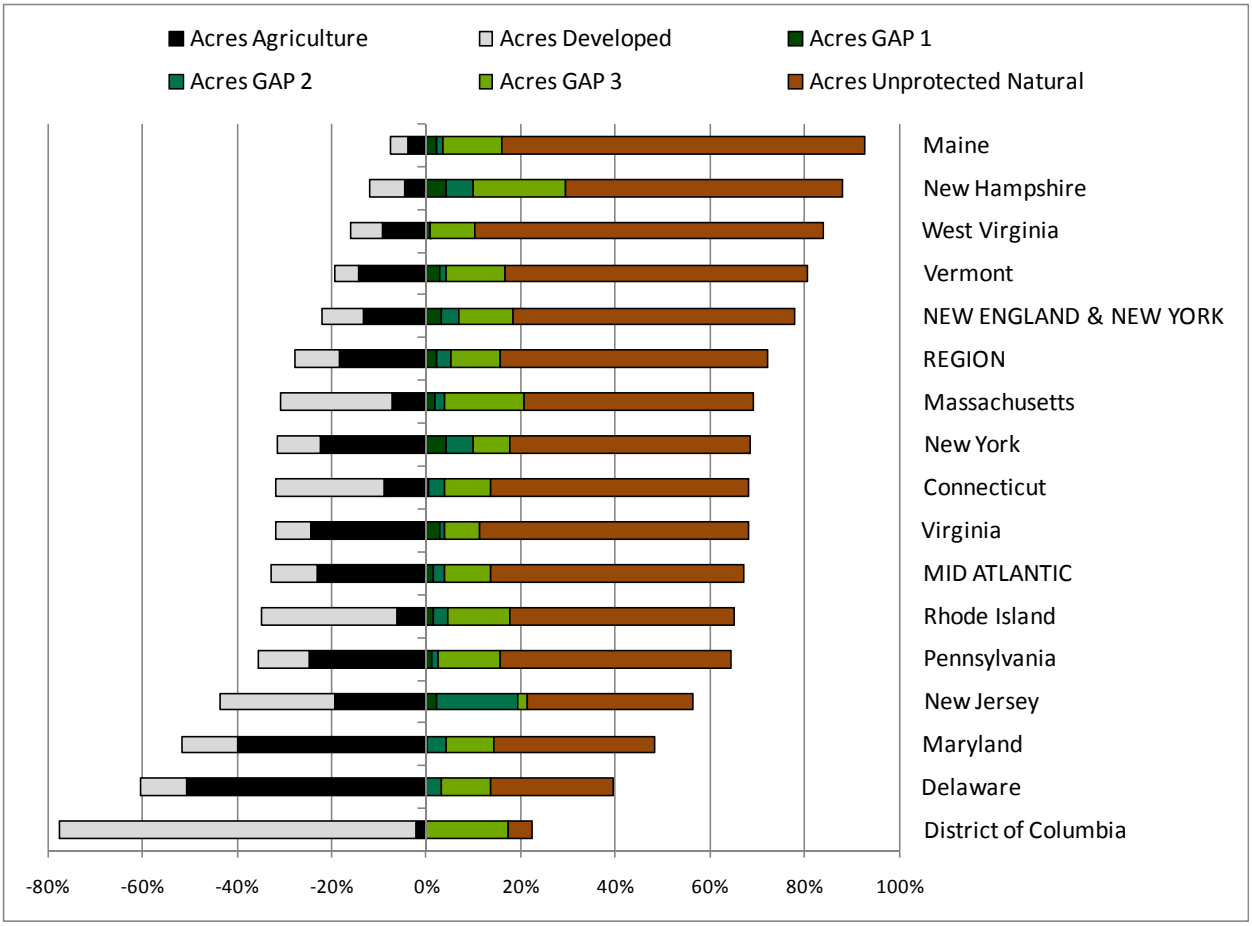



**Table 4. Converted and secured land by state and region.**

| 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 |

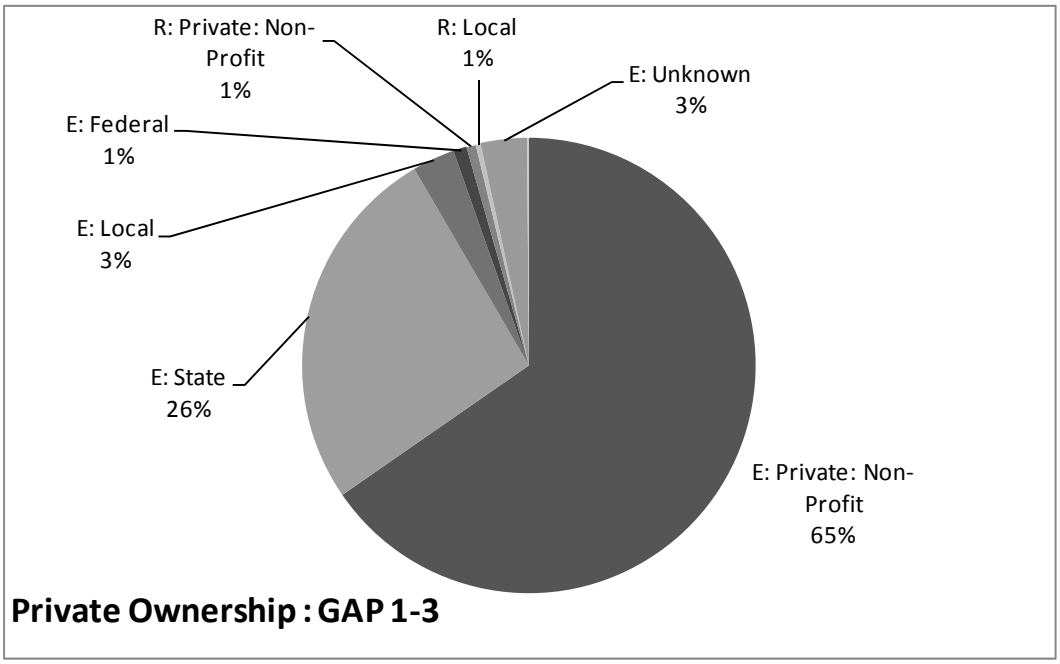
## Ownership and Designation

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).

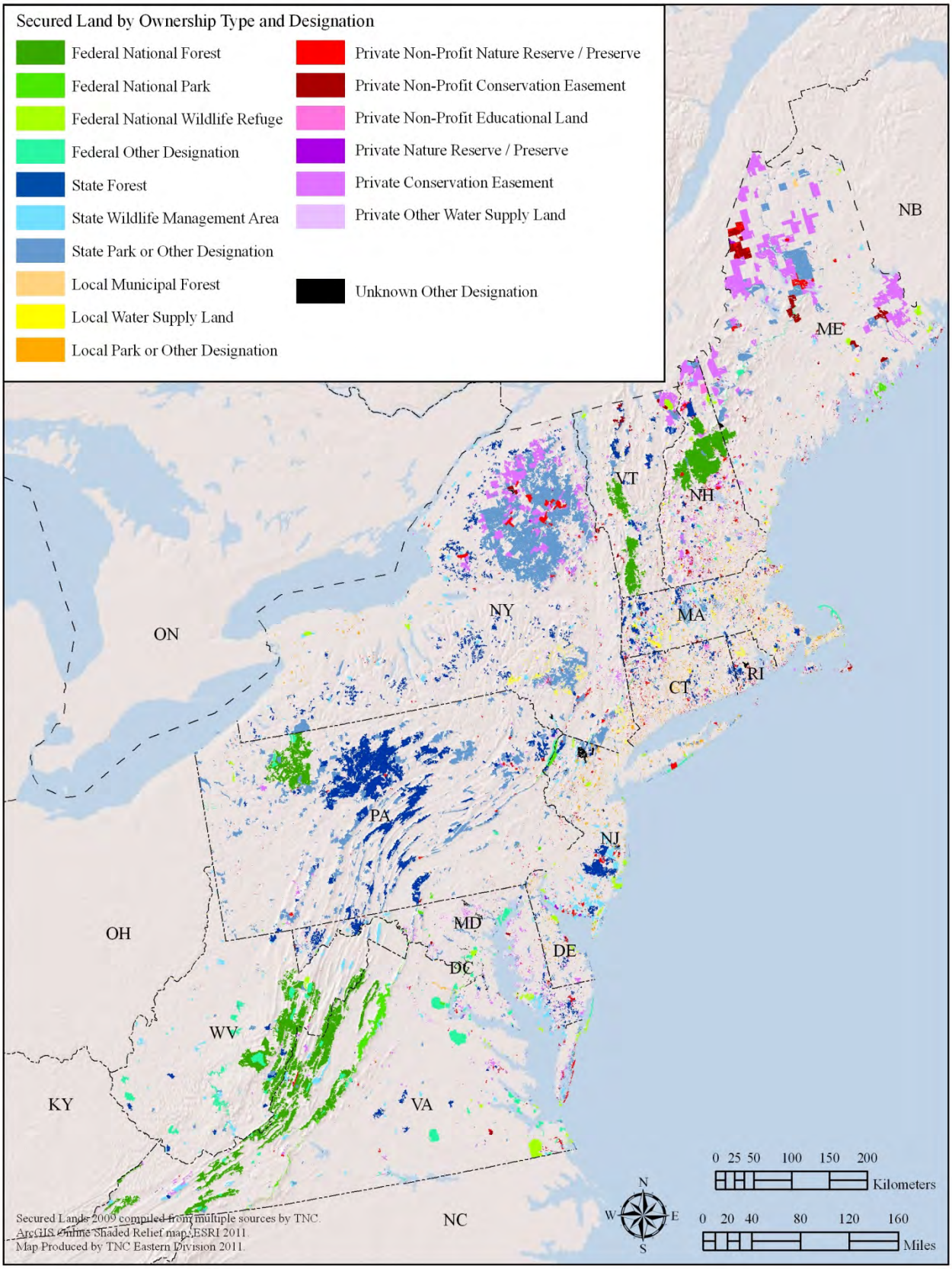
**Table 5. Secured land ownerships.** This table is organized by fee ownership types and shows both the average size of the ownership as well as the average tract or parcel size. Ownership by private individuals must have a conservation easement or restriction to qualify as permanent securement.

| 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 secured primarily 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 GAP 1 or 2 lands. While land secured primarily for nature 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. Some conservationists are uncomfortable calling a state-owned forest that is managed for timber, a "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 of all types of securement (GAP 1-3) or the percent secured primarily for nature (GAP 1-2), and the ratio of conversion to all types of **s**ecurement (CRI-**S**) or to securement **p**rimarily for nature (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 of all types of securement (GAP 1-3) or the percent secured primarily for nature (GAP 1-2), and the ratio of conversion to all types of **s**ecurement (CRI-**S**) or to securement **p**rimarily for nature (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

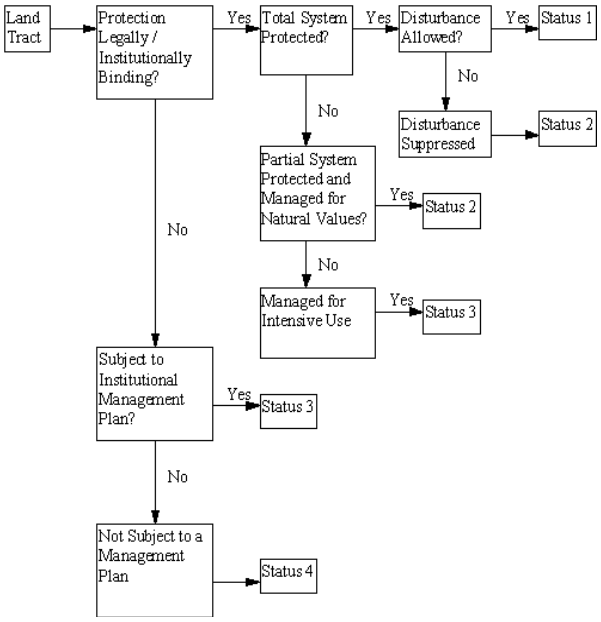
B-4:

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 shape file.
**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

# Eastern Forests

4

## 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 secured primarily 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 land secured for nature 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 2” to 6” in diameter. Upland boreal forests are the most heavily logged, and they differ from the other types in having fewer trees in the larger diameter size classes. 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 appeared less extensive suggesting that logging has not had as obvious an effect on bird abundance as fragmentation, but due to data limitations 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.

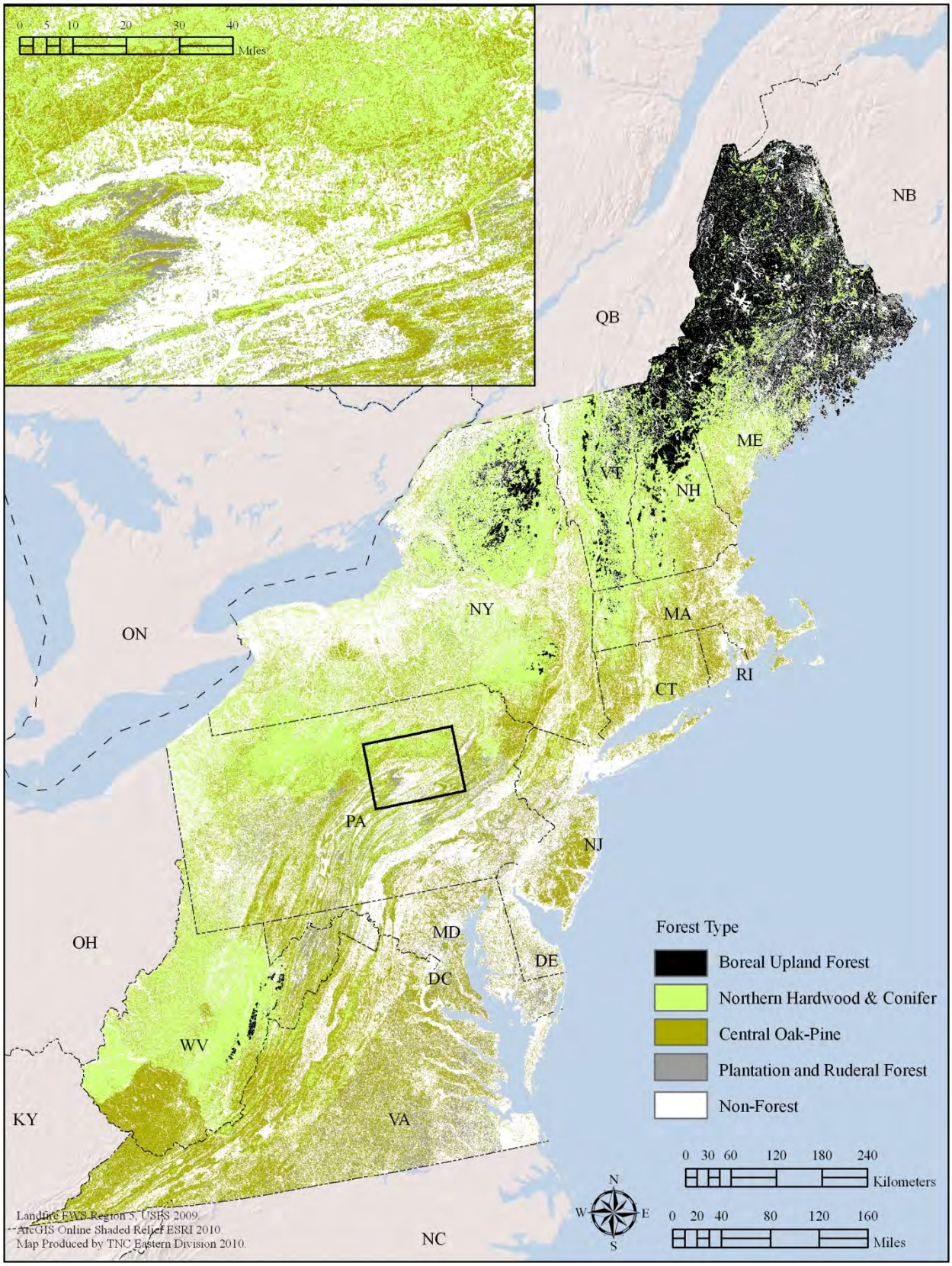
Northern Hardwood and Conifer Forest: This heterogeneous forest type is typical of mesic settings and was the most common forest of the region, covering 51 percent of the region (48.9 million acres) and occurring throughout (Map 1). It is a deciduous or mixed forest dominated by sugar maple, American 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 secured 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 secured primarily for nature, while upland boreal forest had the most (5 and 12 percent respectively). Northern Hardwood forests were 23 percent secured and 8 percent secured for nature.

**Conservation Land Terminology**

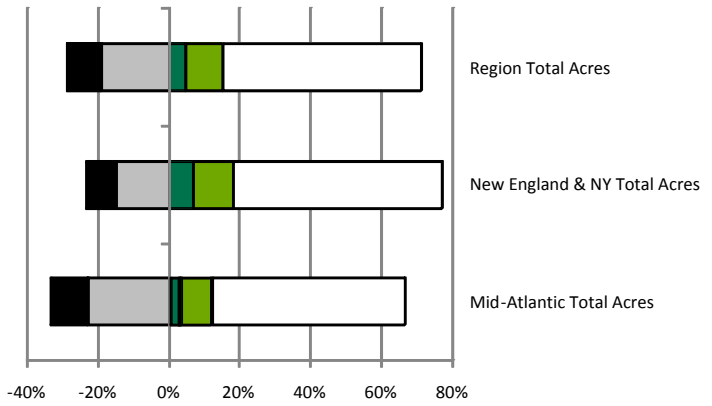
**Secured (GAP 1-3):** The land is permanently secured against conversion to development.

**Secured Primarily for Nature (GAP 1 or 2)**: The land is secured AND the intent of the management is 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 secured primarily for nature: conversion exceeds nature securement 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 secured 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).

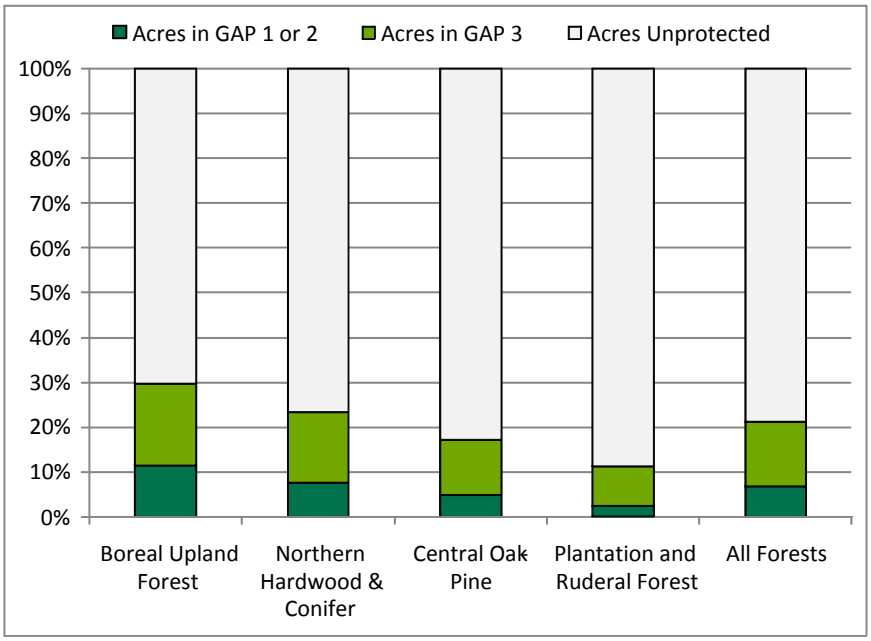
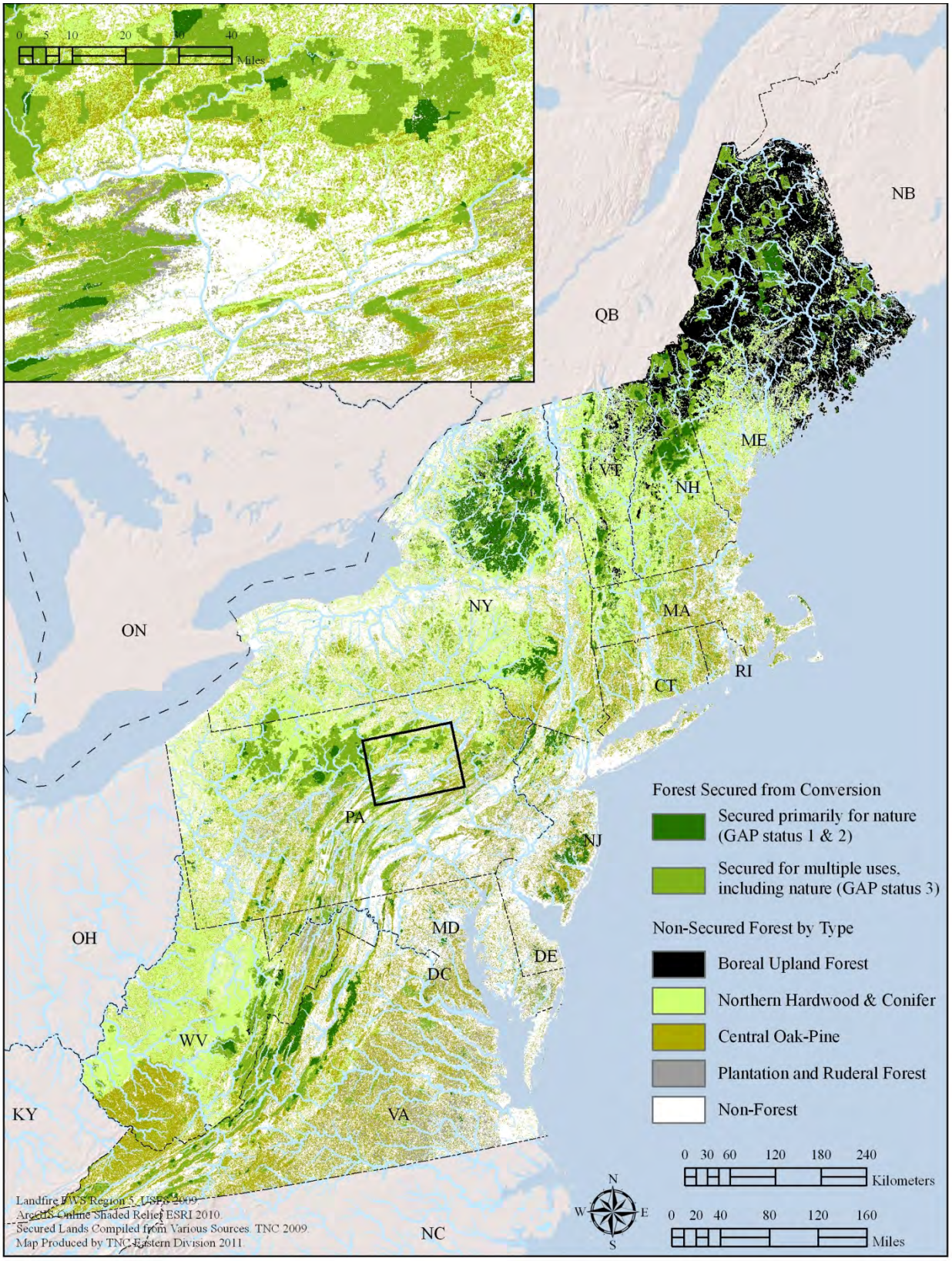



**Table 1. Acres of forest by secured land status, forest type and sub-region.** % C is the percent converted and % S is the percent secured. CRI-S is the ratio of conversion to securement and CRI-P is the ratio of conversion to securement primarily for nature, these were not available by forest type.

| 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.**

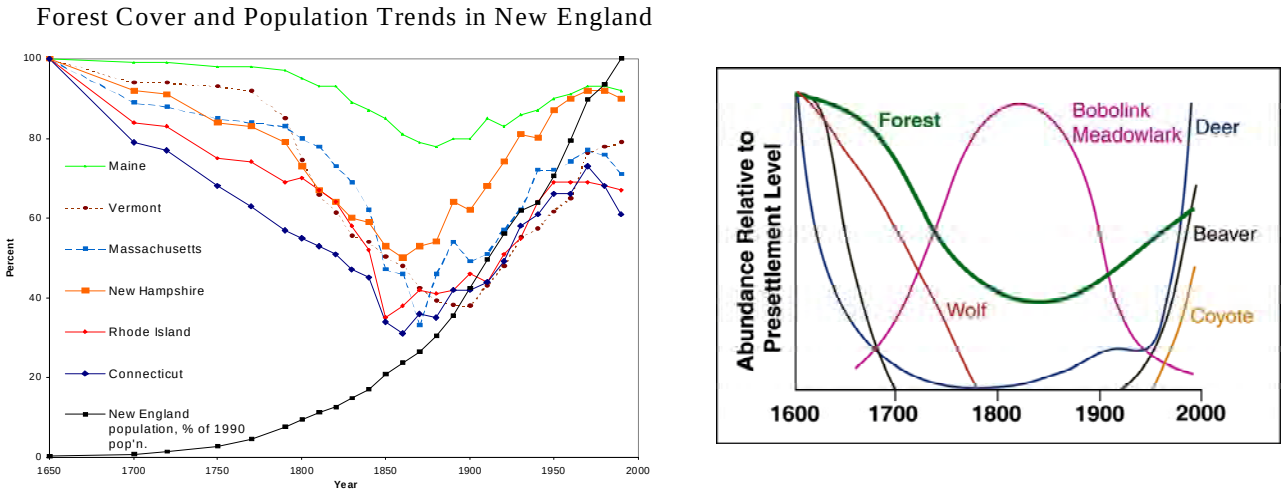


## Forest Condition: Fragmentation, Structure, Disturbances

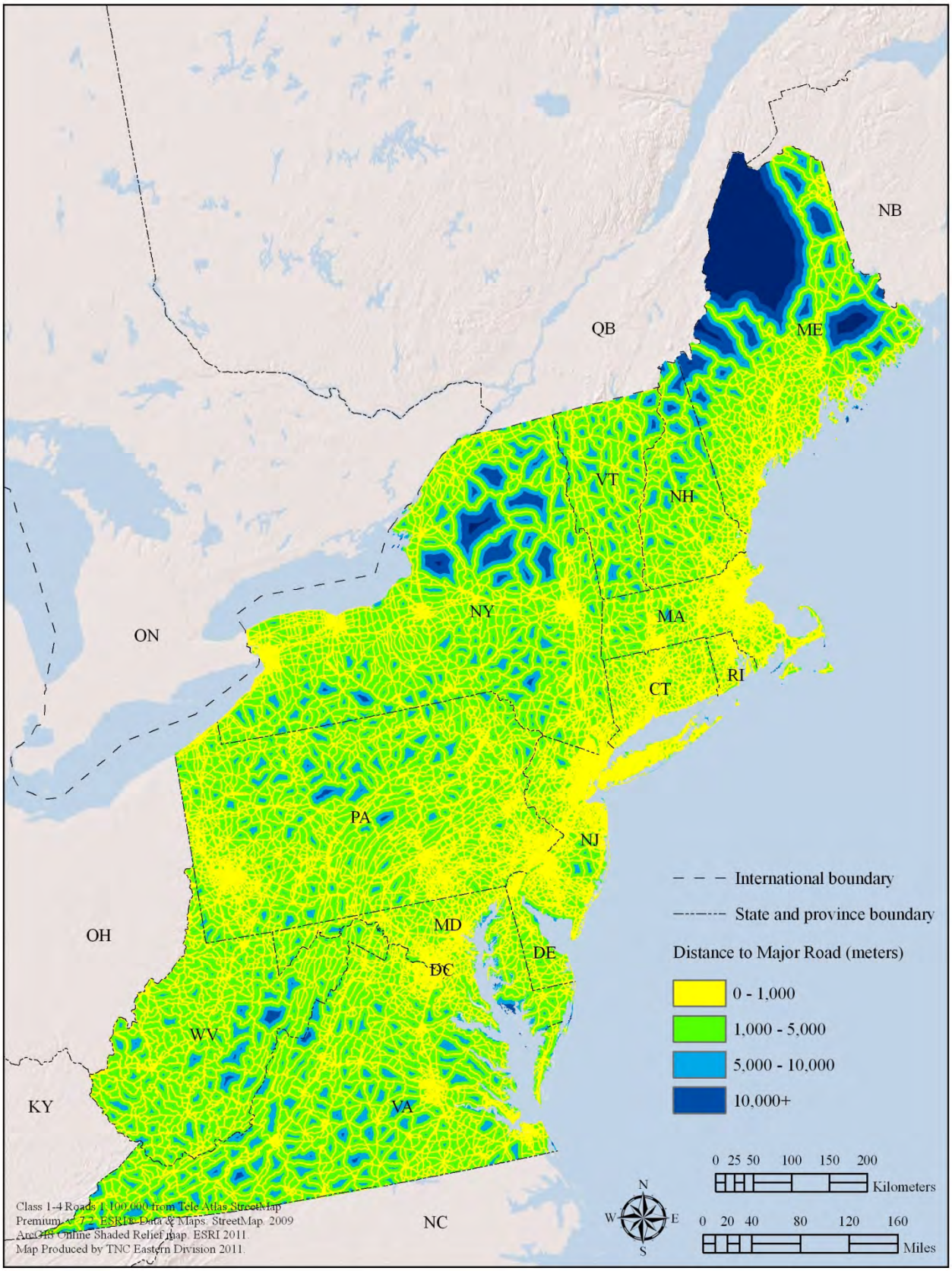
Forests in the east have a long history of human use, from widespread local-scale burning by Native Americans, to extensive clearing for agriculture and pasture by settlers in the 1800s, to the current logging of hardwoods and conifers for materials. Moreover, as eastern forests recovered from turn-of-the-century 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.**

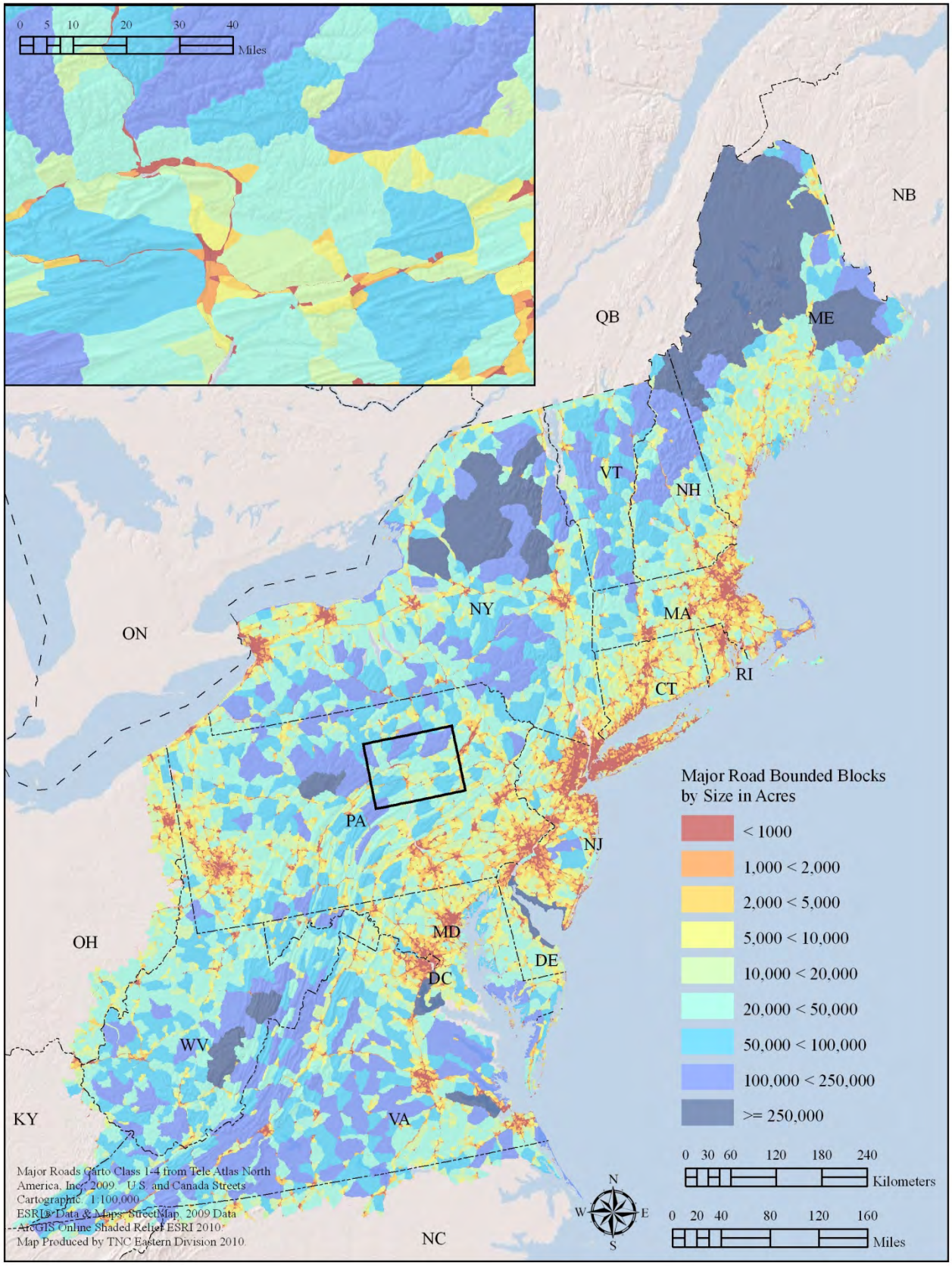


**Figure 4. Percent of forest acres within major road bounded blocks.** Size classes are in acres (*note figures do not include all local paved roads or any unpaved roads).

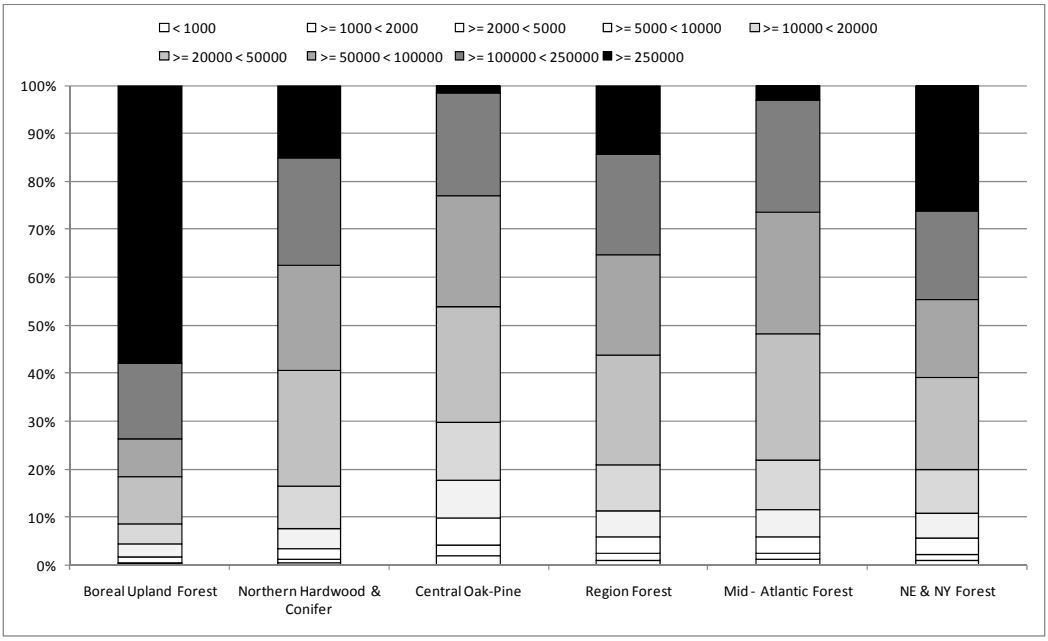
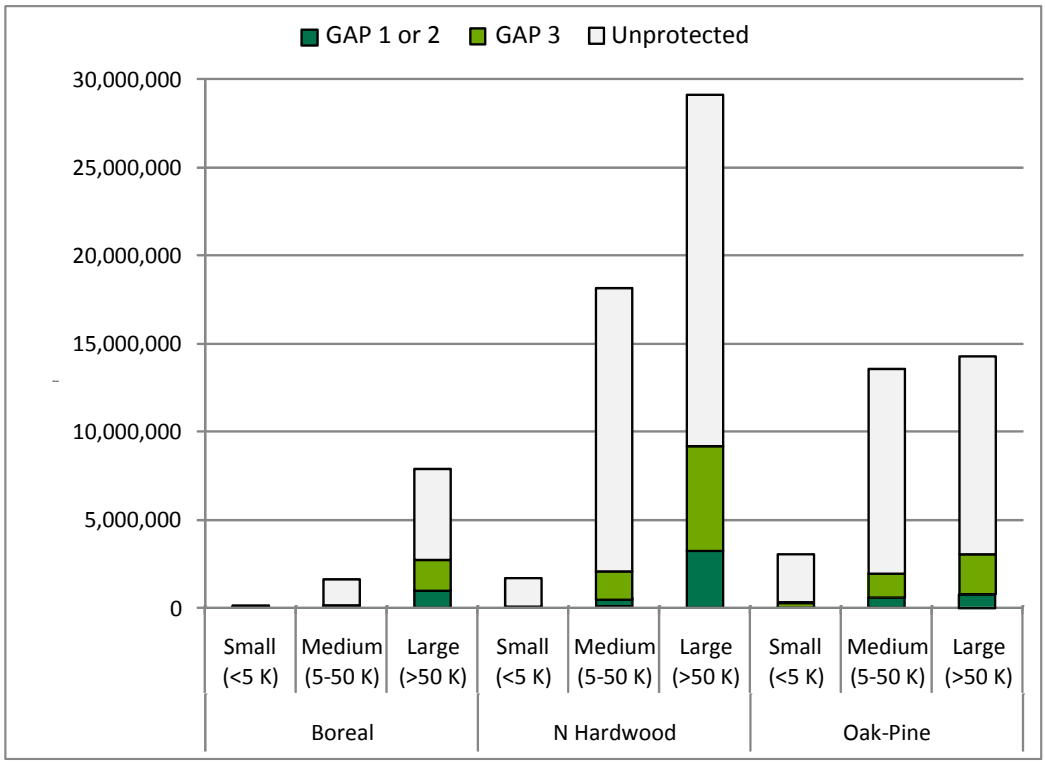



**Figure 5. Secured status by block size.** Securement is defined as forest land permanently secured against conversion to development and either secured primarily for nature (GAP 1 or 2) or intended for multiple uses such as forest management (GAP 3).




.

**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 |

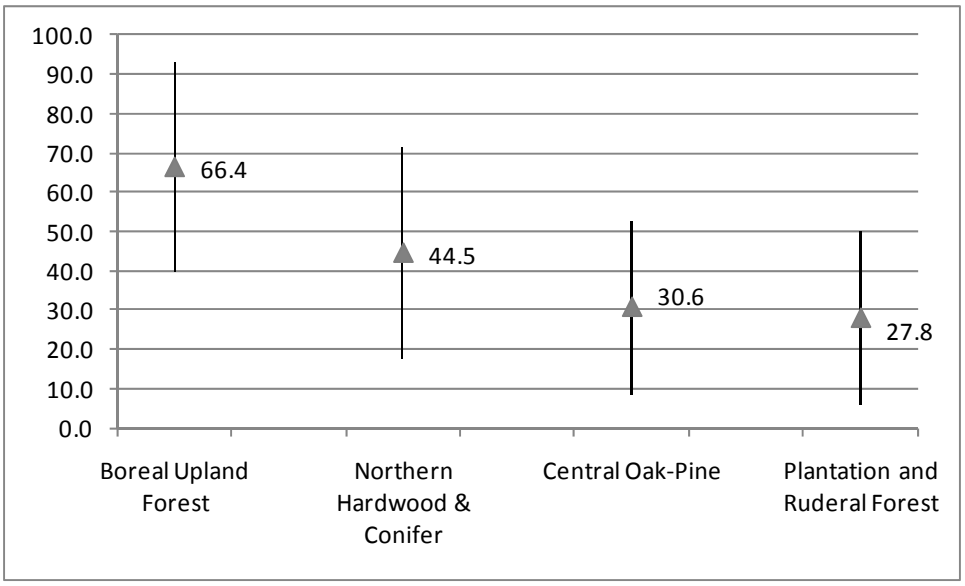
For every 30 m grid cell in the region, a circular area with a 3 km radius around the cell was evaluated and the amount of resistance /permeability was calculated to create a wall-to-wall grid with cell values ranging from 0 to 100; “0” indicating complete impermeability (e.g. developed) and “100” indicating 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).

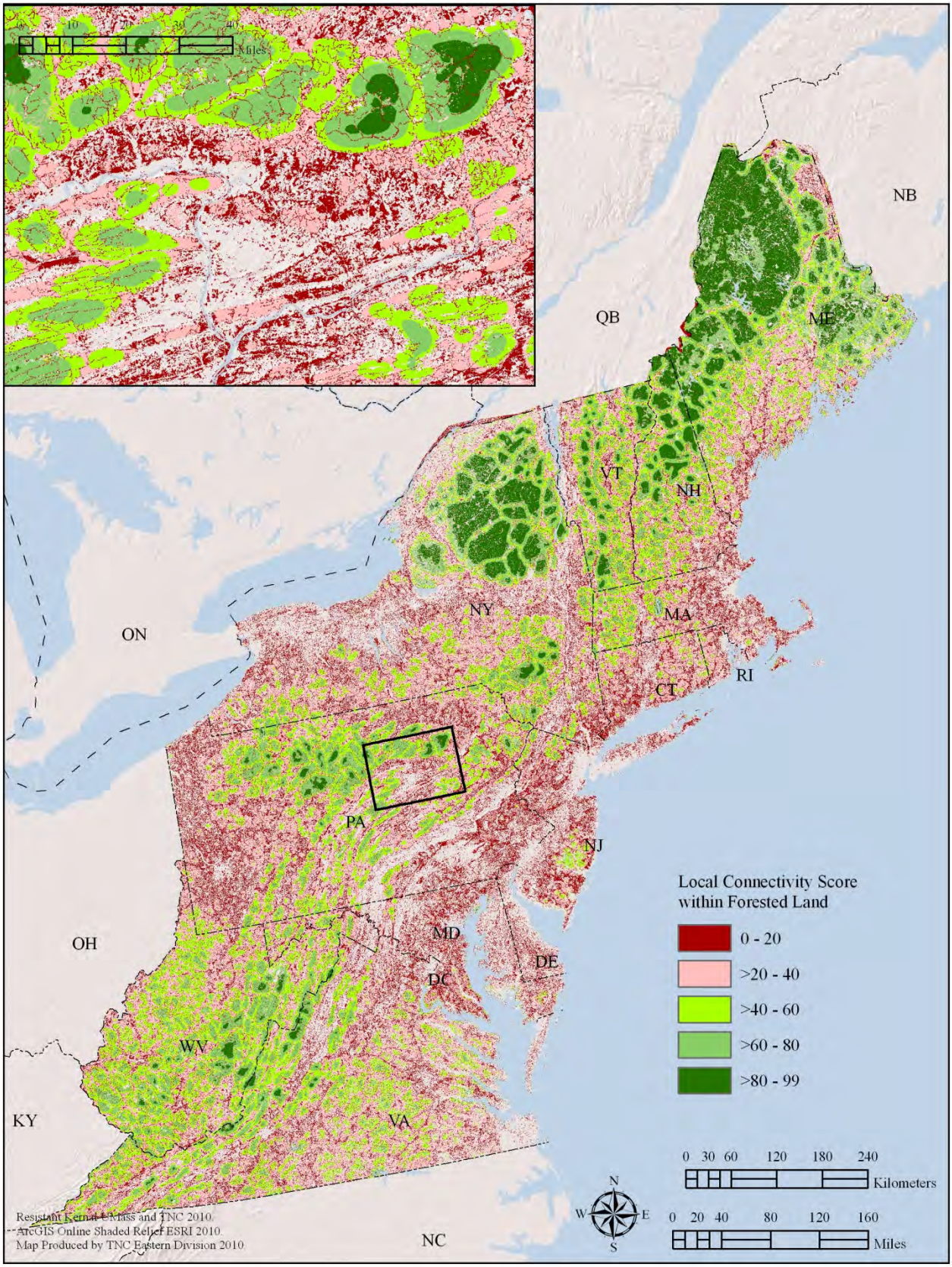
The three natural forest types differed markedly in their connectedness scores. Boreal upland forest scored the highest with a mean score of “66,” and the central oak-pine forest scored the lowest with a mean score of “31,” the latter score being similar to ruderal forest (Figure 7).

**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.

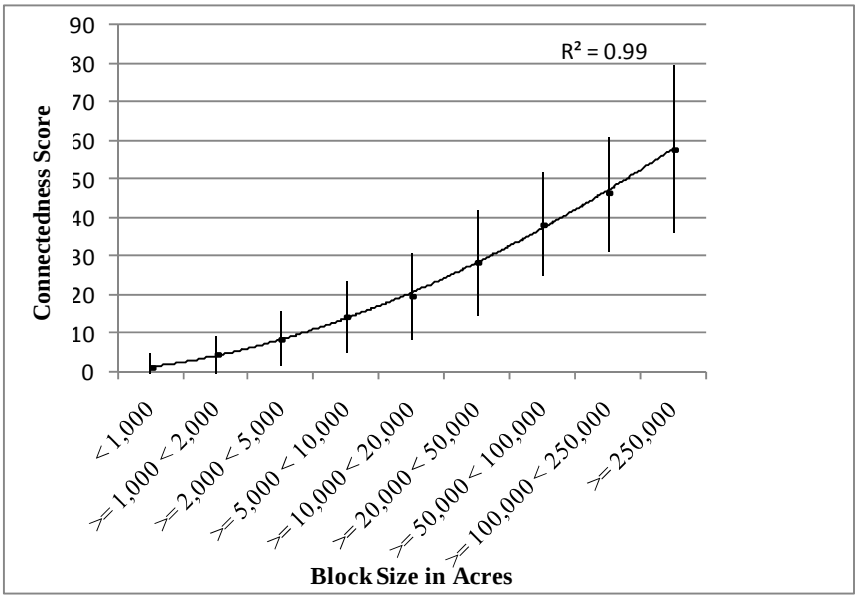


**Map 5. Local Connectedness.**



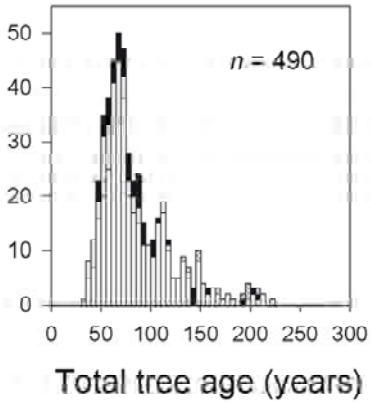
We found that the local connectedness scores were directly related to the forest block size such that connectedness increased at a faster rate as the blocks got larger (Figure 8).

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




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 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).




This information is for a single stand, and is not directly comparable to the composite charts presented later in this section. However, note the spikes and high frequencies of trees over 100 years of age.

Seedlings and regenerating saplings are not shown.

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 the available FIA samples for this region from USFS, with each plot 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 (5000 k buffer) to protect the actual location of the plot, so there may be error associated with these assignments; presumably the error was distributed evenly across the forest types so as not to skew the results.

**Specifics on the FIA data**: In total, we were provided with 11,352 samples, but not all plots were usable for each analysis so the actual numbers used are given with each result. The plots were collected between 2001 and 2006 in 13 states and were a mix of partial and complete cycles, with no repeat measures of the same plot. Three states (PA, NY, ME) accounted for 55 percent of the samples, with all other states making up 5 percent or less of the samples. Most of the plots were National FIA mapped plot design consisting of four fixed-radius subplots (4081) or Northeastern Station designs (4676). For individual trees, we only used information from the "Tree" table, and this restricts our data to stems over 1" in diameter, and 1' in height. FIA surveys include a "Seedling" table designed to sample regeneration of seedlings with diameters less than <1.0 inch including conifer seedlings are at least 6 inches tall and hardwood seedlings are at least 12 inches tall. Because we did not use this table, *information on seedlings and regenerating saplings under 1" diameter is not summarized here*. Samples were collected fairly close to roads, with 29 percent less than 1000 ft. from a road, 22 percent between 1000 ft. and 1 mile, and 4 percent over 1 mile. Distance to a road was not recorded for the remaining samples.

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," (STDAGE in Condition table: The average total age, to the nearest year, of the trees in the predominant stand-size class of the condition, determined using local procedures). We 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).

**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). This information based the field "STDAGE" in table of plot condition: defined as the average total age, to the nearest year, of the trees in the predominant stand-size class of the condition, determined using local procedures.

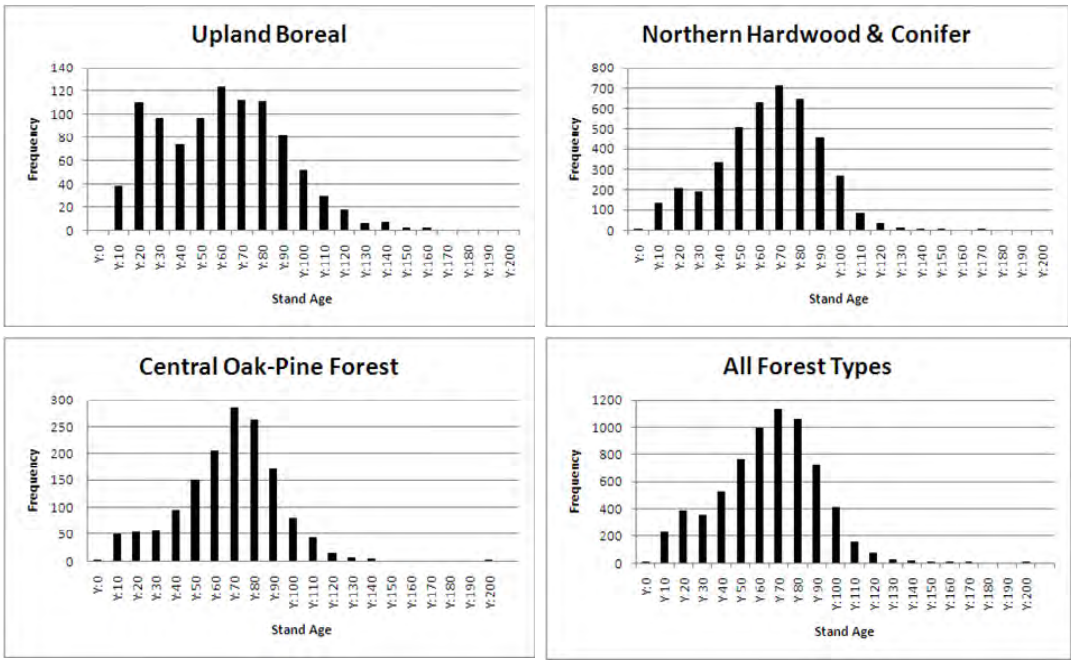
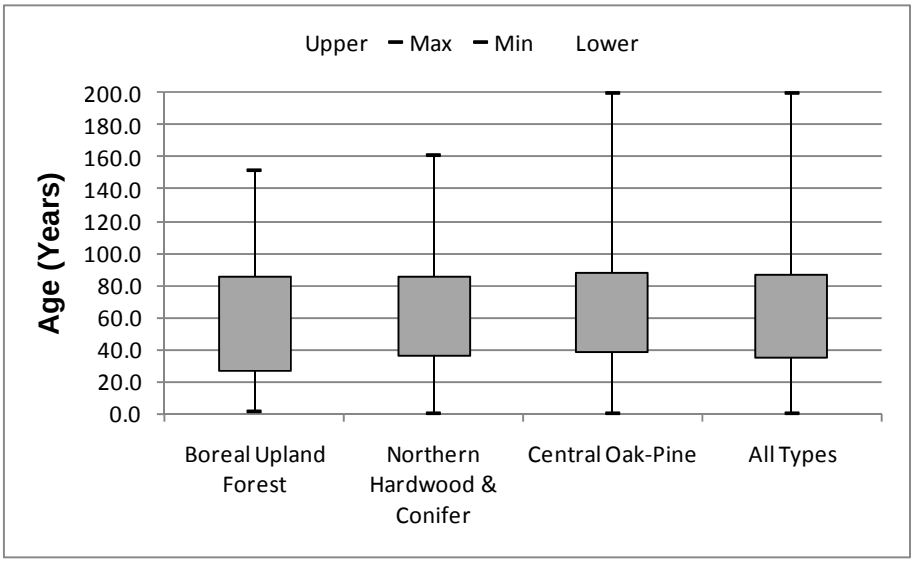
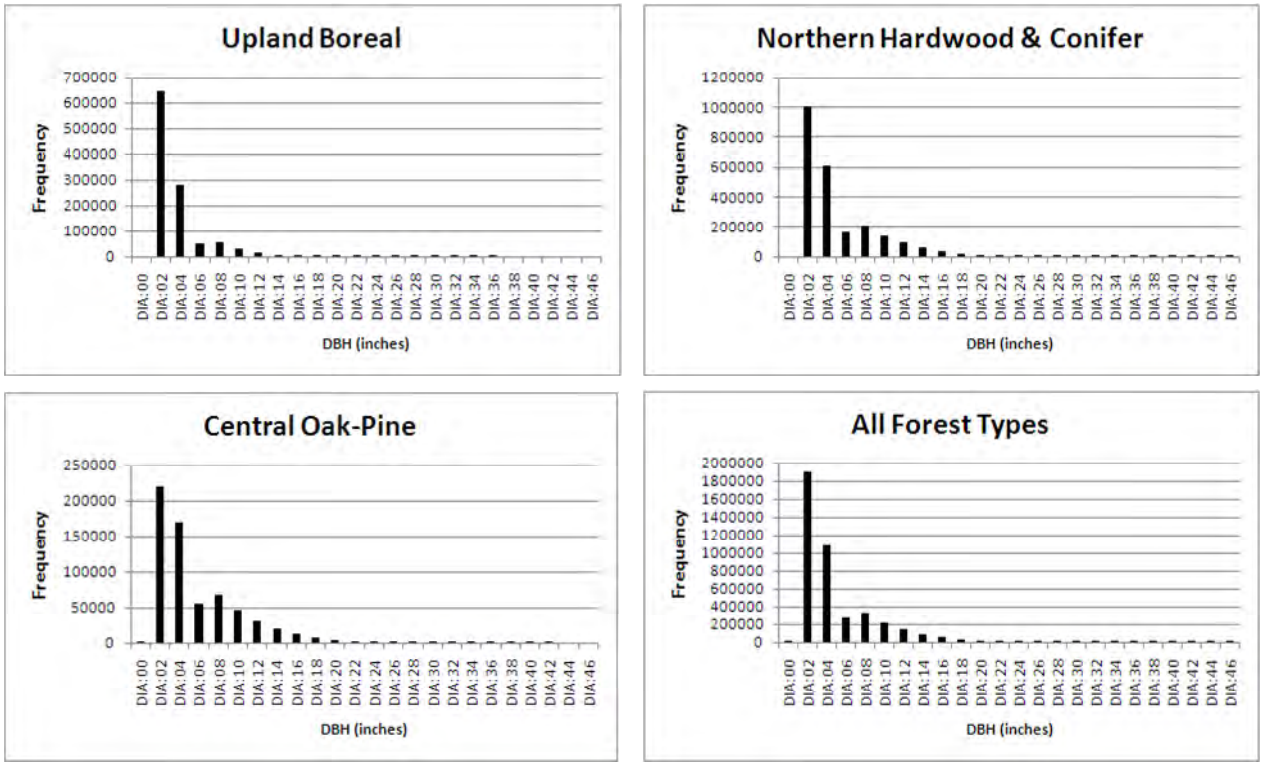



**Figure 11. Average stand age: Standard deviation and range of each forest types.** Mean ages are: Upland Boreal = 56.1, Central Oak-Pine = 62.9, Northern Hardwood = 60.6, All Forests = 60.4. Data sources as for Figure 10



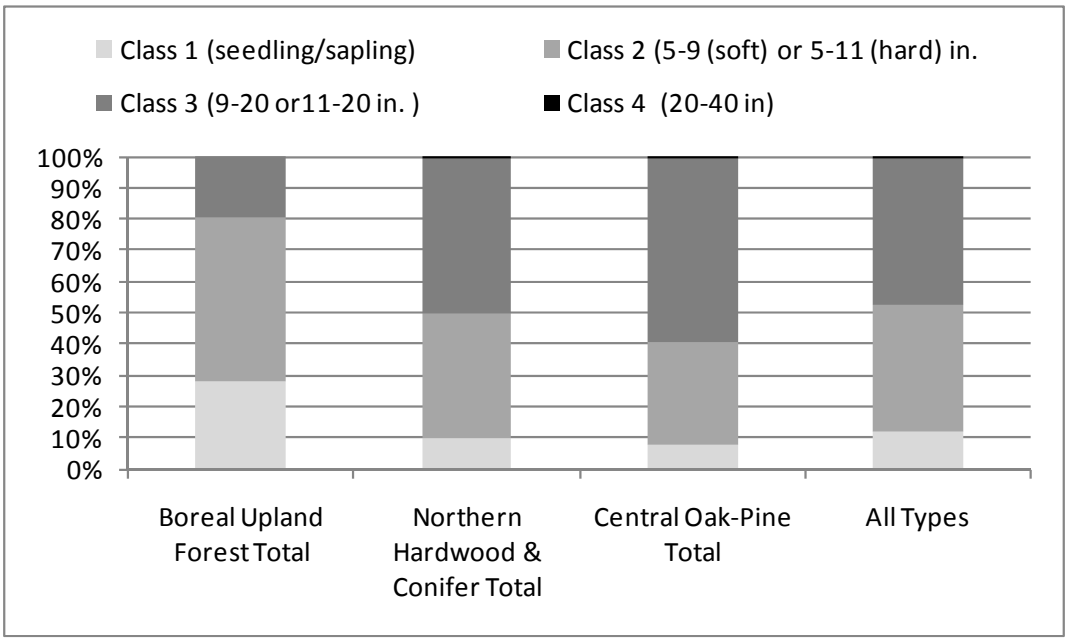
The size structure of forests is easier to measure in the field than the age structure, as the latter requires coring individual trees. Thus, the FIA data had more comprehensive information on size structure, and, because size is recorded along with each individual tree species, we could summarize the internal size structure for each sample. To summarize size we used the FIA field "current diameter" (DIA in the Tree Table: The current diameter -in inches- of the sample tree at the point of diameter measurement. All measurements were for breast height). To standardize these measurements to a one-acre unit, plot and micro-plot data was multiplied by the expansion factor given in the "trees per acre" field. Results of summarizing the size structure across all plots indicated that the forest stands were almost entirely composed of small trees: 3" to 4" in diameter (Figure 12). Across all forest types the most frequent size class was 3" in diameter, but the upland boreal forest had fewer classes over 11" Although size is not necessarily related to age, the size structure patterns corresponded with the patterns of age structure.

**Figure 12. Stand level size structure of forests in the Northeast and Mid-Atlantic.** The figures are based on the field "diameter" (DIA) in the FIA Tree table: defined as the current diameter - in inches - of the sample tree at breast height (DBH). Information is for all trees over 1" in diameter or 1' in height. 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). *Regenerating seedlings and saplings under 1" diameter and 10' in height are not included in these charts*.



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." (FLDSZCD in the Condition table: stand-size class assigned by the field crew). A classification of the predominant (based on stocking) diameter class of live trees within the condition; ranging from 0 = Non-stocked and 1 = 1-4.9 to 5 = >40+ inches). 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 usable 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 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.



Forest Disturbance: 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.

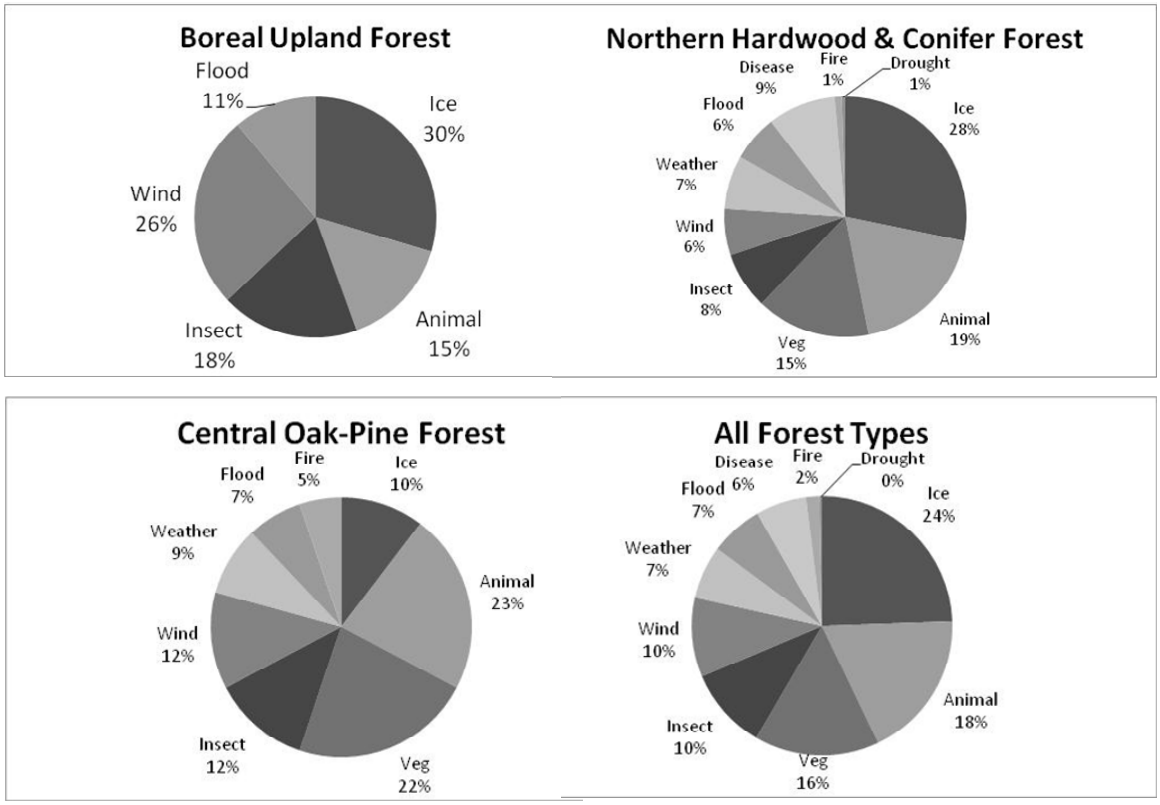
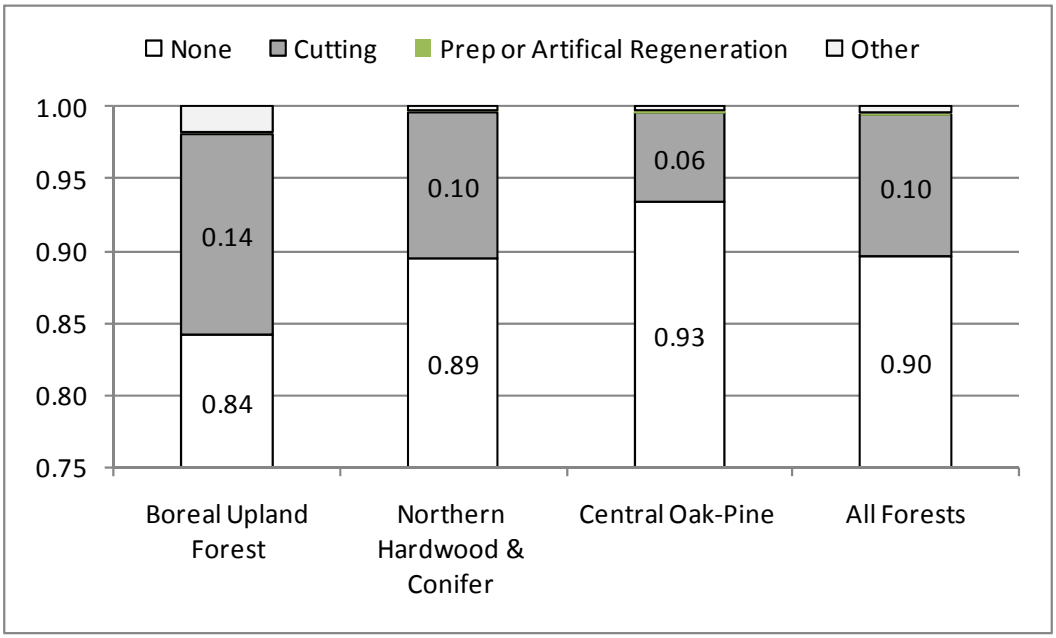



**Figure 15. Percent harvest by forest type.**



## 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 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.

**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, DI = Declining and Increasing, 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 |

Northern Hardwood and Conifer Forest: 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, DI = Declining and Increasing, 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, DI = Declining and Increasing, 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 |

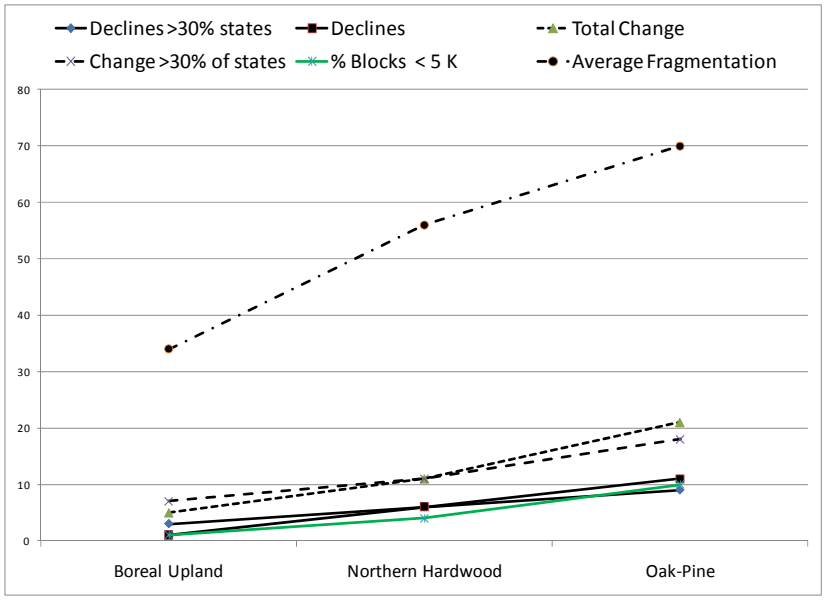
## Synthesis of Species Data with Forest Condition

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 can only hint at possible relationships because we did not correct for state size, inventory effort, or the ease with which particular species can be monitored. Never-the-less changes to breeding birds appeared to be most extensive in the oak-pine forest, and changes across the three forest types were correlated with increasing forest fragmentation (Figure 15). Degree of harvest was less correlated with changes in bird abundances suggesting that logging may have a less dramatic effect of bird populations than fragmentation. This question, however, needs further research.

**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.

| | Species Change in >= 3 States | | | Species Change in >= 30 % of All Possible States | | | Average stand age | % Blocks >250 K | % Blocks < 5 K | Average Connectness |
|---|---|---|---|---|---|---|---|---|---|---|
| Forest Types | 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 and average fragmentation (calculated as the inverse of local connectedness, or as the % of blocks under 5000 acres).**



## 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.**

Compton, Brad. 2010. Resistant Kernal. 90m cell. University of Massachusetts. 2010.

DeGraff, R. M., and M. Yamasaki. 2001. New England Wildlife: Habitat, Natural History and Distribution. University Press of New England, Hanover, NH.

Foster, David. 2010. Changes in forest cover, population, and wildlife composition over the last three centuries. Unpublished presentation.

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.

LANDFIRE: LANDFIRE 1.1.0. 2009. Existing Vegetation Type layer. U.S. Department of Interior, Geological Survey. [Online]. Available: http://landfire.cr.usgs.gov/viewer/ [2010, October 28].

McCarthy, J. W. and G. Weetman. 2006. Age and size structure of gap-dynamic, old-growth boreal forest stands in newfoundland. Silva Fennica **40**(2)**:**209-230.

Poole, A. and F. Gill, (eds) 1992-ongoing. The Birds of North America Online. Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/

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.

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

## 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 |

CHAPTER

# Wetlands

5

## 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 secured primarily for nature.

**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 bird 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.

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% |

Marshes: 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).

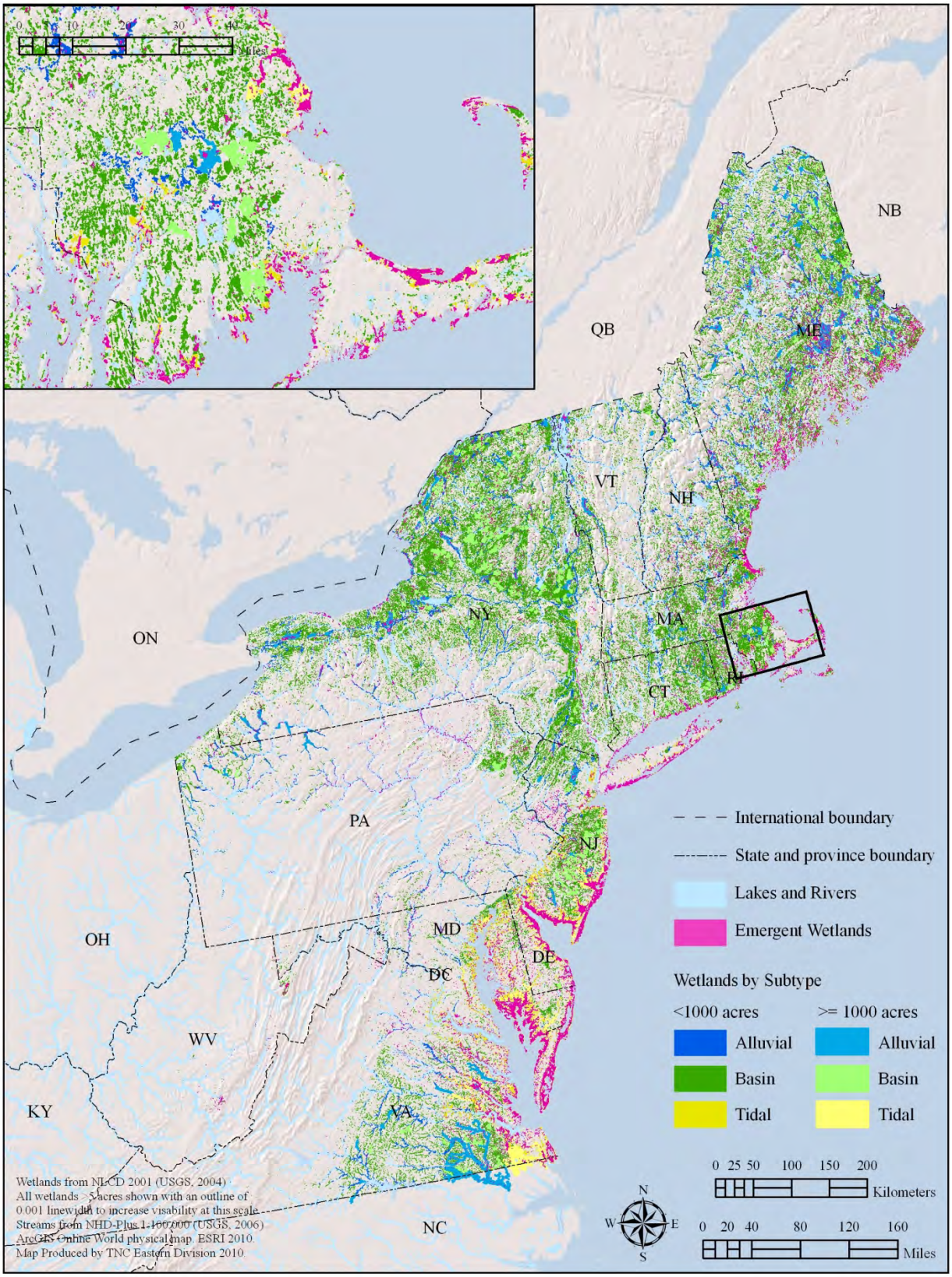
***Basin marshes*** are the most numerous type of herbaceous wetland, and were found throughout the region in depressions where water collects and organic matter accumulates. Eighty percent are under 1,000 acres in size, and collectively they cover almost half a million acres. They sustain an abundant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

Forested Swamps: 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.

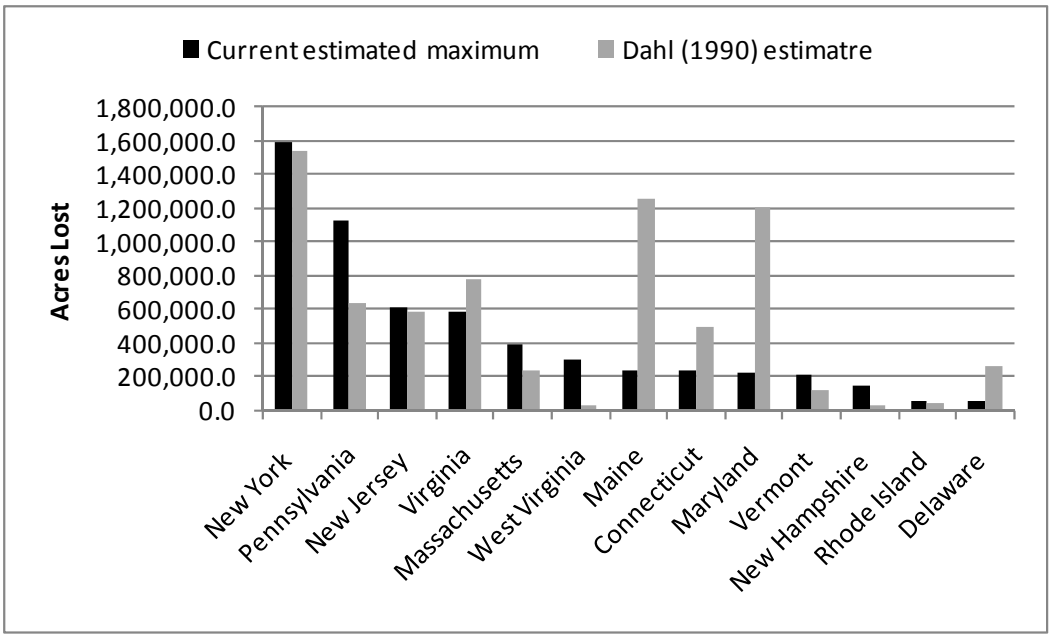
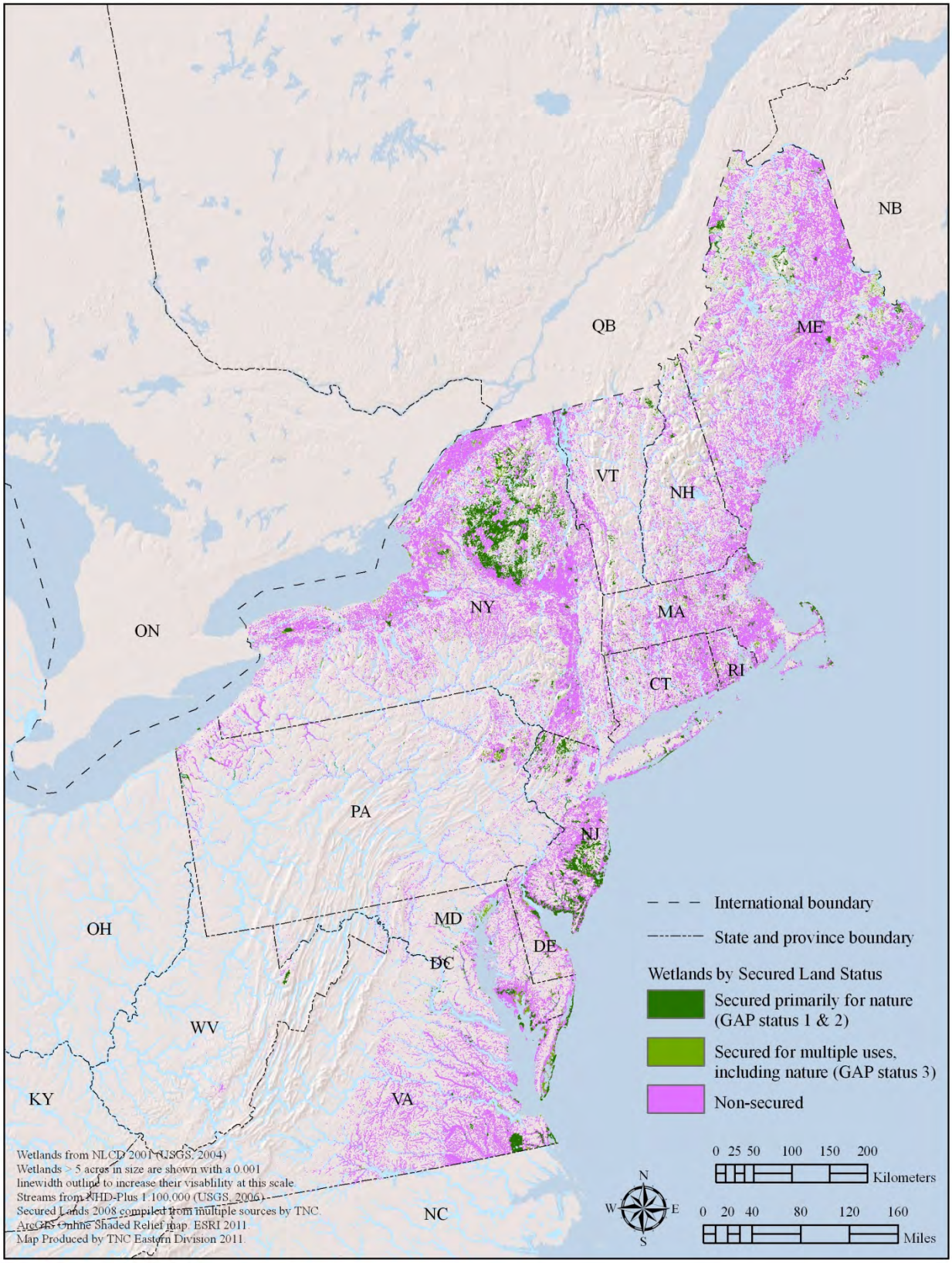



**Table 1. Amounts of conversion and securement**. The units are in acres, organized by wetland type. The term "securement" refers to GAP status 1-3 and "secured primarily for nature" to GAP 1-2 only. The ratio of conversion to **S**ecurement (CRI-**S**) or to land secured **P**rimarily for nature (CRI-**P)**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

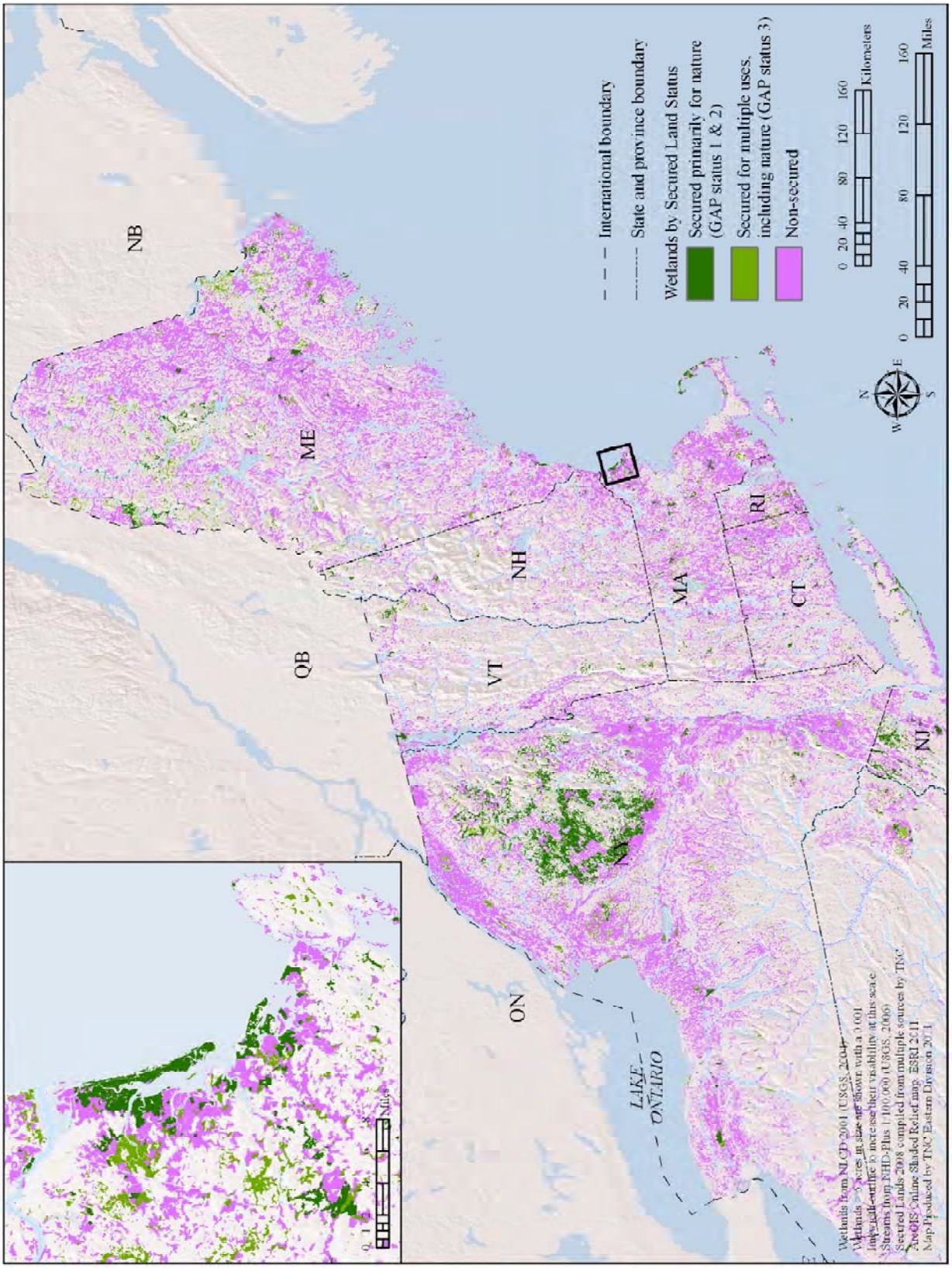
| Types | Agriculture | %A | Developed | %D | Gap 1-2 | %G1 | Gap 3 | %G3 | Un-secured | %U | Total Current | Total Historic | % C | % S | CRI-S | CRI-P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tidal | 119,202 | 0.07 | 222,445 | 0.13 | 359,046 | 0.20 | 227,008 | 0.13 | 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** |

<u>Conversion versus Securement:</u> 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 current wetlands (19 percent of historic) now occur on land that is either secured primarily for nature (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 securement for nature 1:1. The situation is different for other wetland types. For basin wetlands conversion exceeds securement about 2:1 and securement for nature 3:1. Alluvial wetlands are the most converted and least secured with conversion exceeding securement 2:1 and outweighing securement for nature 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.**

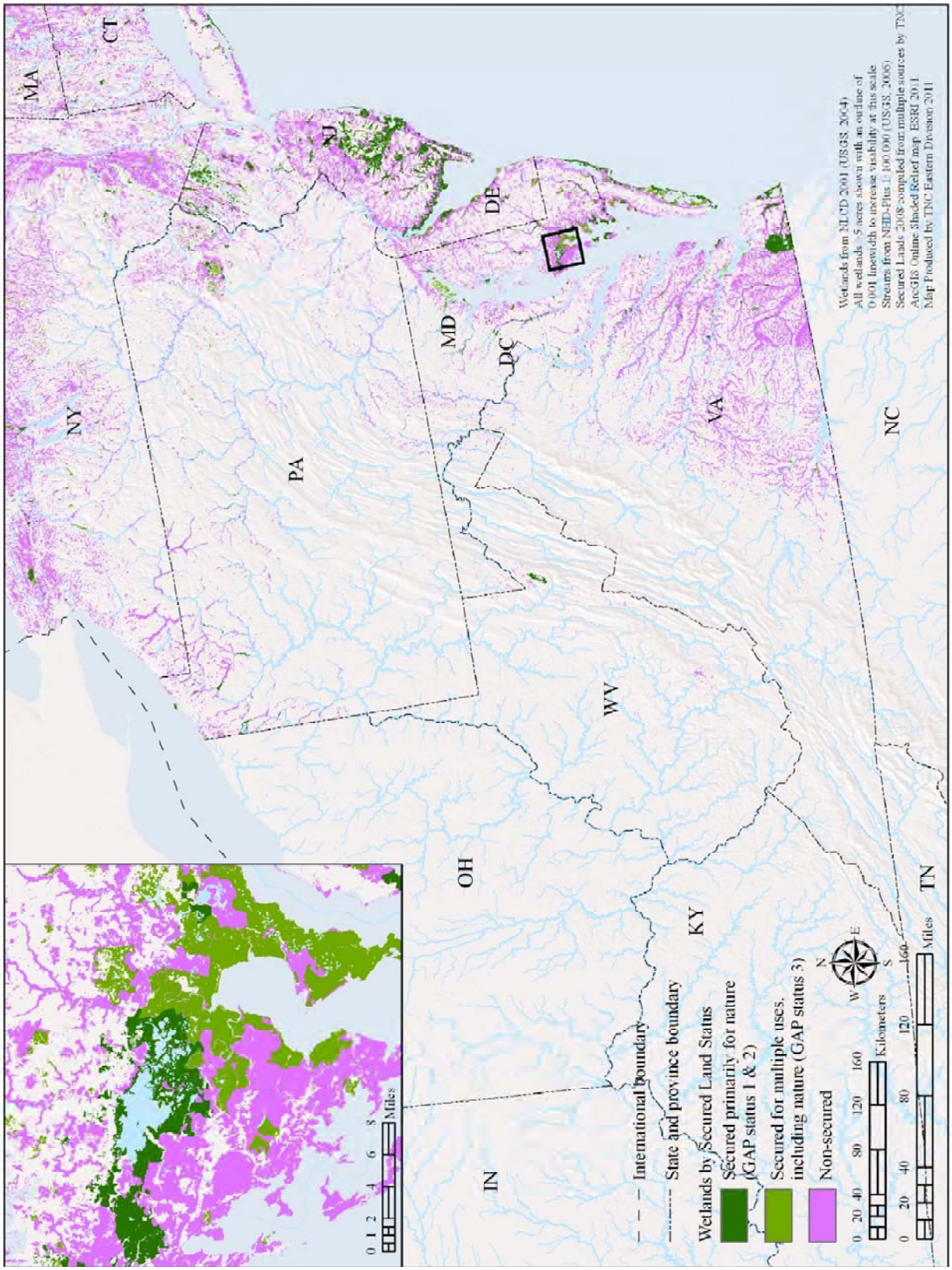
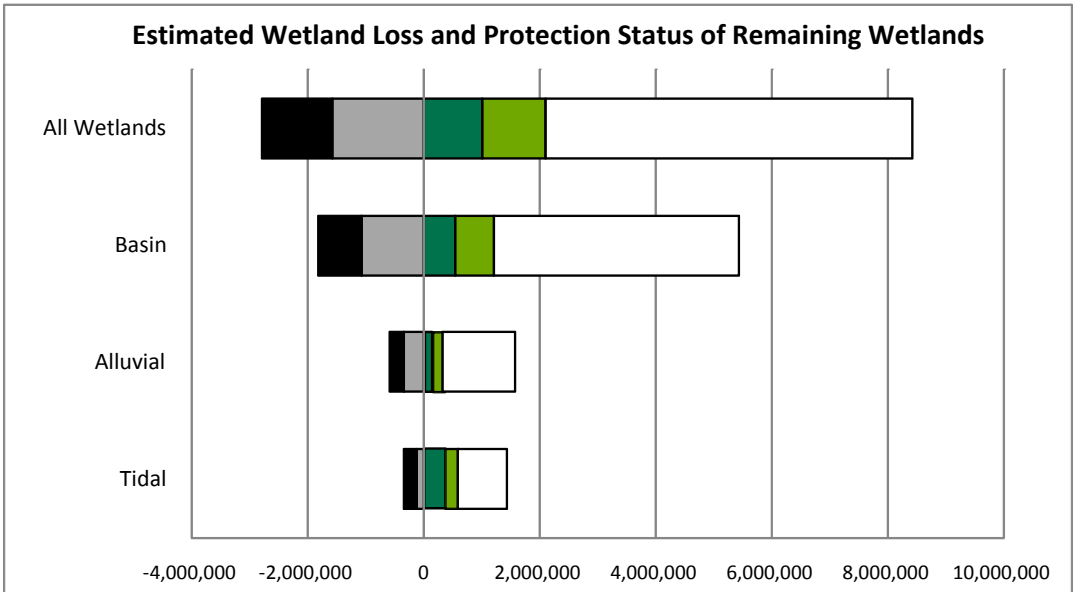


**Figure 2. Estimates of historic wetland conversion to agriculture or development compared with the current status of wetland protection.** Protection is defined as wetlands secured against conversion primarily for nature (GAP 1 or 2) or multiple uses (GAP 3). Each bar represents 100 percent of the 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.

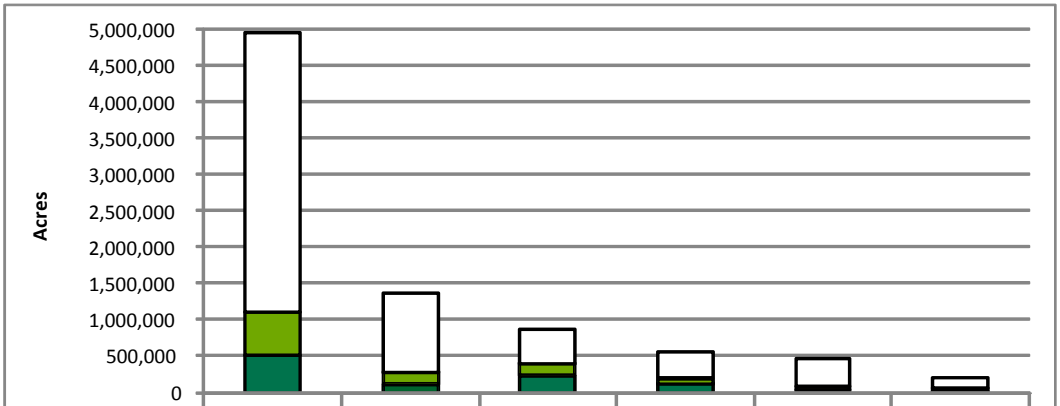



| | Tidal | Alluvial | Basin | All Wetlands |
|---|---|---|---|---|
| Agriculture | -119,202 | -338,004 | -1,074,815 | -1,579,431 |
| Developed | -222,445 | -251,889 | -745,886 | -1,206,335 |
| Wetlands: Gap 1 & 2 | 359,046 | 121,888 | 535,418 | 1,016,352 |
| Wetlands: Gap 3 | 227,008 | 194,541 | 666,621 | 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 secured primarily for nature, so conversion exceeds securement for nature 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 secured primarily 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.

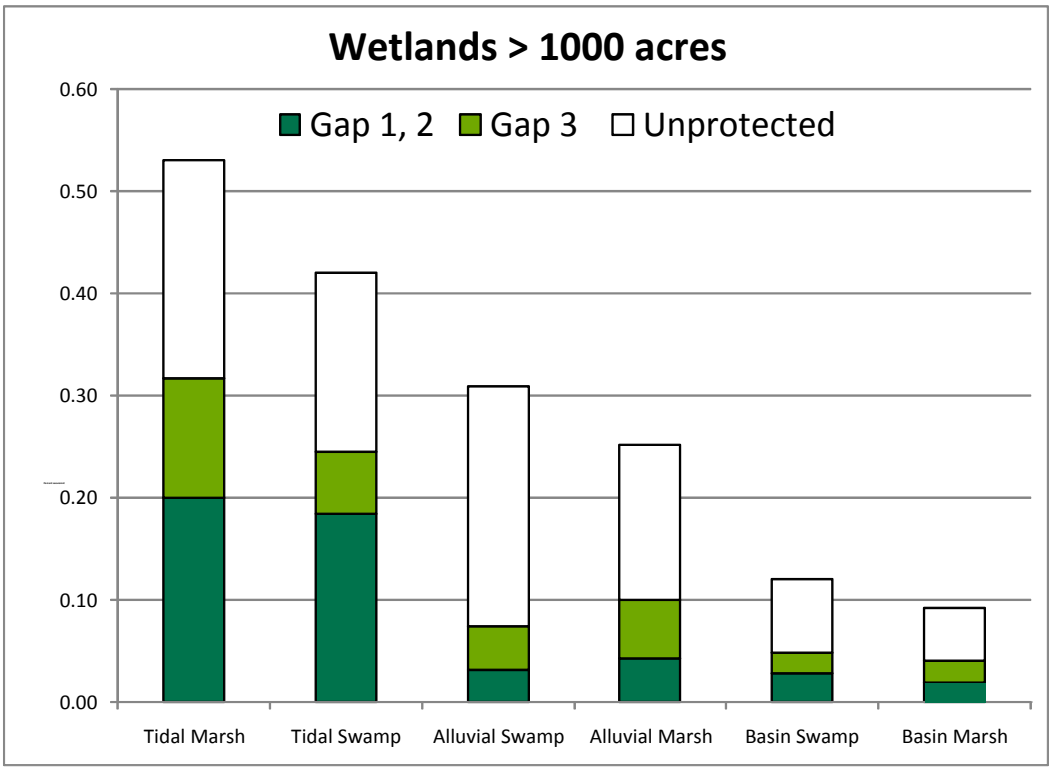


**Table 3. Conservation status by size and securement types.** These numbers reflect the remaining wetland area and do not account for the historic distribution.

| | 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.**

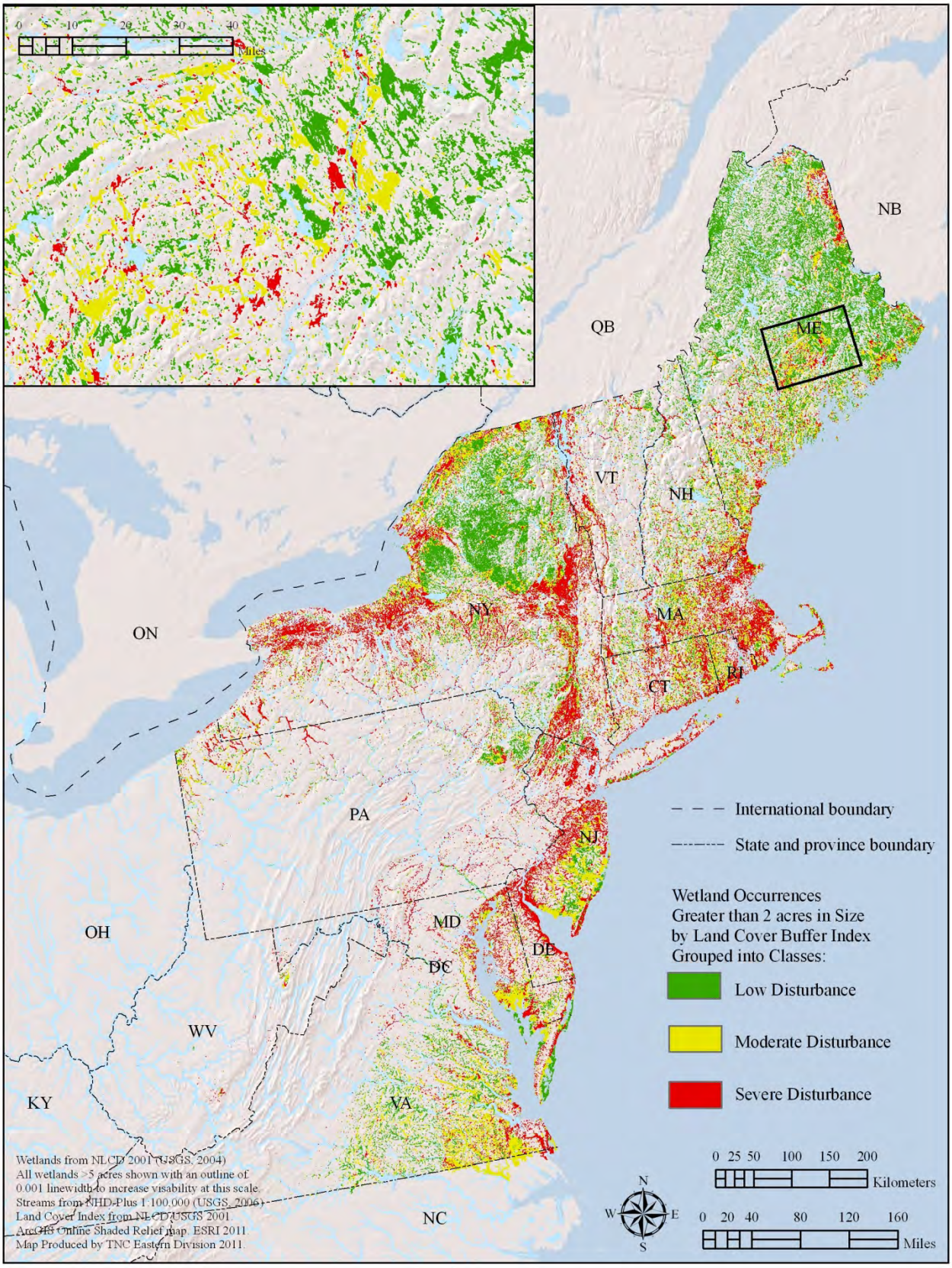
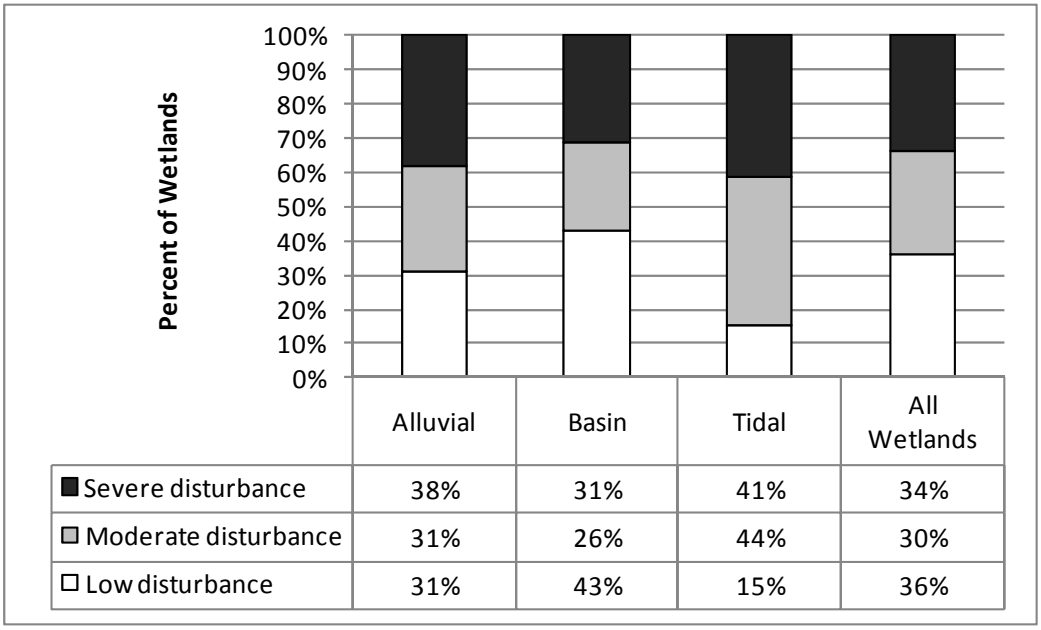


**Table 4. Percent of wetland acreage in each impact class across wetland types and subregions.**

| 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.




Road Density: 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

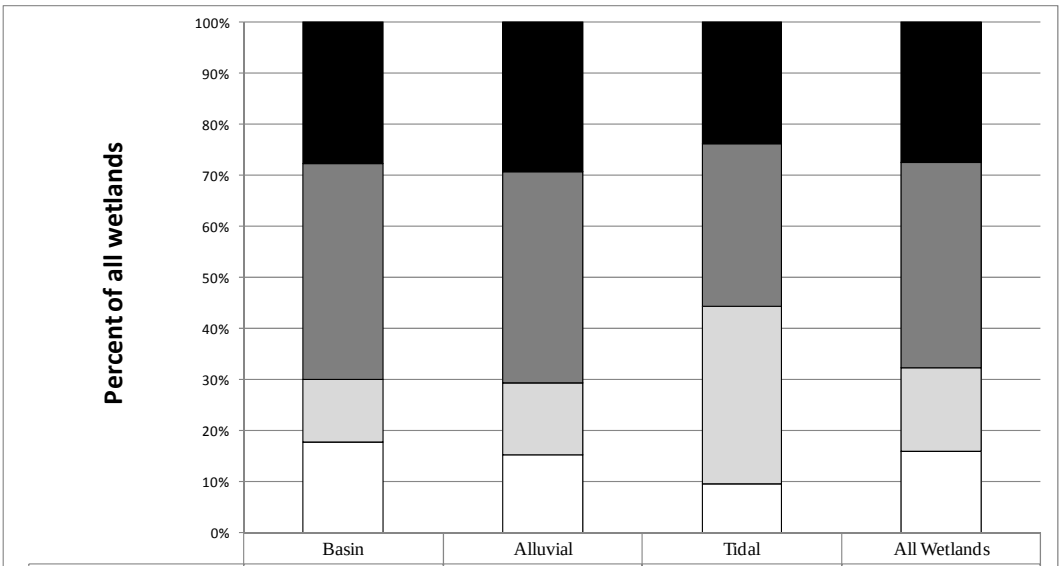
in the region. Subsequently, we calculated the mean road density value for each wetland by taking the average of all pixels within each occurrence. This method takes into account roads in the buffer zone as well as the total size of the wetland, so that large wetlands show fewer impacts from roads.

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)

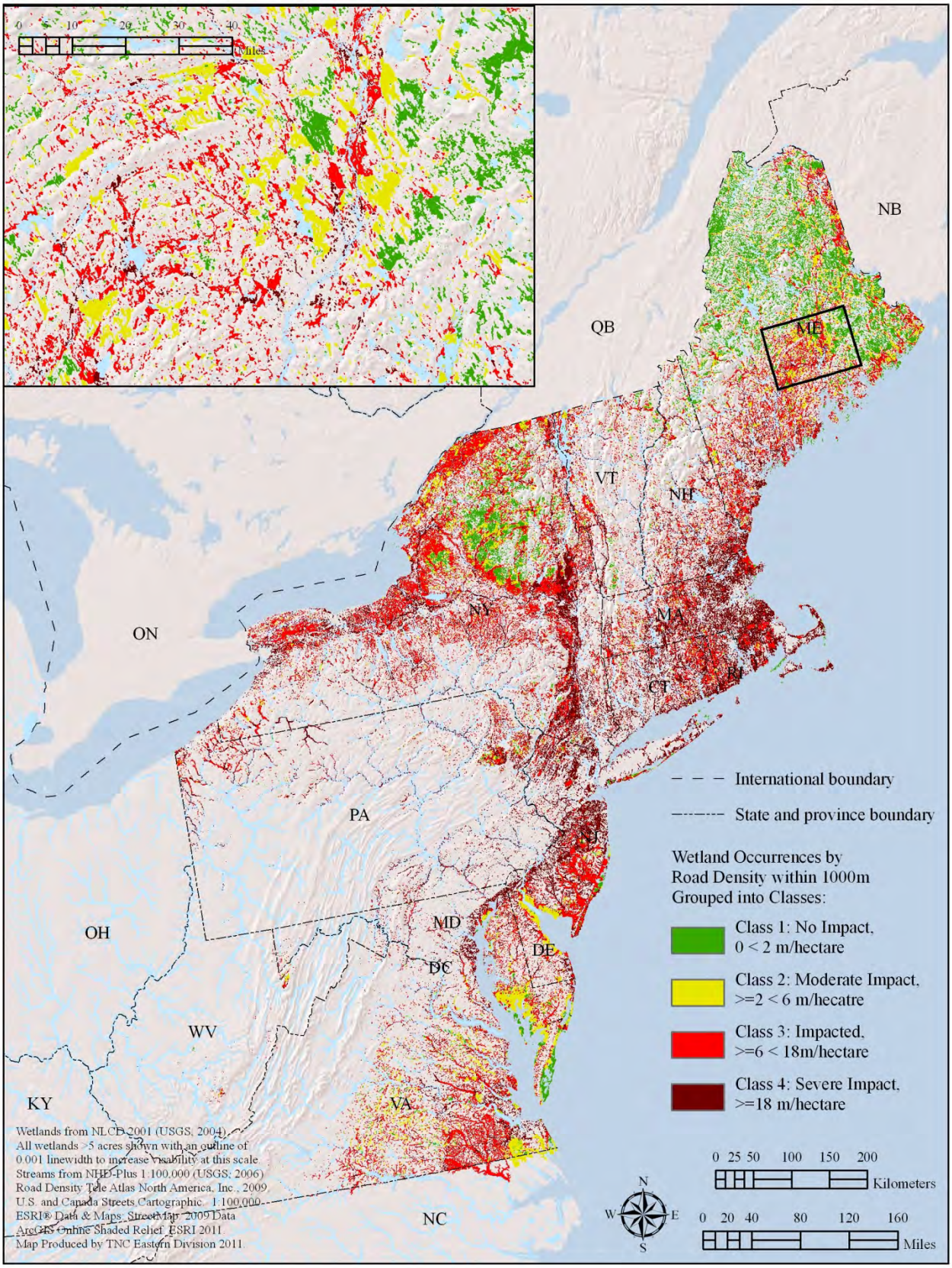
The results of applying the index to all wetlands indicated that only 16 percent of all wetlands in this region were free of road impacts. Sixty-seven percent were in the impacted to severe impact categories, suggesting that most wetlands in the region do not support a full complement of native species. 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% |

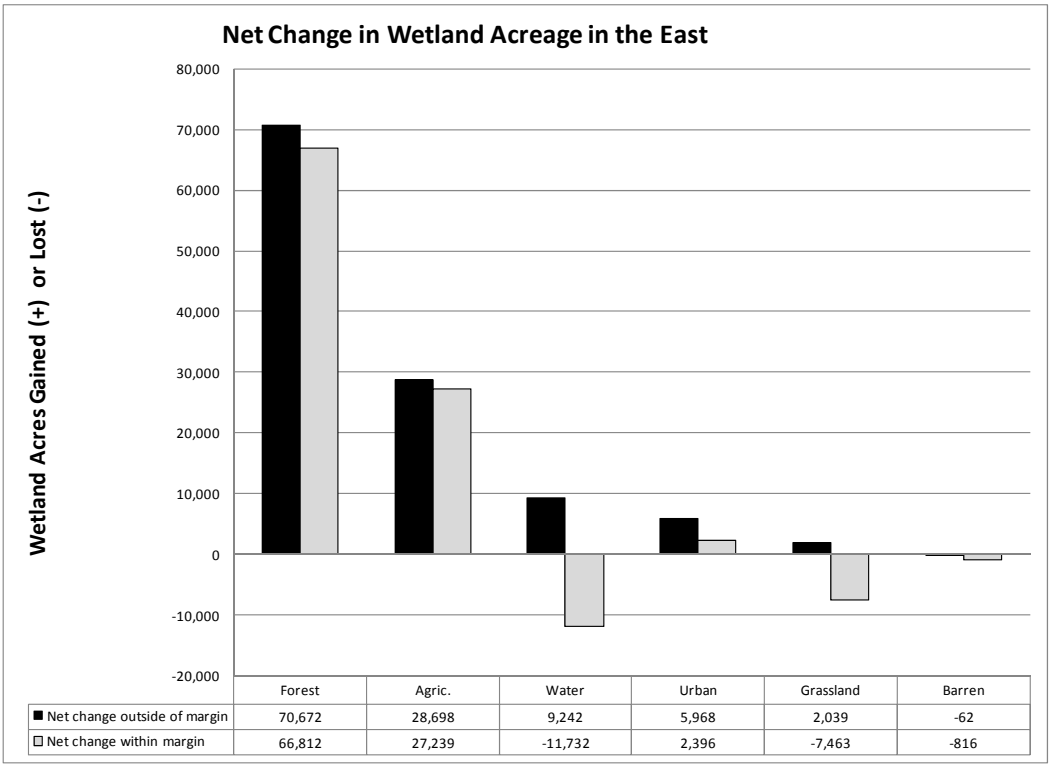
**Map 6. Wetland occurrences by road impact category.**



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.

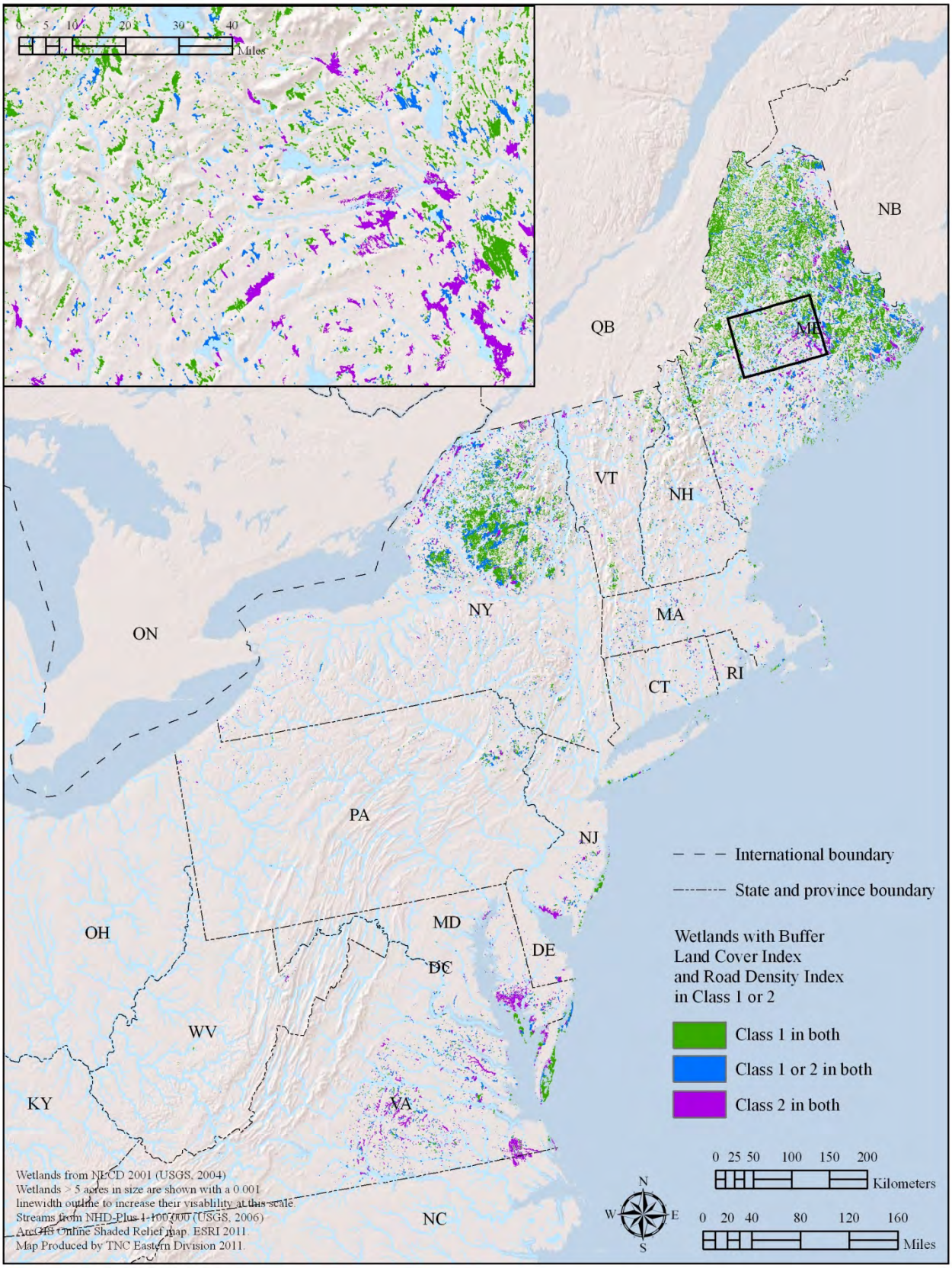
Changes in Wetland Acreage over Time: Over the last two decades, the region has seen both losses and gains in wetland acreage. The National Land Cover Database (NLCD) 1992–2001 Land Cover Change Retrofit Product (Fry et al. 2009) was developed to provide a more accurate and useful land cover change dataset. 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)




| | Forest | Agric. | Water | Urban | Grassland | Barren |
|---|---|---|---|---|---|---|
| Net change outside of margin | 70,672 | 28,698 | 9,242 | 5,968 | 2,039 | -62 |
| Net change within margin | 66,812 | 27,239 | -11,732 | 2,396 | -7,463 | -816 |

**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.**

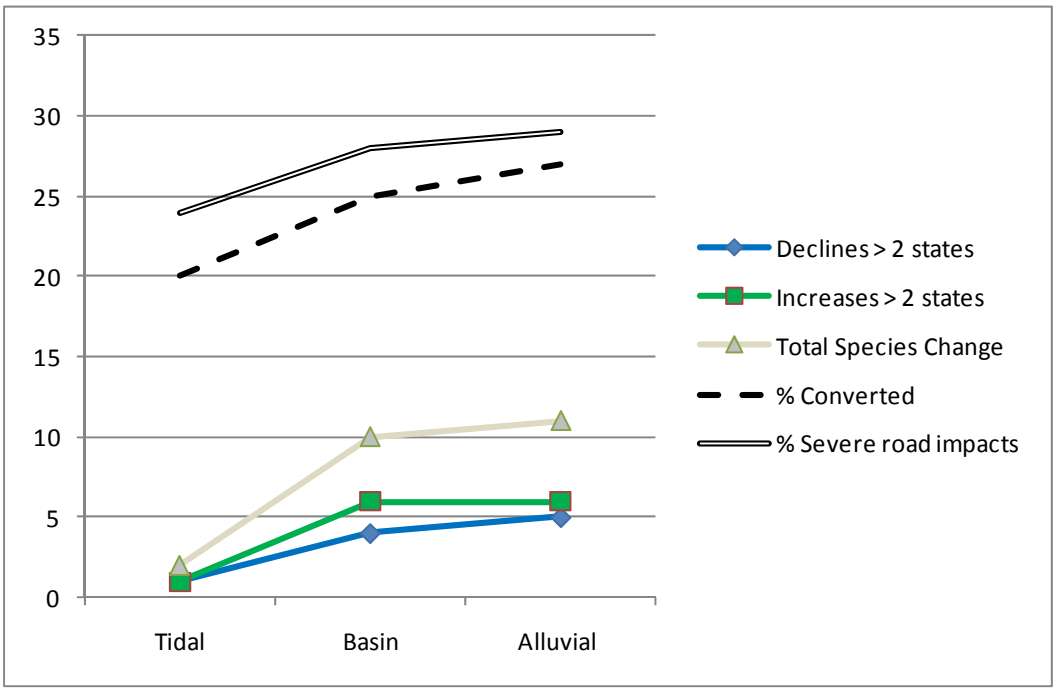


**Table 9. Species that have consistently declined or increased in five or more states.**

| 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.**

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. 2006b. The North Atlantic Coast: Ecoregional Assessment, Conservation Status Report and Resource CD. The Nature Conservancy, Eastern Conservation Science, Boston, MA.

Dahl, T. E. 1990. Wetlands losses in the United States 1780's to 1980's. Washington, D.C: U.S. Department of the Interior, Fish and Wildlife Service.

Ferree, C. 2008. Ecological Land Units. Version 11/2008. The Nature Conservancy Eastern Conservation Science Office. Boston, MA.

Findlay, S. and Houlahan, J. 1997. Anthropogenic Correlates of Species Richness in Southeastern Ontario Wetlands. Conaservation Biology, Vol. 11 No. 4. Pp 1000-1009

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.

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.

Mitsch, W. J., Gosselink, J. G. (1986). Wetlands. New York: Van Nostrand Reinhold Co..
Poole, A. and Gill, F. (eds), 1999-ongoing. Birds of North America. 1992-2010. Species accounts. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D. C.

Reed, Jr., Porter B. 1988. National List of Plant Species That Occur in Wetlands: National Summary. U.S. Fish & Wildlife Service. Biol. Rep. 88 (24). 244 pp.

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

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/

Sheldon, A. O. 2009. Active River Area. 30m. The Nature Conservancy Eastern Conservation Science. Boston, MA.

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.

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.

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.

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

| 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 |
| **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 | 5702.39 | 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 | | | | 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 |
| **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

April 2011

M. Anderson and A. Olivero Sheldon

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, securement for nature was equal to, or greater than, conversion on granite settings, on summits and cliffs, and at high elevations. In stark contrast, habitat conversion exceeds securement for nature 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 attention.

**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:

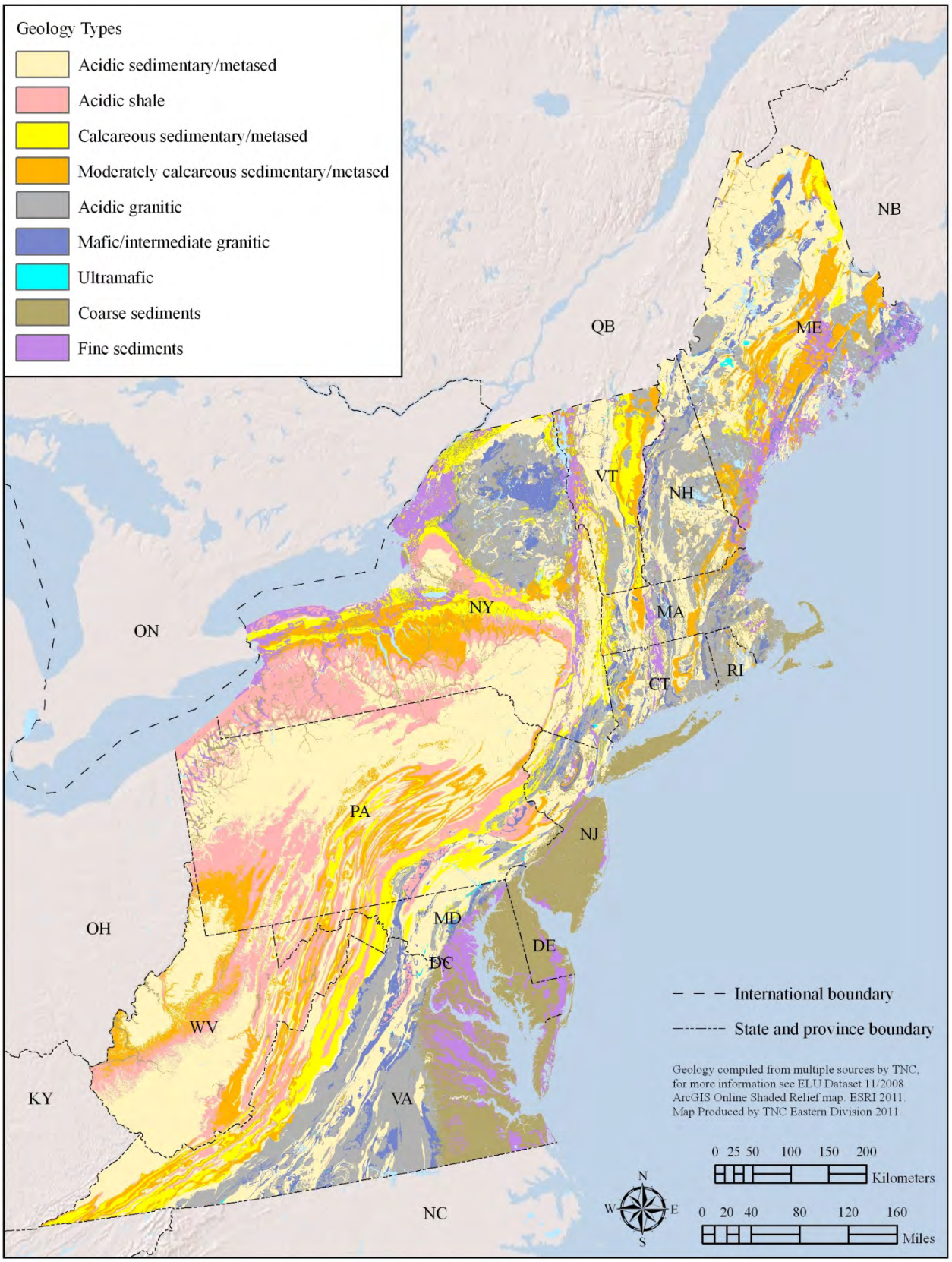
The unique habitats include:

- 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)

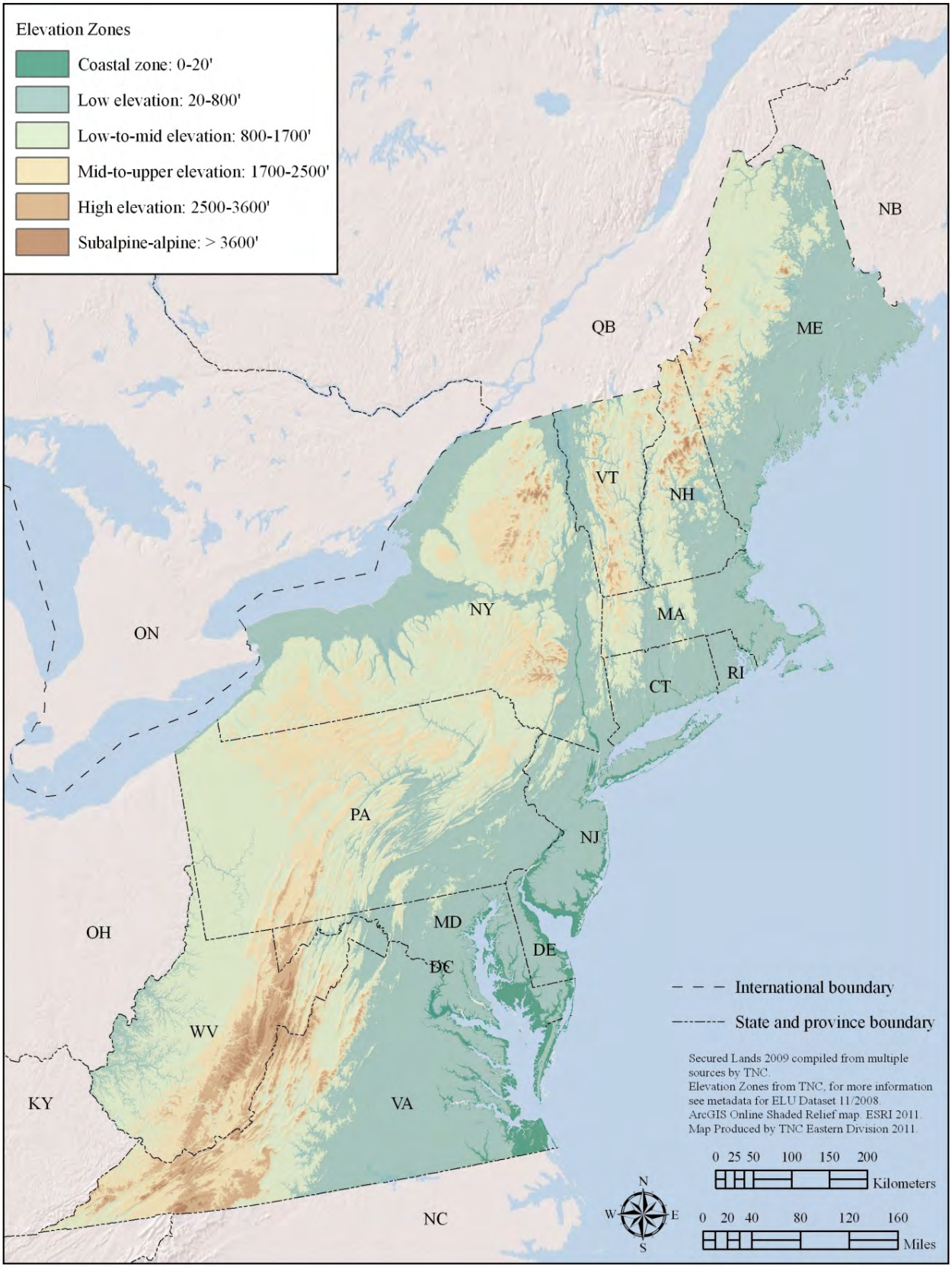
To evaluate the biodiversity associated with each setting, we compiled information on the location of natural communities and rare species tracked by the 14 State Natural Heritage programs. We overlaid the locations on geology, elevation and landform maps, and summarized the patterns to characterize 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.

Calcareous Settings: 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**

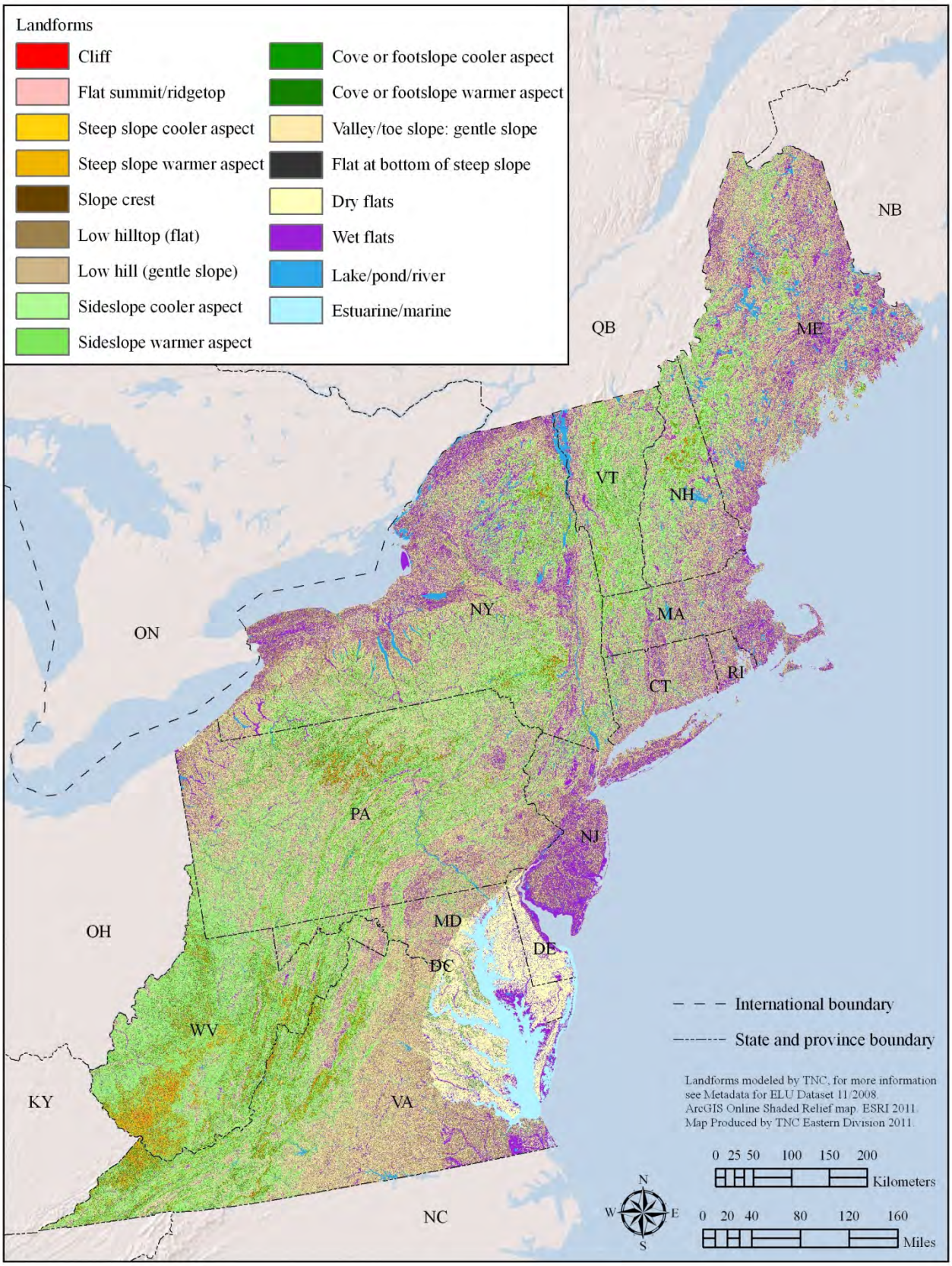


**Table 1. Communities and species associated with calcareous settings in this region.** Restricted species have over 50 percent of their locations found in this setting based on 4 or more occurrences.

| 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 |

Moderately Calcareous Settings: 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 |

Shale Settings: 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).

**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 secured 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 |

Mafic Settings: 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 |

Ultramafic Settings: 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.

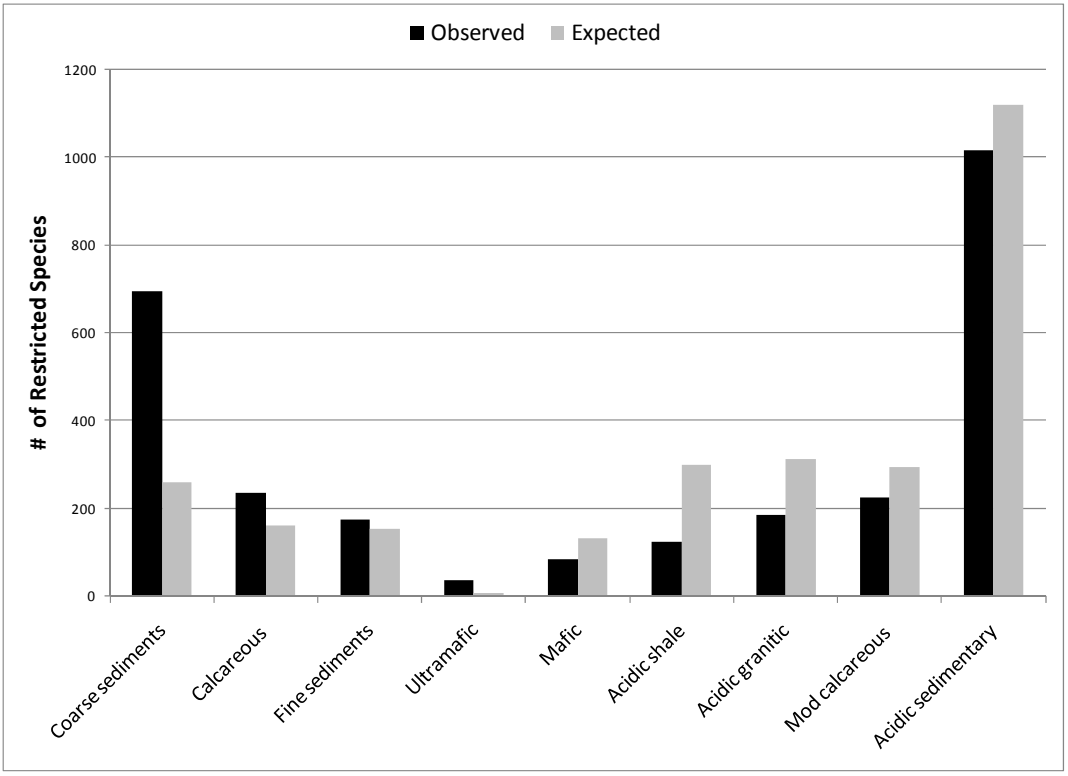



**Table 10. The number of more-than-expected restricted rare species arranged by taxonomic group and geology class.** O-E indicates the number of observed species ("O") on the geology class minus the number of expected species ("E") Positive numbers indicate more species than expected, and the All-Count 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 securement for nature 51:1 the highest of any setting in the region. Coarse-grained settings were the next most converted, but had higher levels of securement: 43 percent converted and 11 percent secured, a 4:1 ratio, and a conversion to nature securement ratio of 8:1. Fine–grained settings with

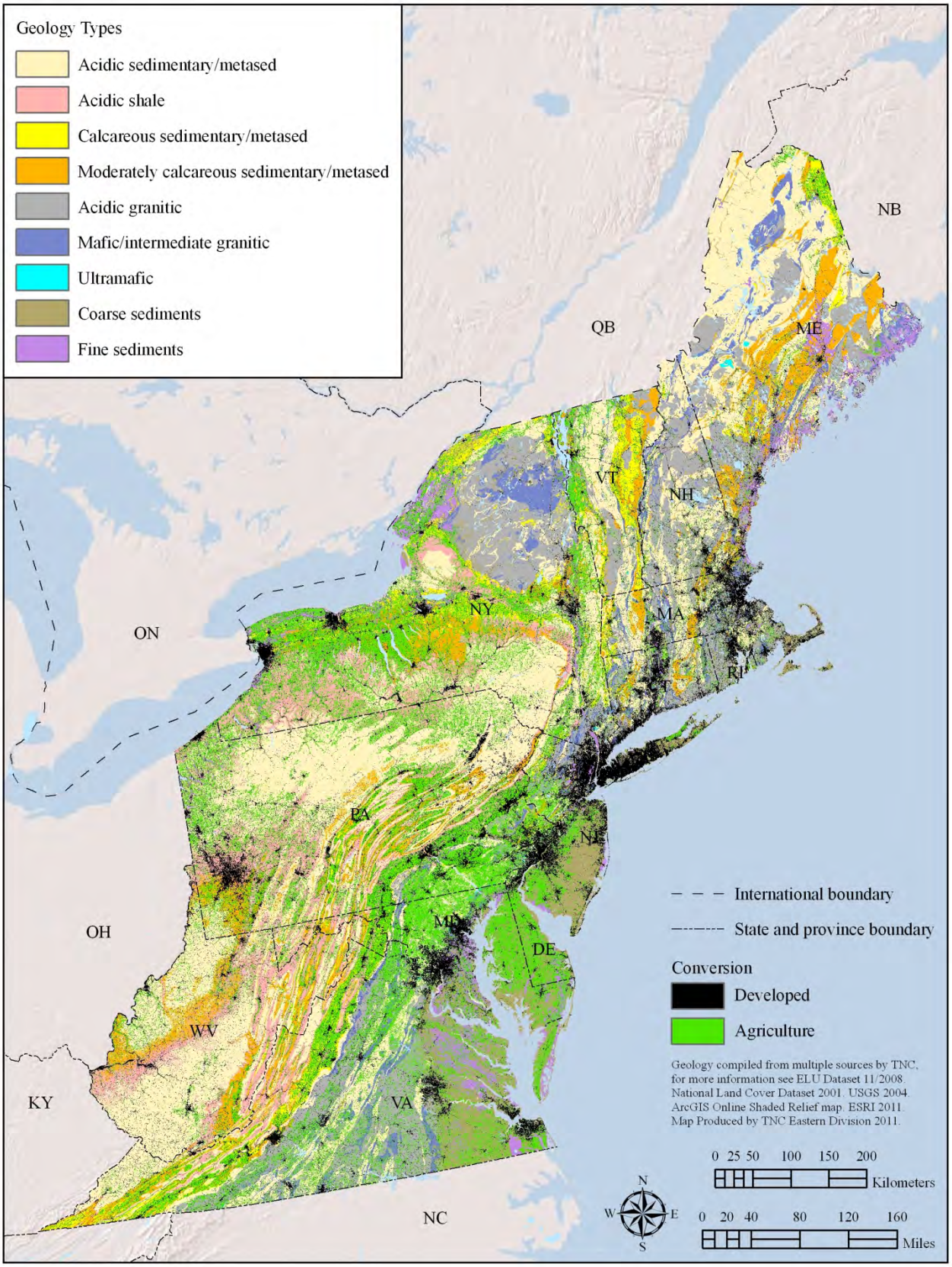
38 percent converted to 8 percent secured were at higher risk 5:1, and conversion exceeded securement for nature 11:1. Acidic shale was also at high risk, having a conversion to securement ratio of 4:1 and a conversion to securement for nature ratio of 29:1. Conversion in ultramafic settings had a 3:1 ratio to securement and a 6:1 ratio to securement for nature. In 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.** This chart gives the proportions of conversion and securement in each setting. CRI-S is the ratio of conversion to securement (GAP 1-3) and CRI-P is the ratio of conversion to securement primarily for nature (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.**

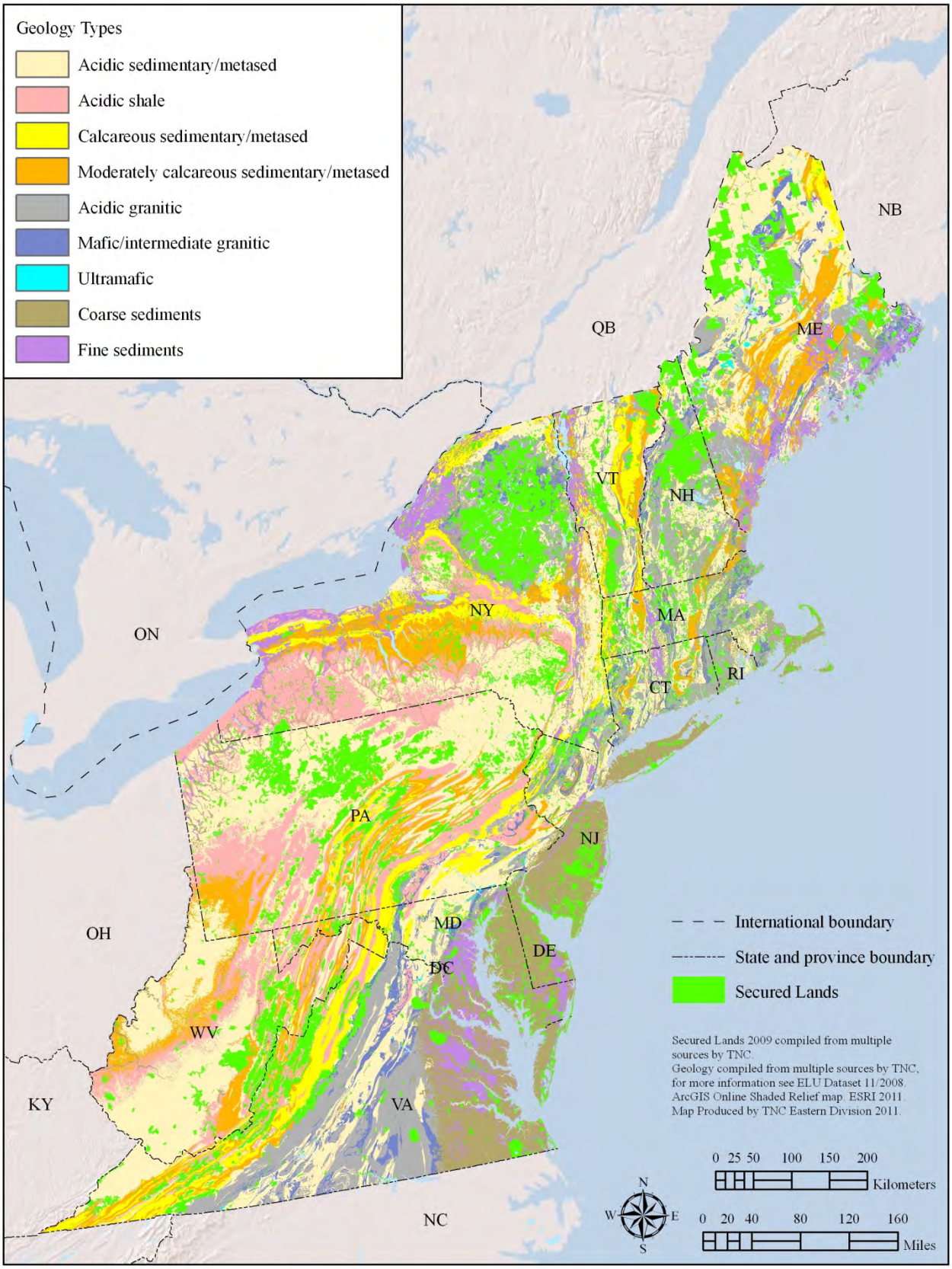
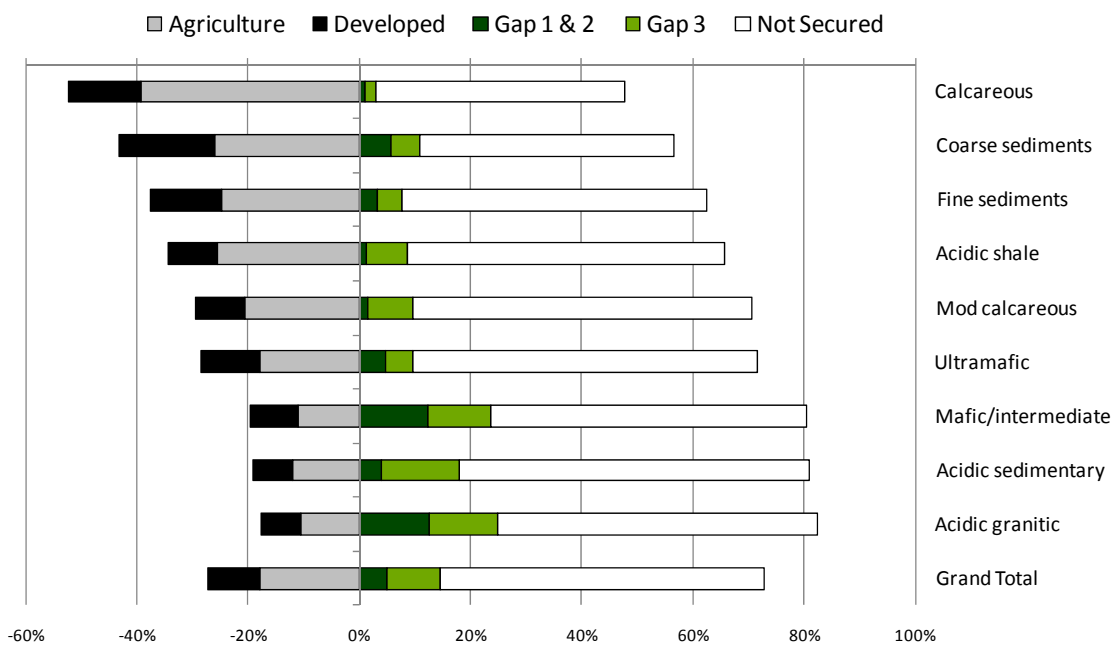
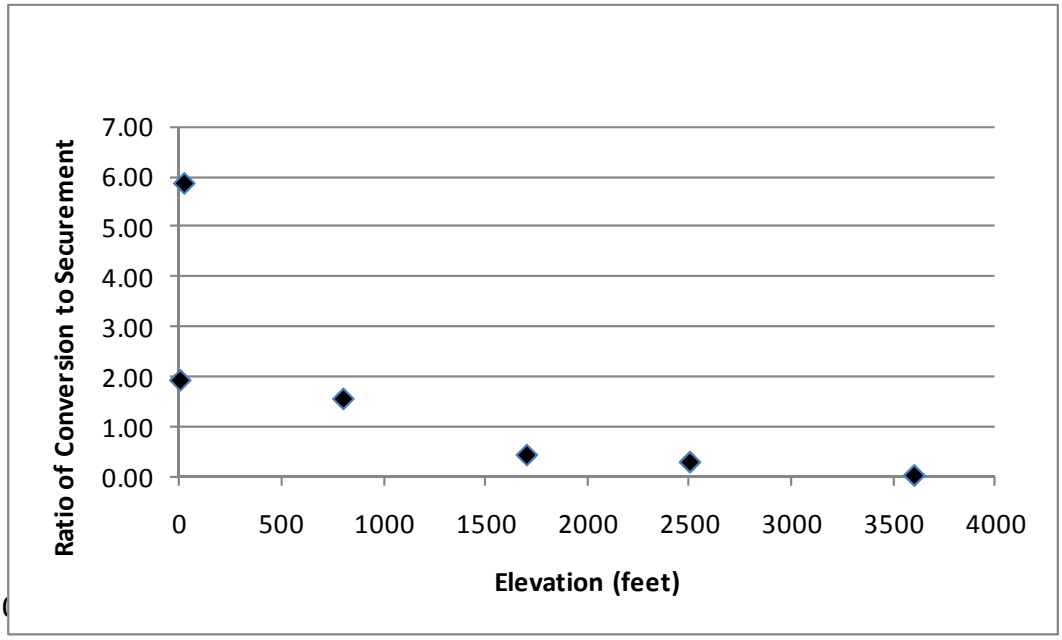


**Figure 2. Geology Classes: Amount of conversion compared with the amount of securement.** Each bar represents 100% of the historic area. Area to the left of the "0" axis indicates acreage converted, area to the right shows the remaining natural land by securement status (see also Maps 4 and 5).

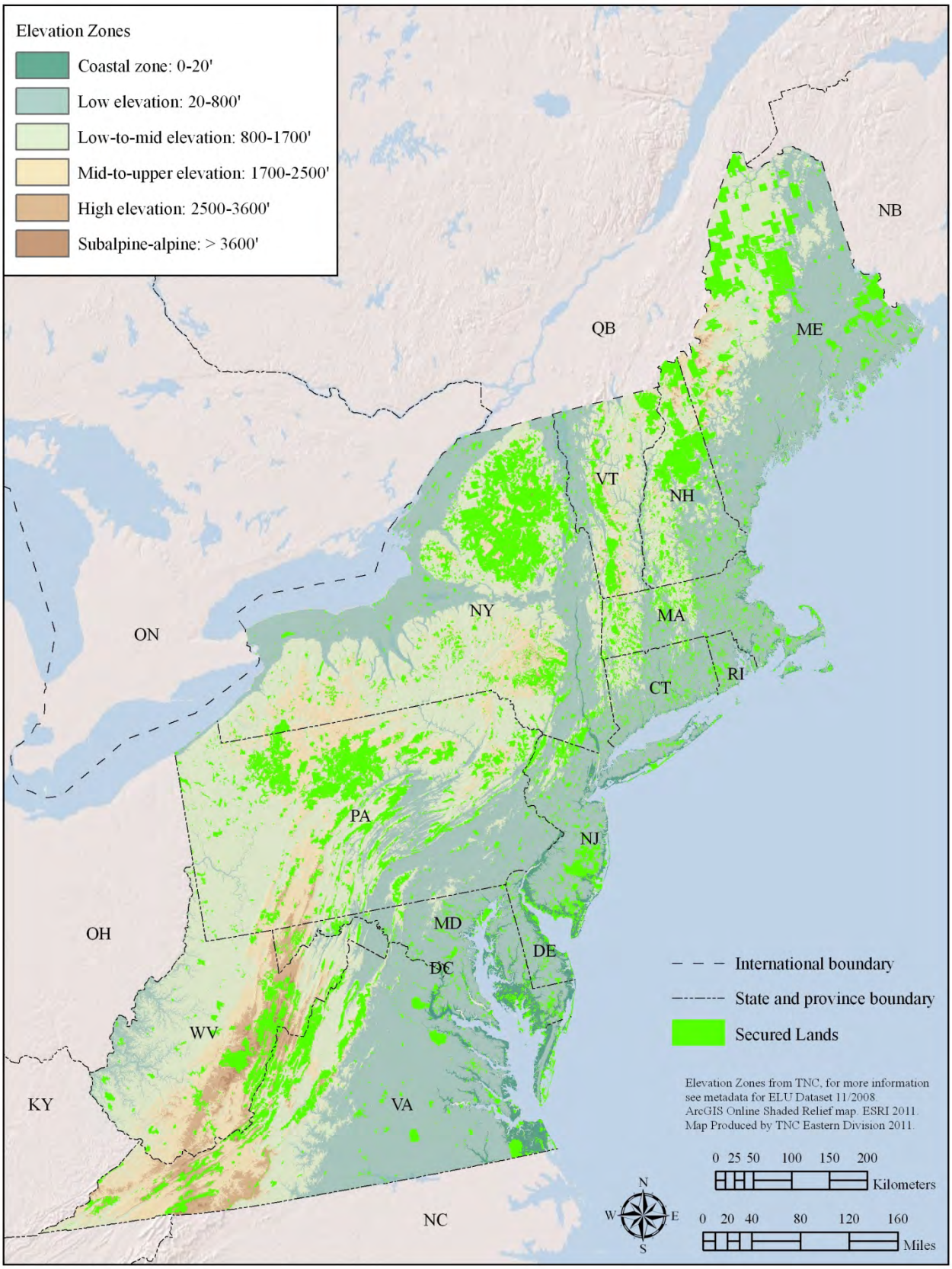



| | Grand Total | Acidic granitic | Acidic sedimentary | Mafic/intermediate | Ultramafic | Mod calcareous | Acidic shale | Fine sediments | Coarse sediments | Calcareous |
|---|---|---|---|---|---|---|---|---|---|---|
| Agriculture | -28,558,491 | -2,283,753 | -6,728,847 | -793,354 | -21,227 | -3,222,082 | -4,687,094 | -2,287,296 | -4,578,490 | -3,954,349 |
| Developed | -14,646,837 | -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 | 7,732,069 | 2,704,205 | 2,260,050 | 891,617 | 5,575 | 238,712 | 215,721 | 305,576 | 1,001,712 | 102,901 |
| Gap 3 | 15,547,357 | 2,679,990 | 7,868,414 | 819,021 | 5,791 | 1,264,275 | 1,373,246 | 400,960 | 917,493 | 211,844 |
| Not Secured | 92,320,628 | 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.**



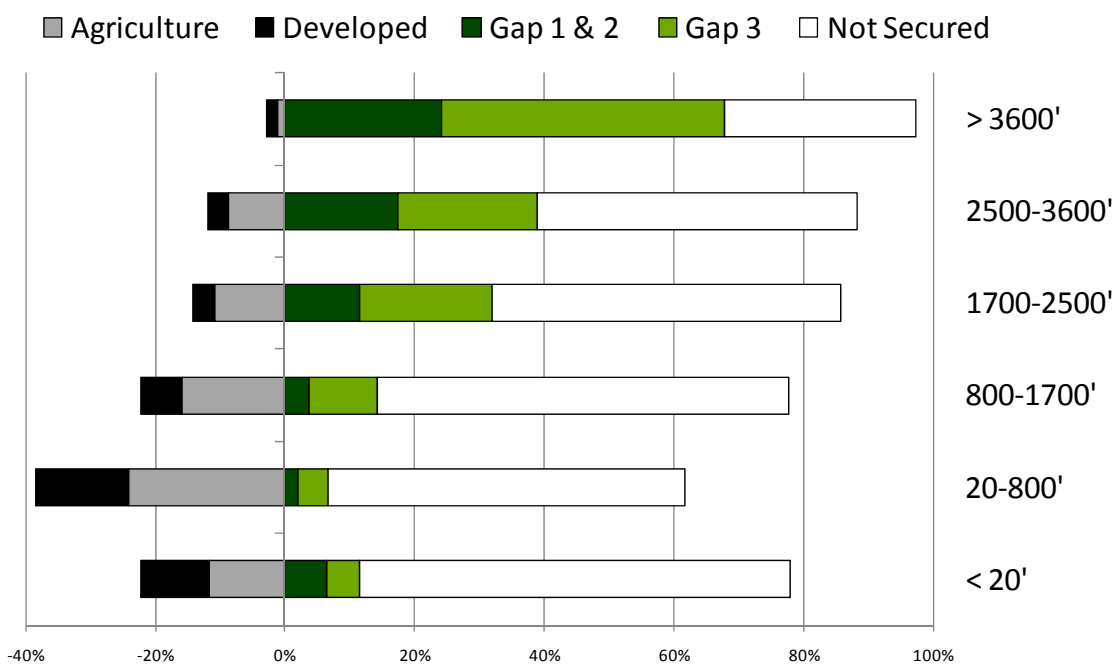
**Map 6. Securement by elevation zone.**



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 securement for nature 22:1 (Figure 4, Table 14). In contrast, every type of sloping landforms had more securement than conversion, and all except sidelopes and coves were better secured for nature as well. (Figure 4, Table 14).

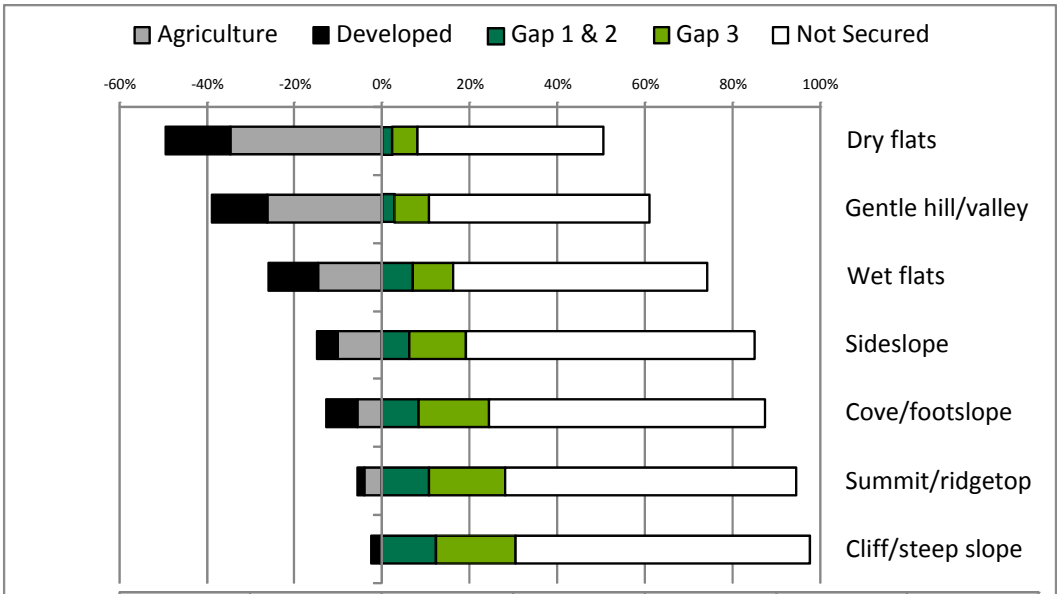
Finally, we tested whether the ratio of conversion to securement was simply a function of the acreage of the setting or feature, but found that they were unrelated (Figure 6). In summary, five settings were clearly at risk due to the large amount of conversion and small amount of securement: calcareous,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



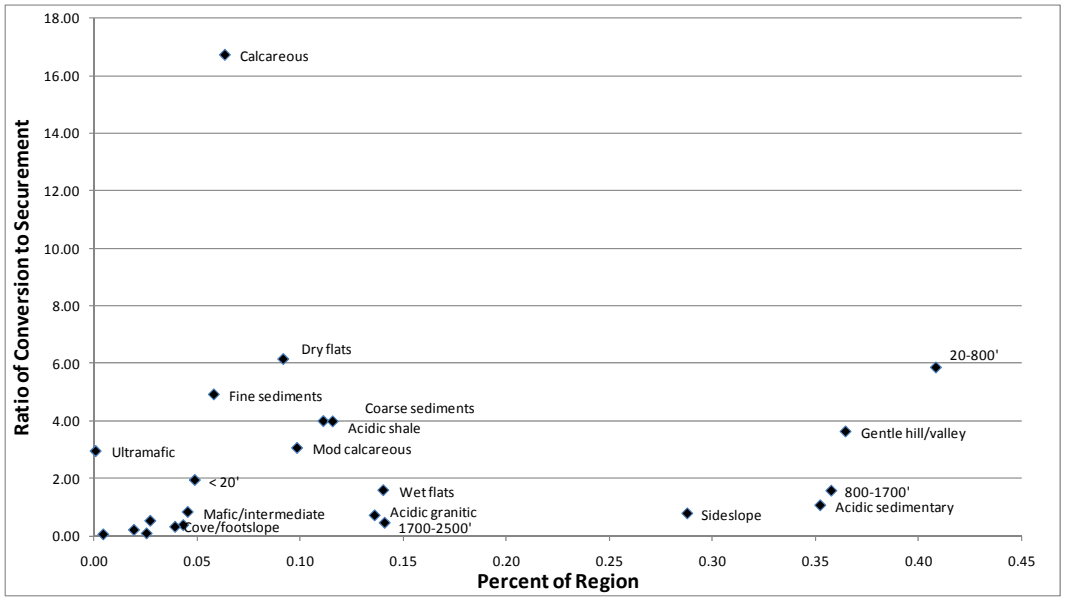

| | < 20' | 20-800' | 800-1700' | 1700-2500' | 2500-3600' | > 3600' |
|---|---|---|---|---|---|---|
| Agriculture | -907,801 | -15,599,386 | -9,086,278 | -2,407,320 | -549,727 | -7,980 |
| Developed | -811,886 | -9,295,169 | -3,556,004 | -782,079 | -190,027 | -11,671 |
| Gap 1 & 2 | 500,486 | 1,338,771 | 2,087,096 | 2,552,344 | 1,082,136 | 171,235 |
| Gap 3 | 388,873 | 2,914,038 | 5,995,445 | 4,596,963 | 1,342,284 | 309,753 |
| Not Secured | 5,150,821 | 35,734,604 | 36,091,983 | 12,056,436 | 3,077,631 | 209,152 |

**Figure 5. Landform Types.** The amount of habitat conversion compared with the amount of habitat 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.




| | 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.

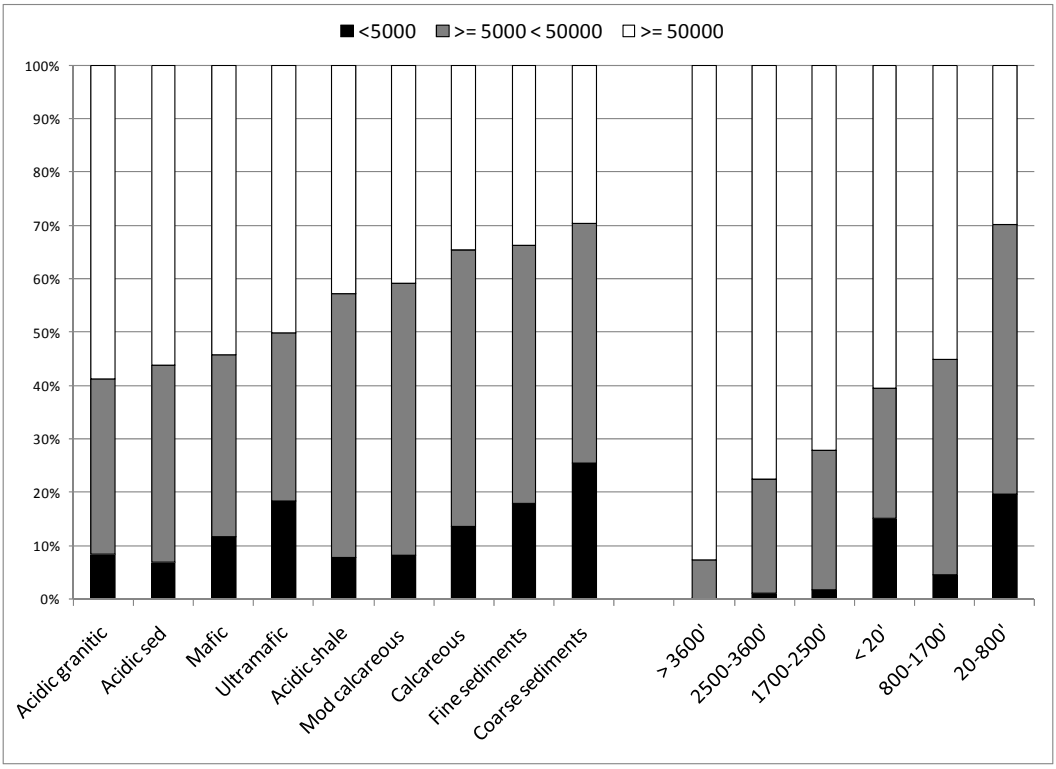
Fragmentation: Fragmentation occurs when a contiguous area of natural land is subdivided into smaller patches, resulting in each patch having more edge habitat and less interior. Because edge habitat contrasts strongly with interior the surrounding edge habitat tends to isolate the interior region and 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).

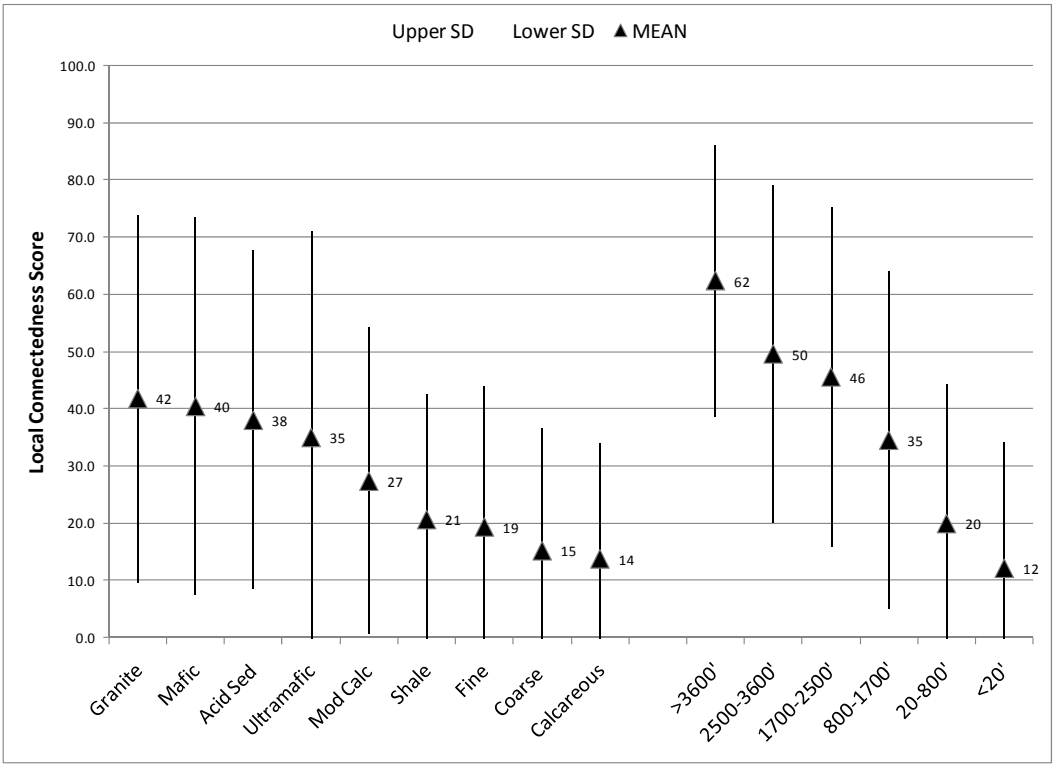
**Figure 6. Block sizes by geology and elevation.** In this chart, the percent of land acres within each block size classes is shown by setting, and arranged in order of decreasing large blocks.




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."

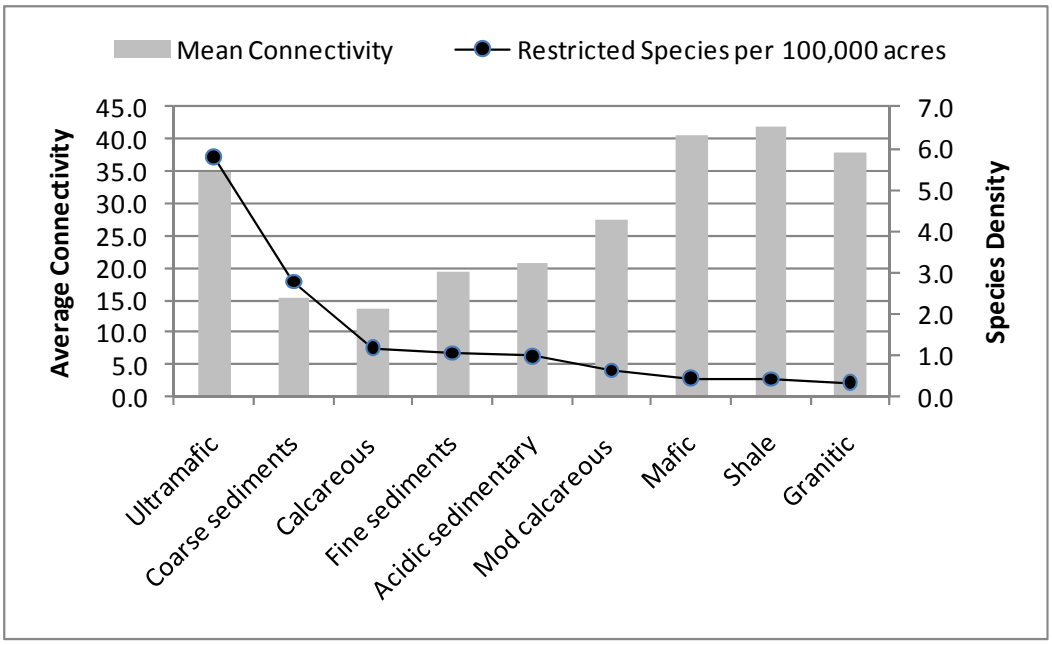
**Figure 8. Average connectedness scores for the nine geology classes and six elevation zones.** Error bars show one standard deviation above and below the mean.




## 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.**

Anderson M.G. and Ferree C.E. 2010. Conserving the Stage: Climate Change and the Geophysical Underpinnings of Species Diversity. PLoS ONE 5(7): e11554. doi:10.1371/journal.pone.0011554

Ferree, C. 2008. Ecological Land Units. Version 11/2008. The Nature Conservancy Eastern Conservation Science Office. Boston, MA.

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.

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.

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

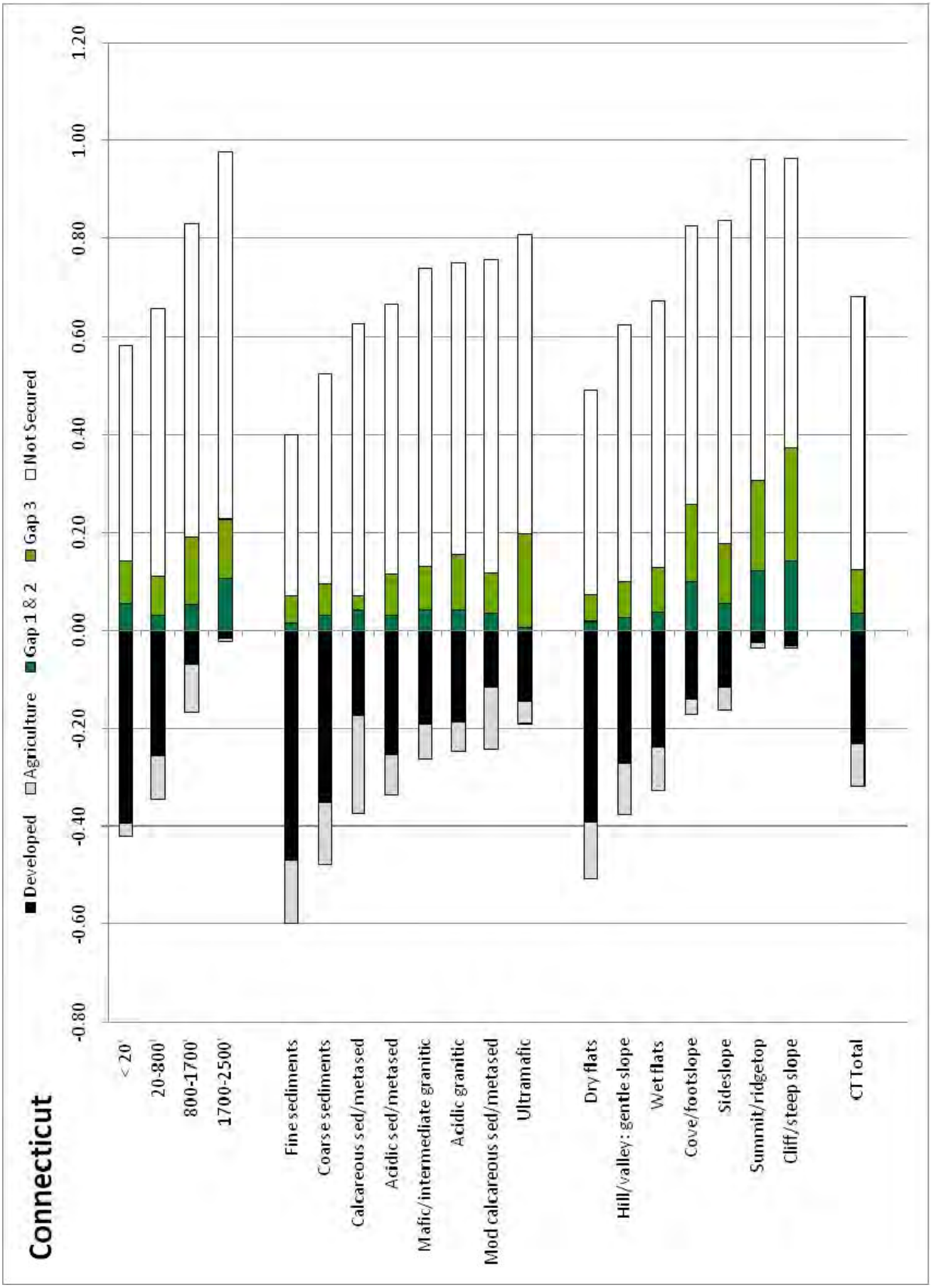
| | Acres Agriculture | Percent Agriculture | Acres Developed | Percent Developed | Acres Gap 1 & 2 | Percent Gap 1 & 2 | Acres Gap 3 | Percent Gap 3 | Acres Not Secured | Percent Not Secured | Total Acres | Percent Converted | Percent Secured | CRI-S | CRI-P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **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** |

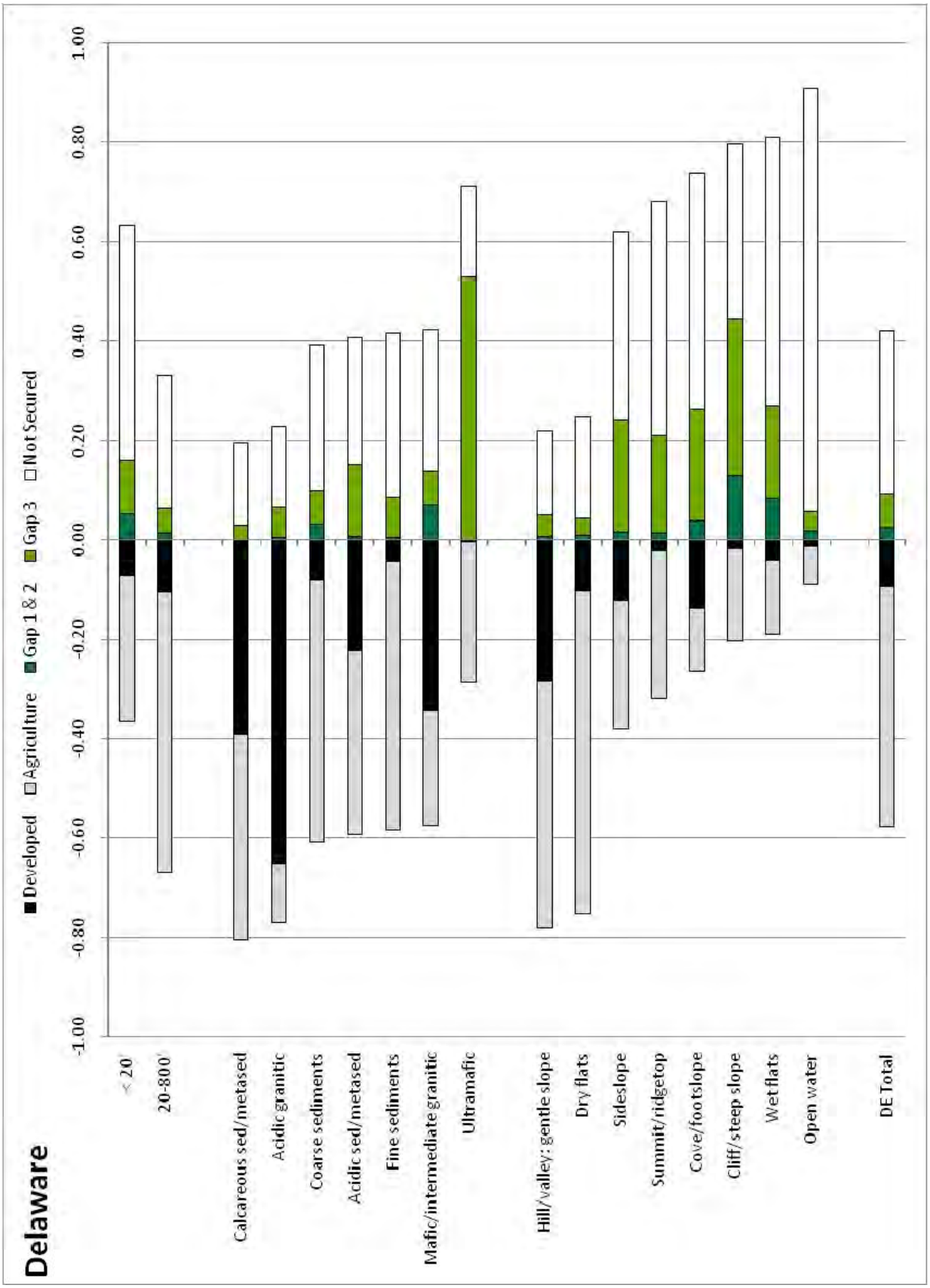
**Washington D.C.**

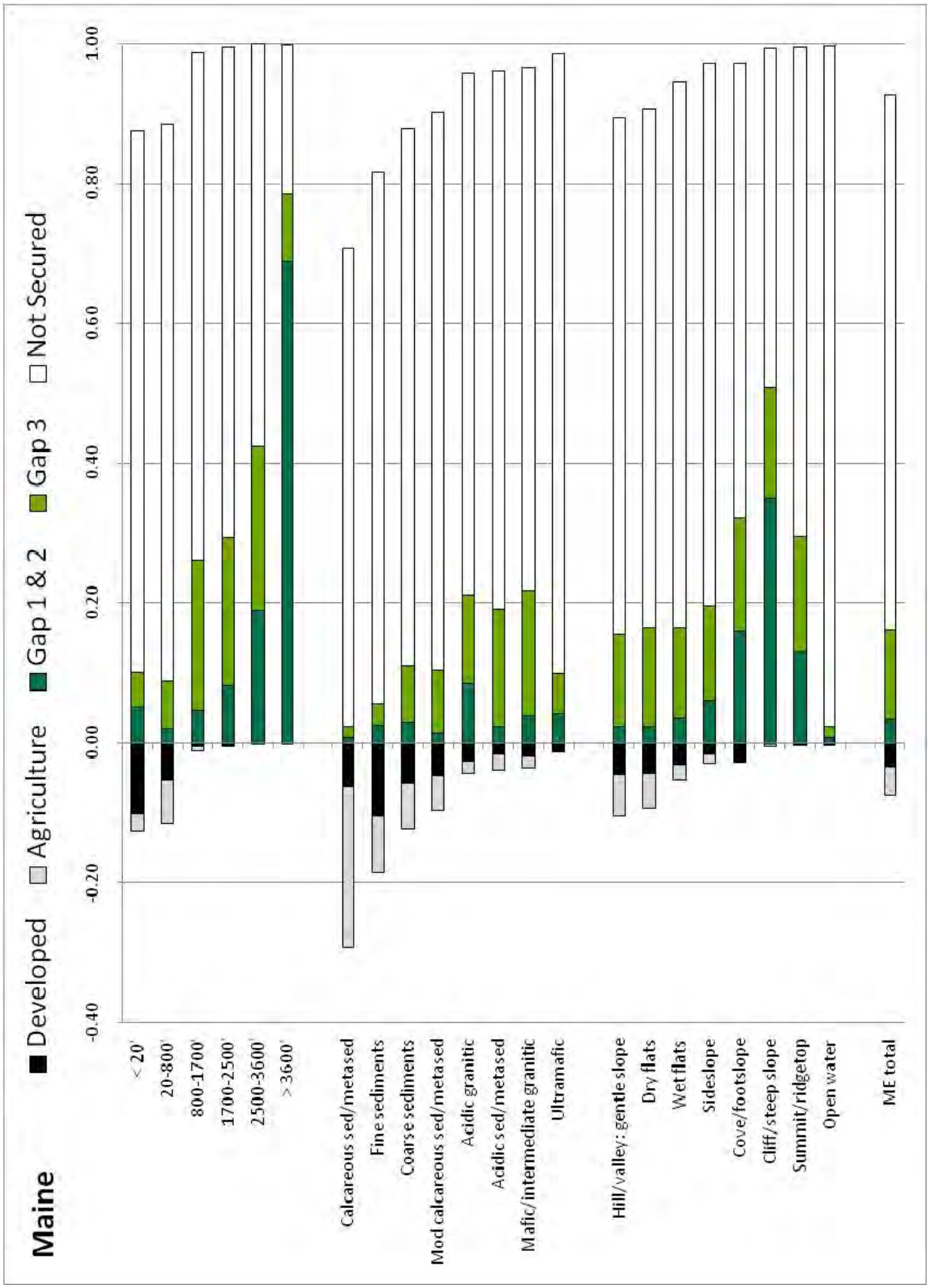
| | Acres Agriculture | Percent Agriculture | Acres Developed | Percent Developed | Acres Gap 1 & 2 | Percent Gap 1 & 2 | Acres Gap 3 | Percent Gap 3 | Acres Not Secured | Percent Not Secured | Total Acres | Percent Converted | Percent Secured | CRI-S | CRI-P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **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** |

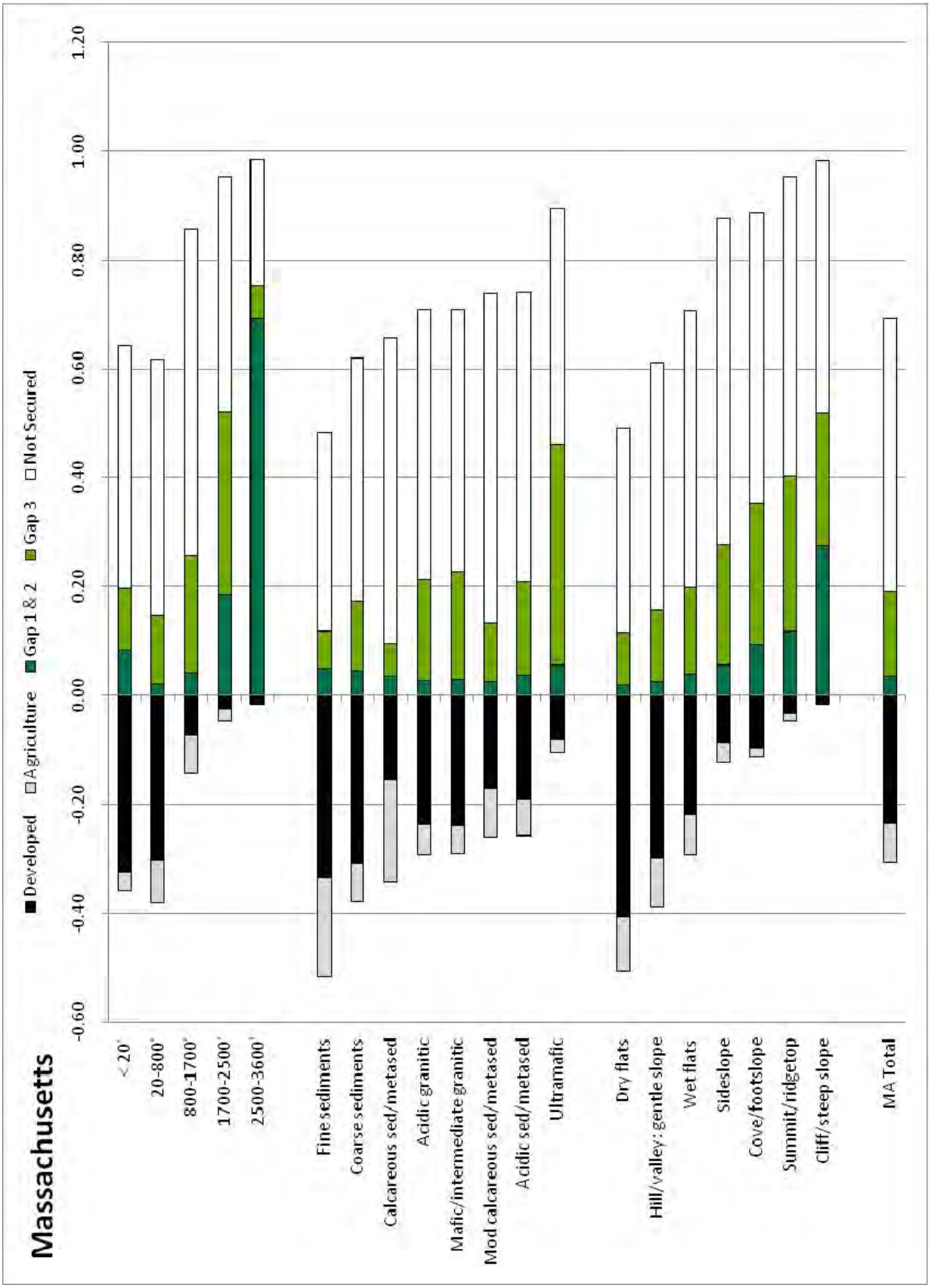
**West Virginia**

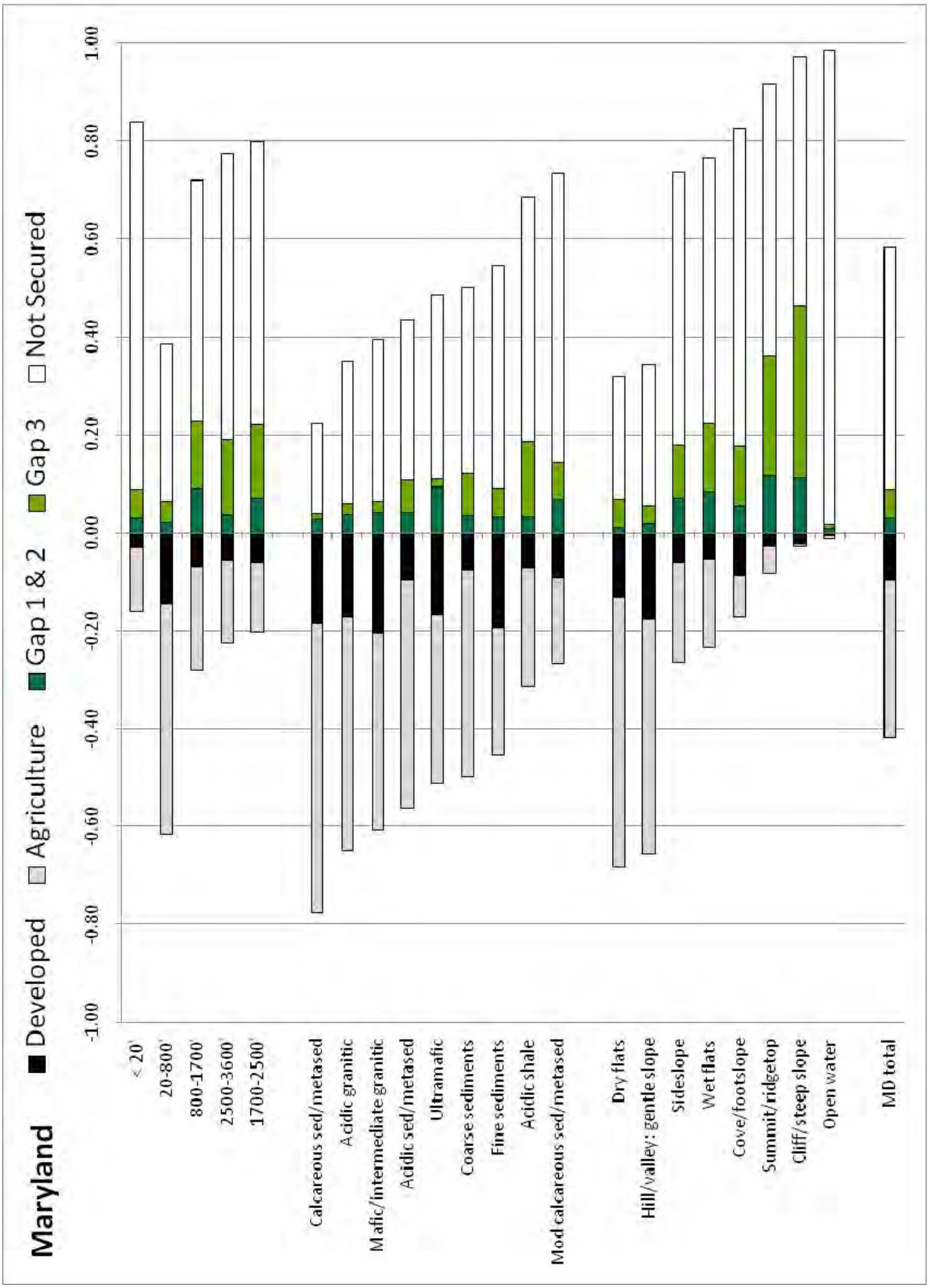
| | Acres Agriculture | Percent Agriculture | Acres Developed | Percent Developed | Acres Gap 1 & 2 | Percent Gap 1 & 2 | Acres Gap 3 | Percent Gap 3 | Acres Not Secured | Percent Not Secured | Total Acres | Percent Converted | Percent Secured | CRI-S | CRI-P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **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** |

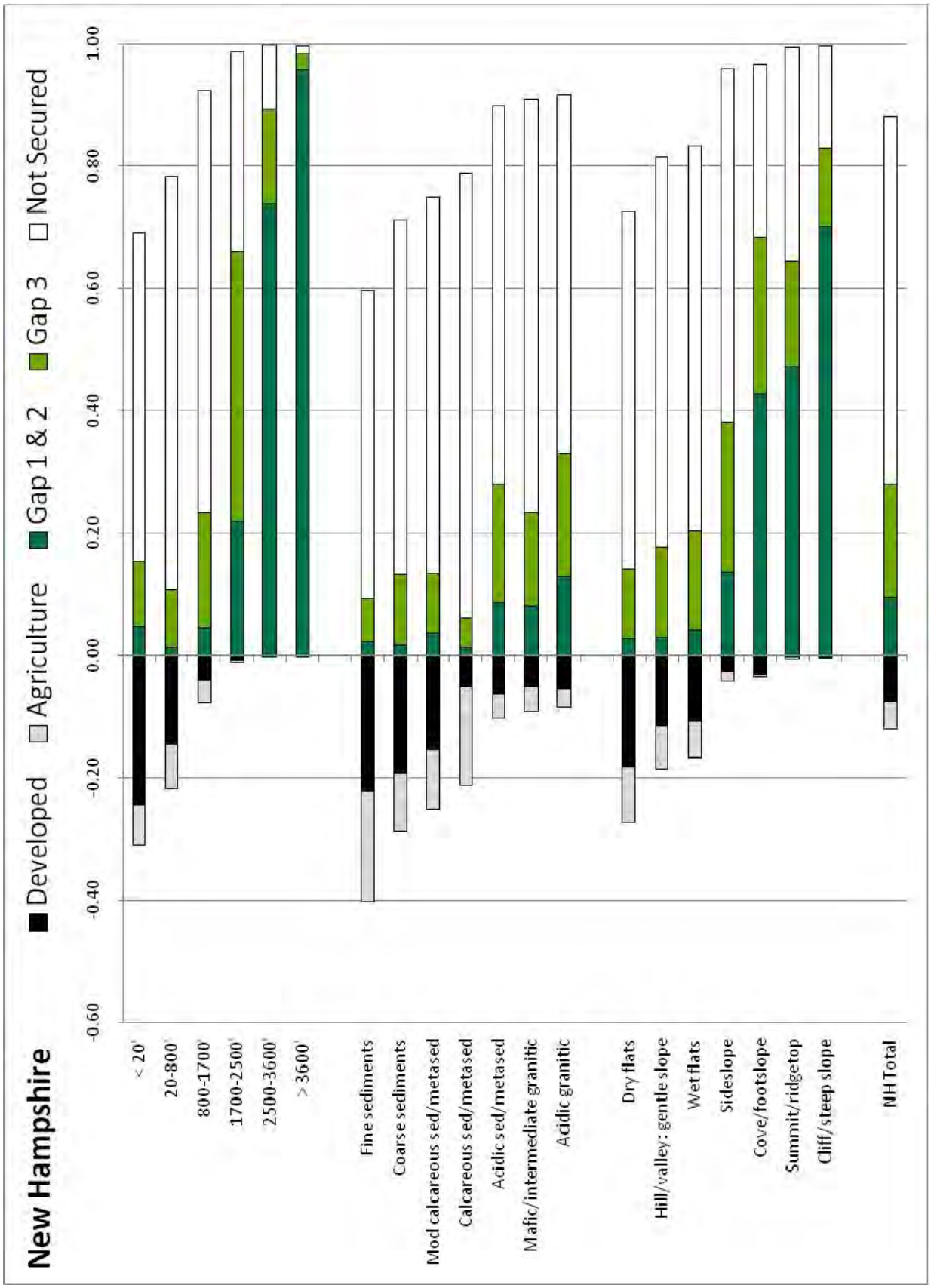

Connecticut
Developed
Agriculture
Gap 1 & 2
Gap 3
Not Secured
-0.80
-0.60
-0.40
-0.20
0.00
0.20
0.40
0.60
0.80
1.00
1.20
< 20'
20-800'
800-1700'
1700-2500'
Fine sediments
Coarse sediments
Calcareous sed/metased
Acidic sed/metased
Mafic/intermediate granitic
Acidic granitic
Mod calcareous sed/metased
Ultramafic
Dry flats
Hill/valley: gentle slope
Wet flats
Cove/footslope
Sideslope
Summit/ridgetop
Cliff/steep slope
CT Total

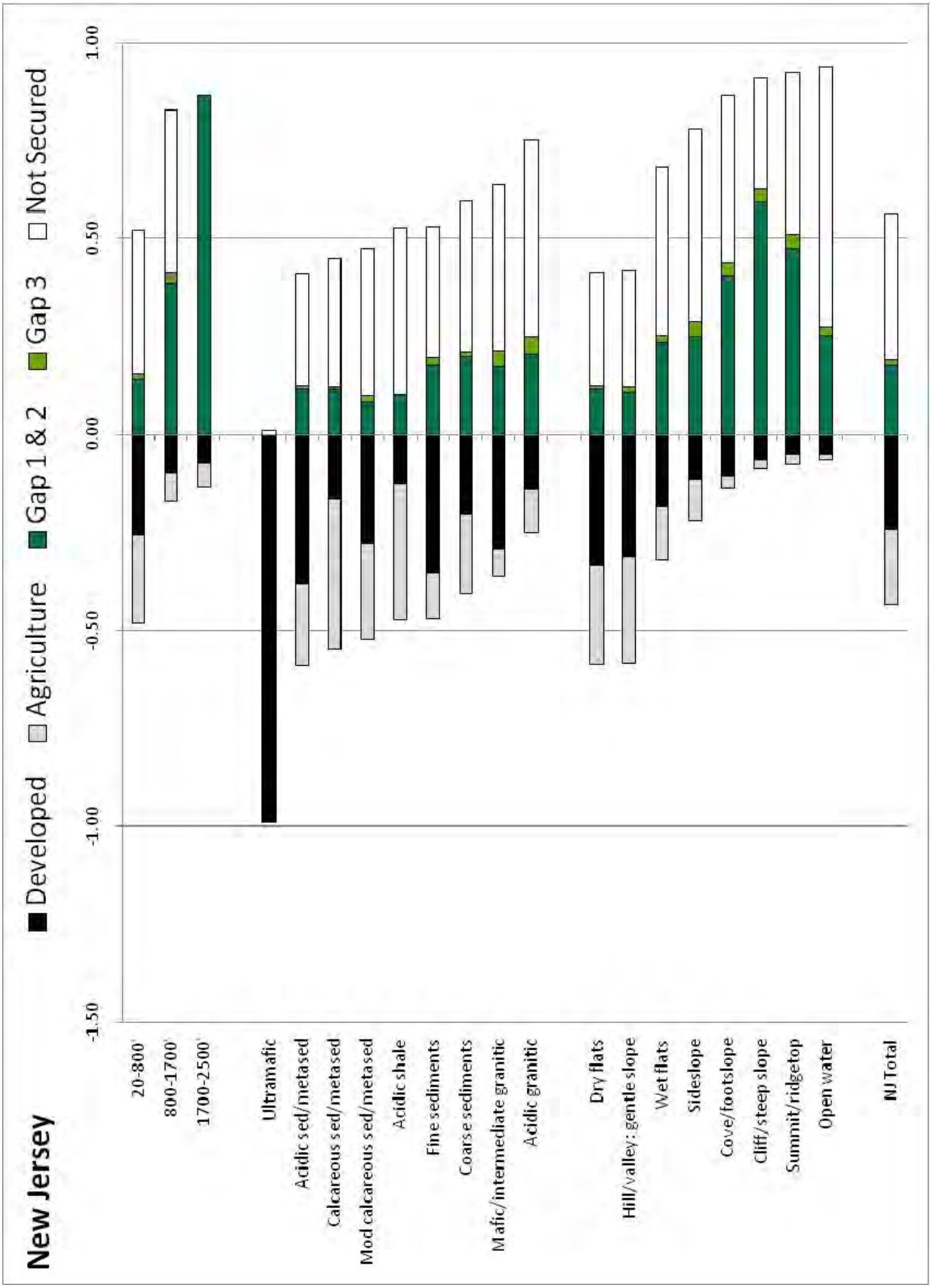

Delaware
Developed
Agriculture
Gap 1 & 2
Gap 3
Not Secured
-1.00
-0.80
-0.60
-0.40
-0.20
0.00
0.20
0.40
0.60
0.80
1.00
< 20'
20-800'
Calcareous sed/metased
Acidic granitic
Coarse sediments
Acidic sed/metased
Fine sediments
Mafic/intermediate granitic
Ultramafic
Hill/valley: gentle slope
Dry flats
Sideslope
Summit/ridgetop
Cove/footslope
Cliff/steep slope
Wet flats
Open water
DE Total

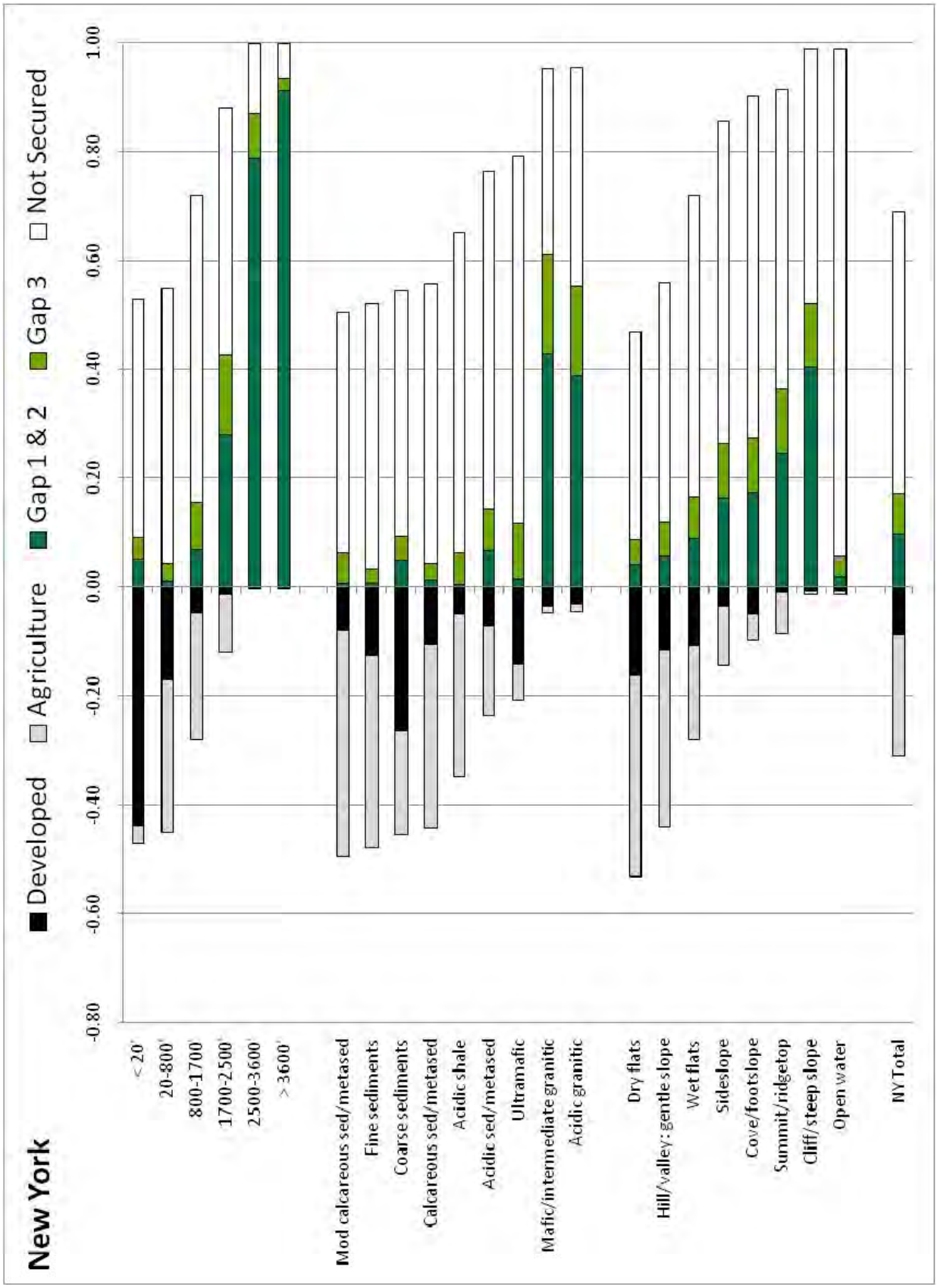

Maine
Developed
Agriculture
Gap 1 & 2
Gap 3
Not Secured
-0.40
-0.20
0.00
0.20
0.40
0.60
0.80
1.00
< 20'
20-800'
800-1700'
1700-2500'
2500-3600'
> 3600'
Calcareous sed/metased
Fine sediments
Coarse sediments
Mod calcareous sed/metased
Acidic granitic
Acidic sed/metased
Mafic/intermediate granitic
Ultramafic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

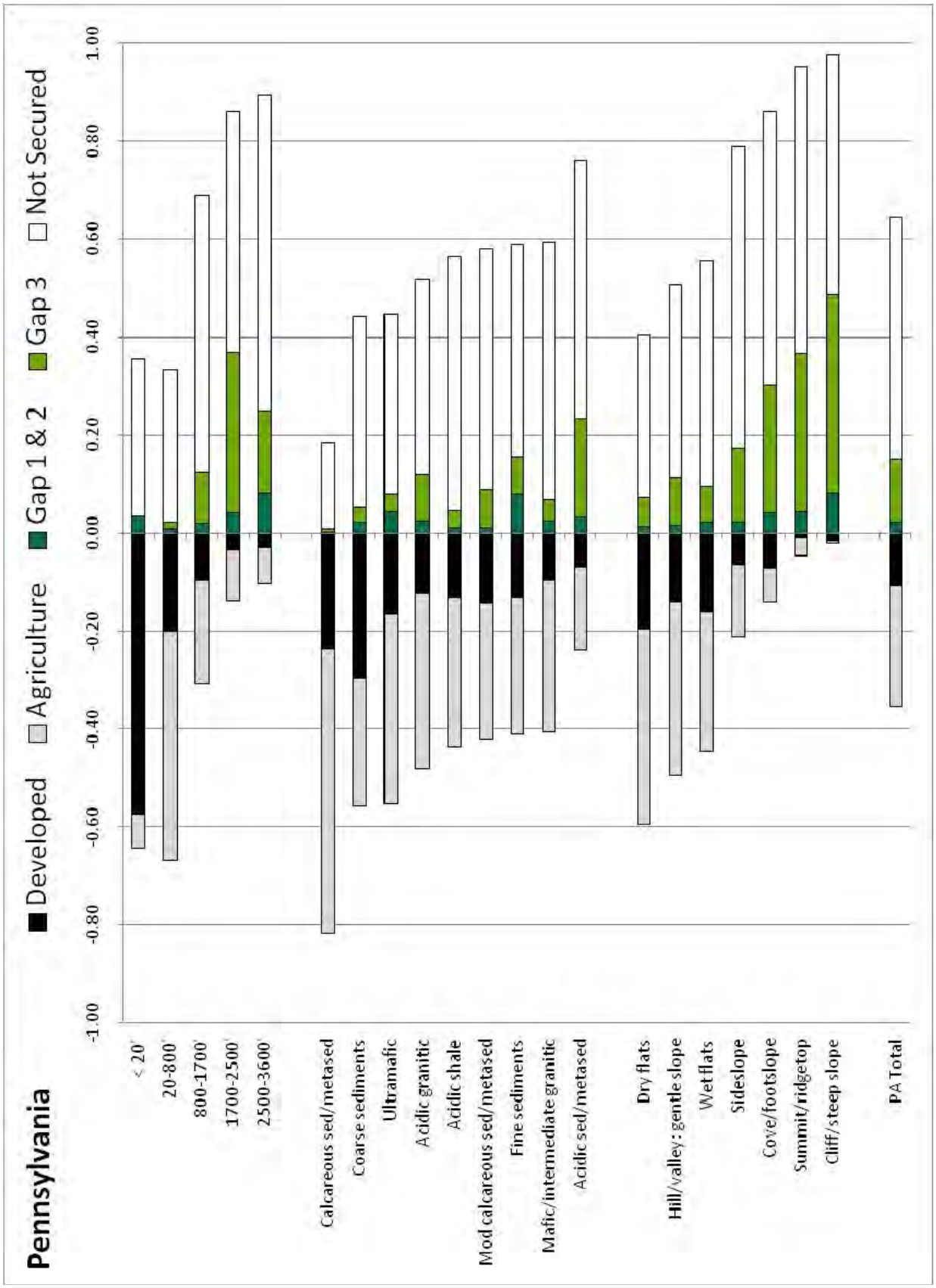

Massachusetts
Developed
Agriculture
Gap 1 & 2
Gap 3
Not Secured
-0.60
-0.40
-0.20
0.00
0.20
0.40
0.60
0.80
1.00
1.20
< 20'
20-800'
800-1700'
1700-2500'
2500-3600'
Fine sediments
Coarse sediments
Calcareous sed/metased
Acidic granitic
Mafic/intermediate granitic
Mod calcareous sed/metased
Acidic sed/metased
Ultramafic
Dry flats
Hill/valley: gentle slope
Wet flats
Sideslope
Cove/footslope
Summit/ridgetop
Cliff/steep slope
MA Total

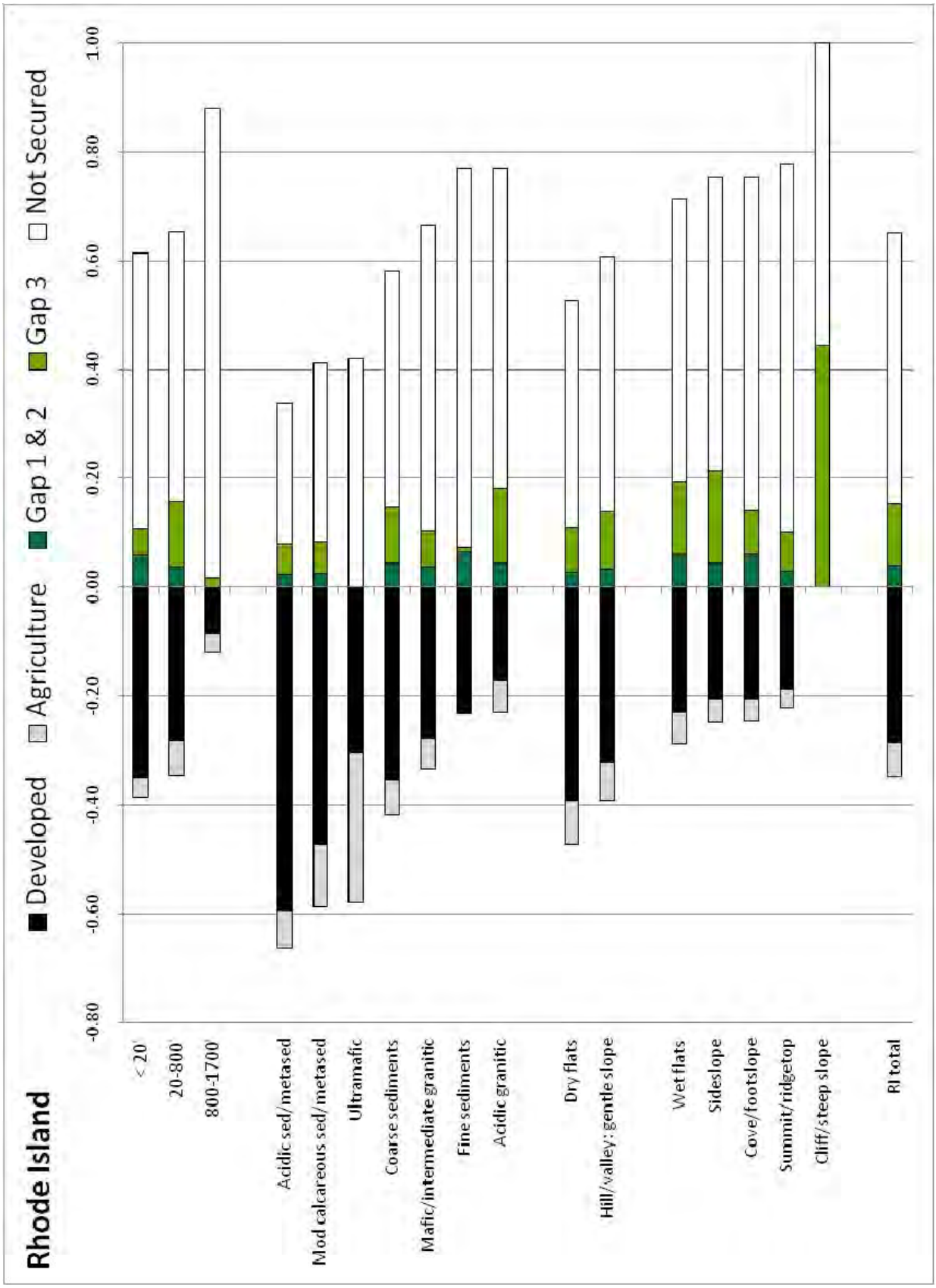

Maryland
Developed
Agriculture
Gap 1 & 2
Gap 3
Not Secured
-1.00
-0.80
-0.60
-0.40
-0.20
0.00
0.20
0.40
0.60
0.80
1.00
< 20'
20-800'
800-1700'
2500-3600'
1700-2500'
Calcareous sed/metased
Acidic granitic
Mafic/intermediate granitic
Acidic sed/metased
Ultramafic
Coarse sediments
Fine sediments
Acidic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

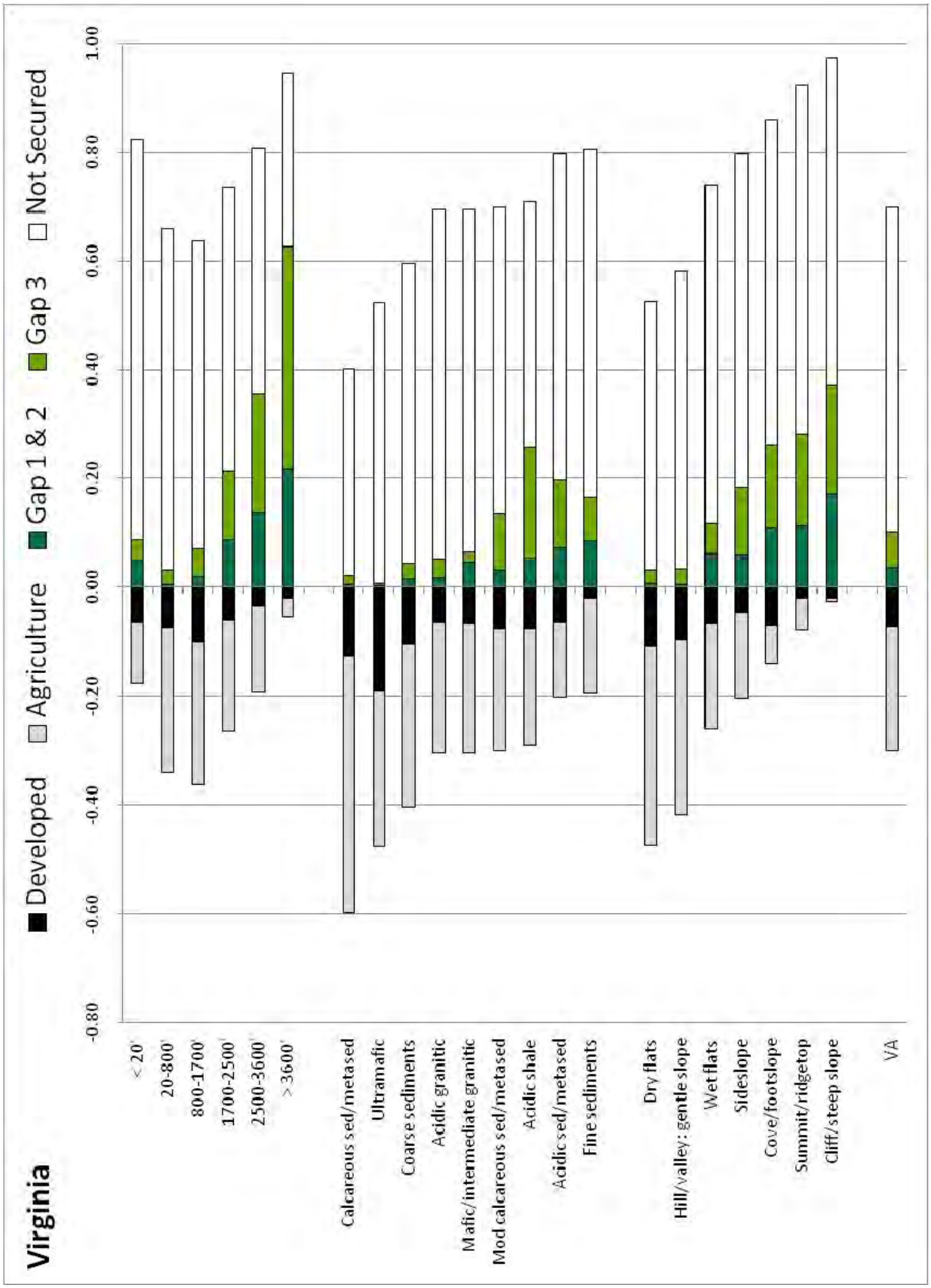

New Hampshire
Developed
Agriculture
Gap 1 & 2
Gap 3
Not Secured
-0.60
-0.40
-0.20
0.00
0.20
0.40
0.60
0.80
1.00
< 20'
20-800'
800-1700'
1700-2500'
2500-3600'
> 3600'
Fine sediments
Coarse sediments
Mod calcareous sed/metased
Calcareous sed/metased
Acidic sed/metased
Mafic/intermediate granitic
Acidic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

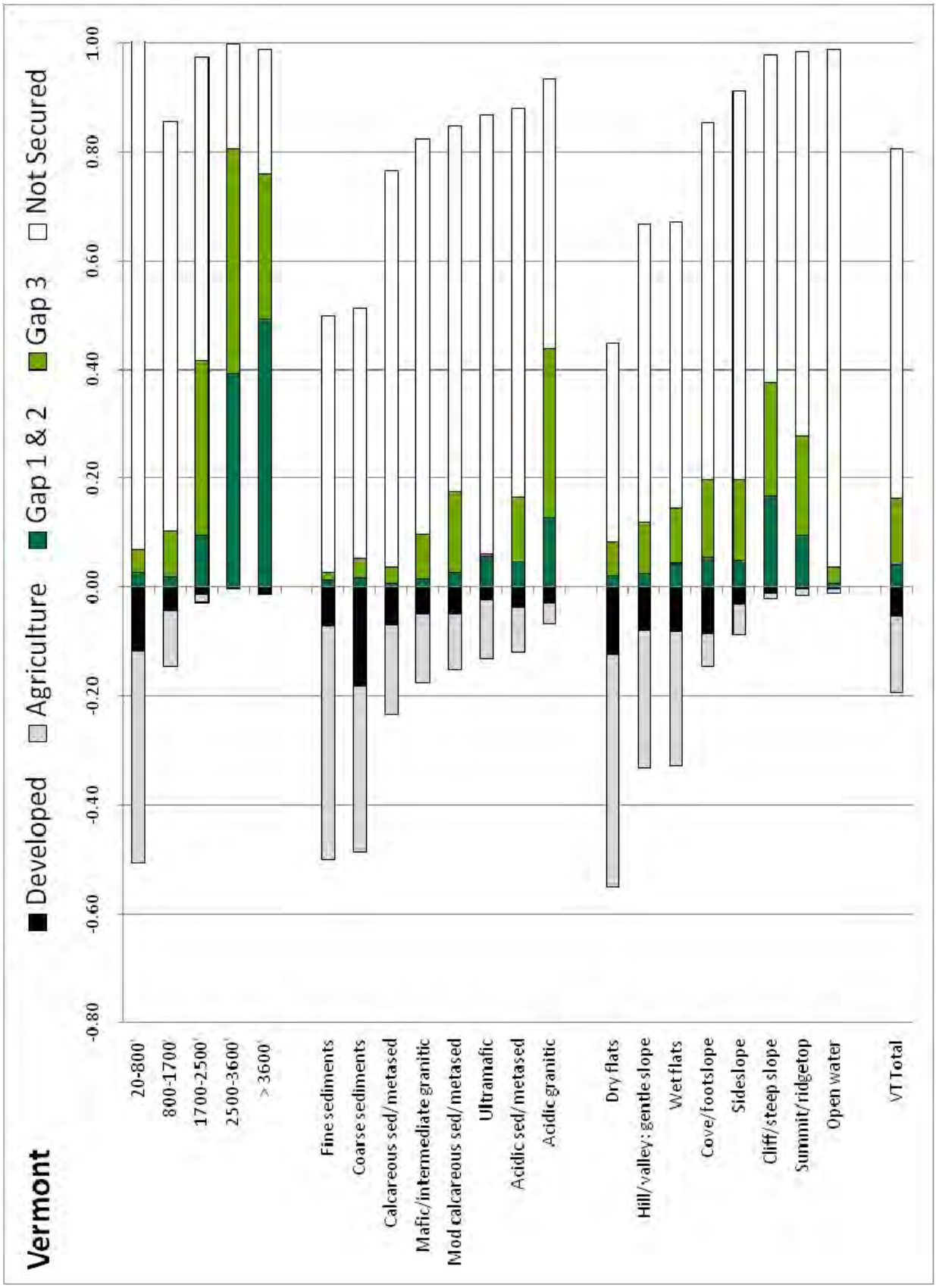

New Jersey
Developed
Agriculture
Gap 1 & 2
Gap 3
Not Secured
1.00
0.50
0.00
-0.50
-1.00
-1.50
20-800'
800-1700'
1700-2500'
Ultramafic
Acidic sed/metased
Calcareous sed/metased
Mod calcareous sed/metased
Acidic shale
Fine sediments
Coarse sediments
Mafic/intermediate granitic
Acidic granitic
Dry flats
Hill/valley: gentle slope
Wet flats
Sideslope
Cove/footslope
Cliff/steep slope
Summit/ridgetop
Open water
NJ Total

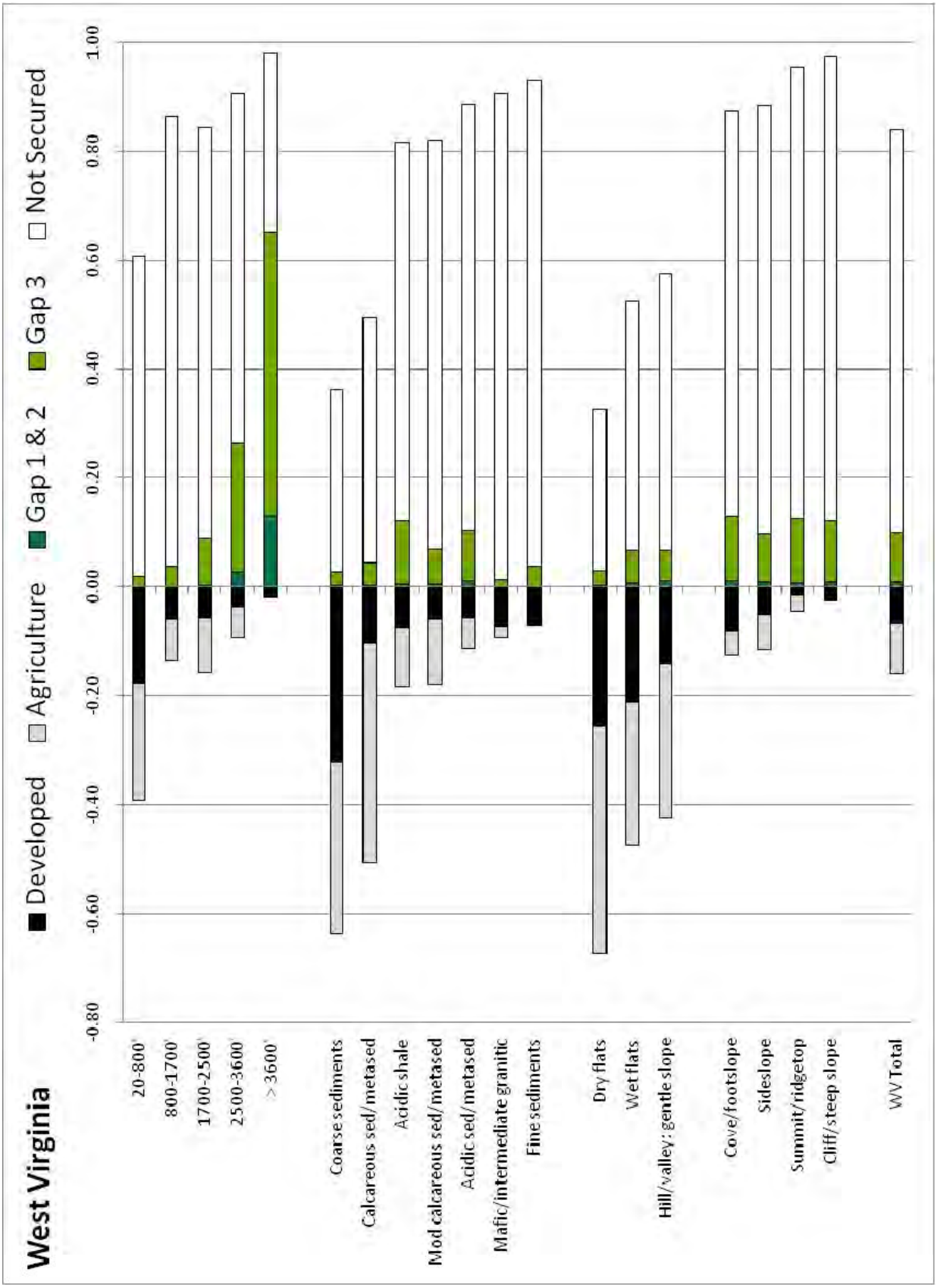

New York
Developed
Agriculture
Gap 1 & 2
Gap 3
Not Secured
-0.80
-0.60
-0.40
-0.20
0.00
0.20
0.40
0.60
0.80
1.00
< 20'
20-800'
800-1700'
1700-2500'
2500-3600'
> 3600'
Mod calcareous sed/metased
Fine sediments
Coarse sediments
Calcareous sed/metased
Acidic shale
Acidic sed/metased
Ultramafic
Mafic/intermediate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


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


Rhode Island
Developed
Agriculture
Gap 1 & 2
Gap 3
Not Secured
-0.80
-0.60
-0.40
-0.20
0.00
0.20
0.40
0.60
0.80
1.00
< 20
20-800
800-1700
Acidic sed/metased
Mod calcareous sed/metased
Ultramafic
Coarse sediments
Mafic/intermediate granitic
Fine sediments
Acidic granitic
Dry flats
Hill/valley: gentle slope
Wet flats
Sideslope
Cove/footslope
Summit/ridgetop
Cliff/steep slope
RI total


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


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


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

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.

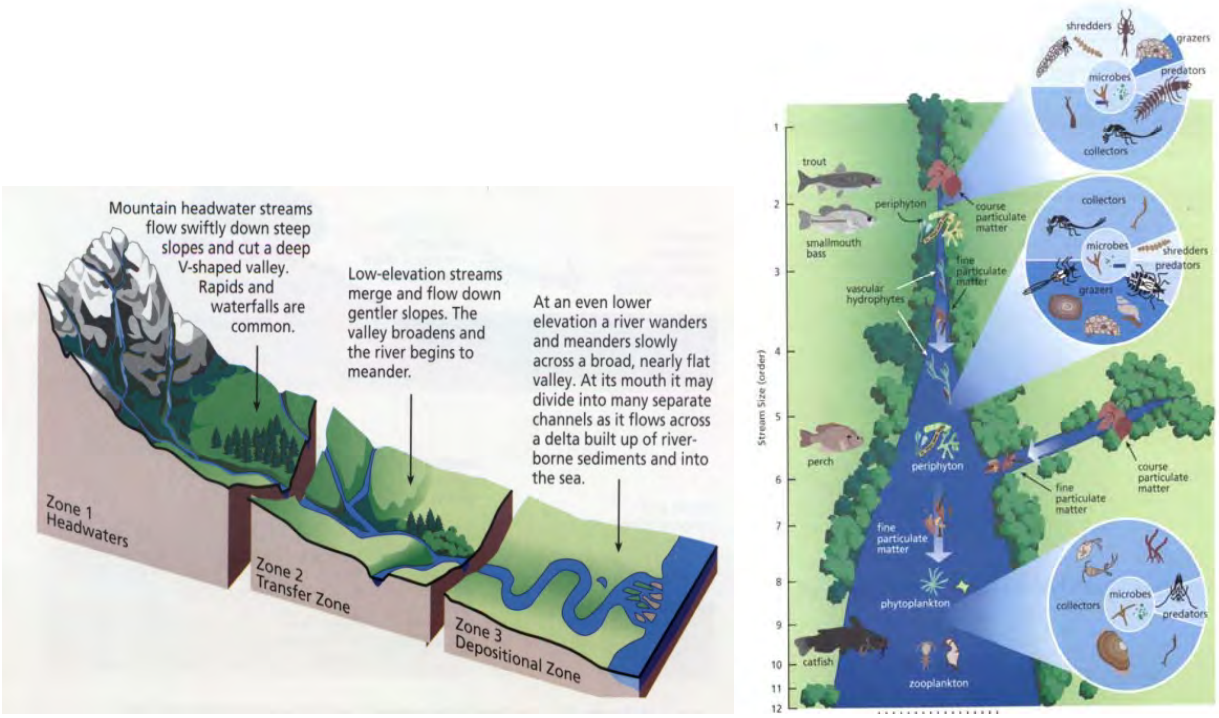
**Water Flow:** Flow is the essence of a stream ecosystem, but 61 percent of the region's streams have flow regimes that are altered enough to result in biotic impacts. One-third of all headwater streams have diminished minimum flow (they dry up), that translates into a reduction of habitat. Seventy 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 |

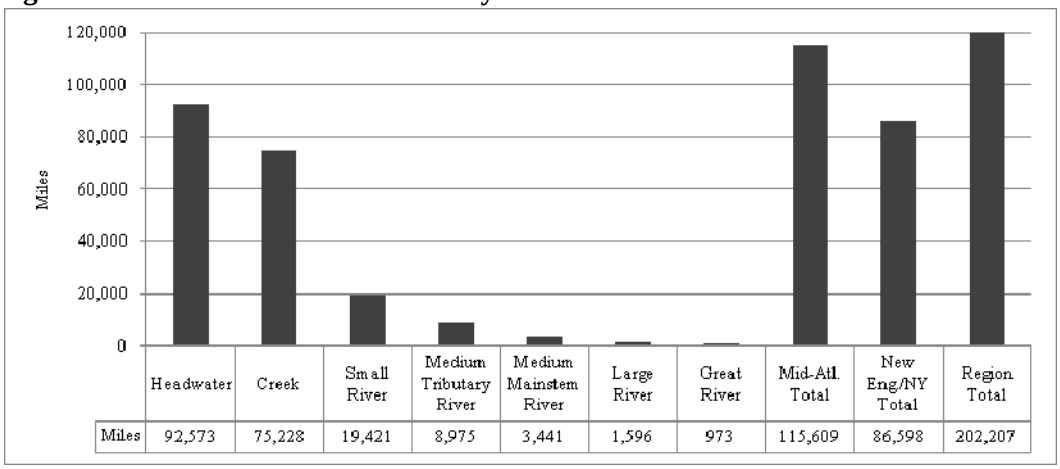
The region contains over 200,000 miles of streams and rivers that drain three major basins, the North Atlantic, Great Lakes, or Ohio-Mississippian (Map 1). Major river systems include the Penobscot, Kennebec, Merrimack, Connecticut, Hudson, Delaware, Susquehanna, Potomac, James, Roanoke, Allegheny, Monongahela,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

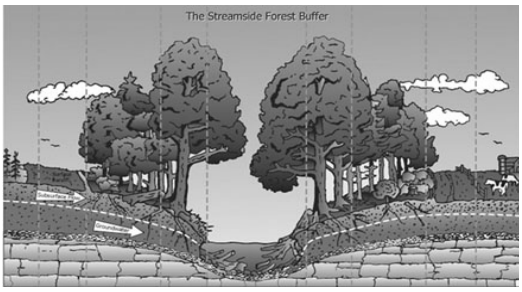
The riparian zone is the land area directly adjacent to a stream or river and subject to its influence. This dynamic zone is an ecologically rich environment, supporting many rare and common species, and numerous natural communities. Vegetated riparian zones provide bank stabilization, water temperature 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).

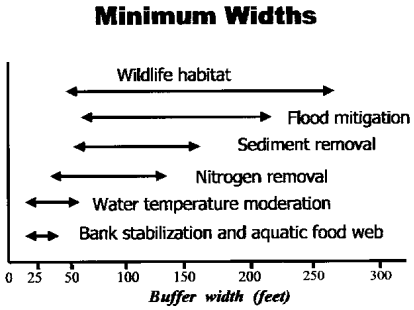
**Figure 2. Miles of streams and rivers by size class.**



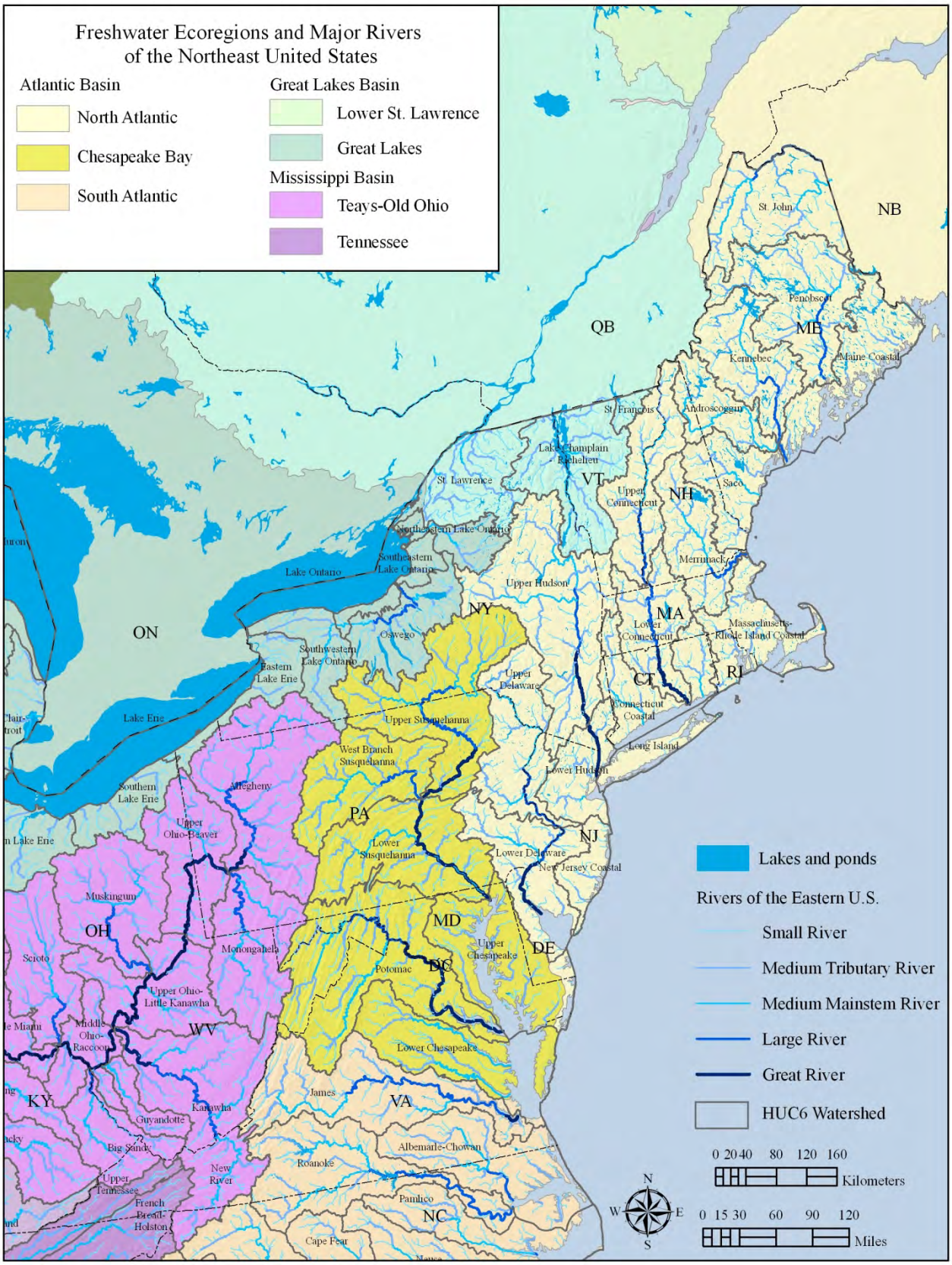

| | Headwater | Creek | Small River | Medium Tributary River | Medium Mainstem River | Large River | Great River | Mid-Atl. Total | New Eng/NY Total | Region Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Miles | 92,573 | 75,228 | 19,421 | 8,975 | 3,441 | 1,596 | 973 | 115,609 | 86,598 | 202,207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

**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.**

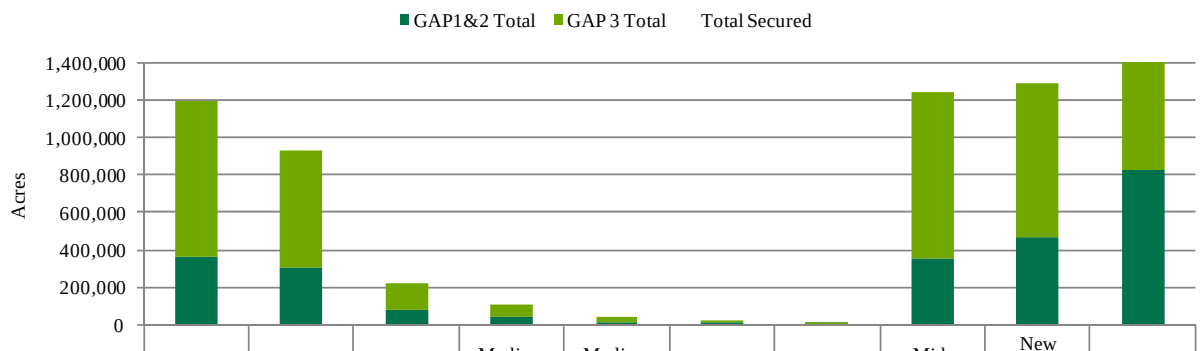


Secured Land in the Riparian Buffer: To evaluate the securement status of each stream's riparian zone we overlaid the TNC secured lands data set (see details in chapter 2) on the 100m (~300ft) riparian buffer zone and tabulated the amount of area secured primarily for nature or secured for multiple uses. 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 securement 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 |
| GAP 3 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.**

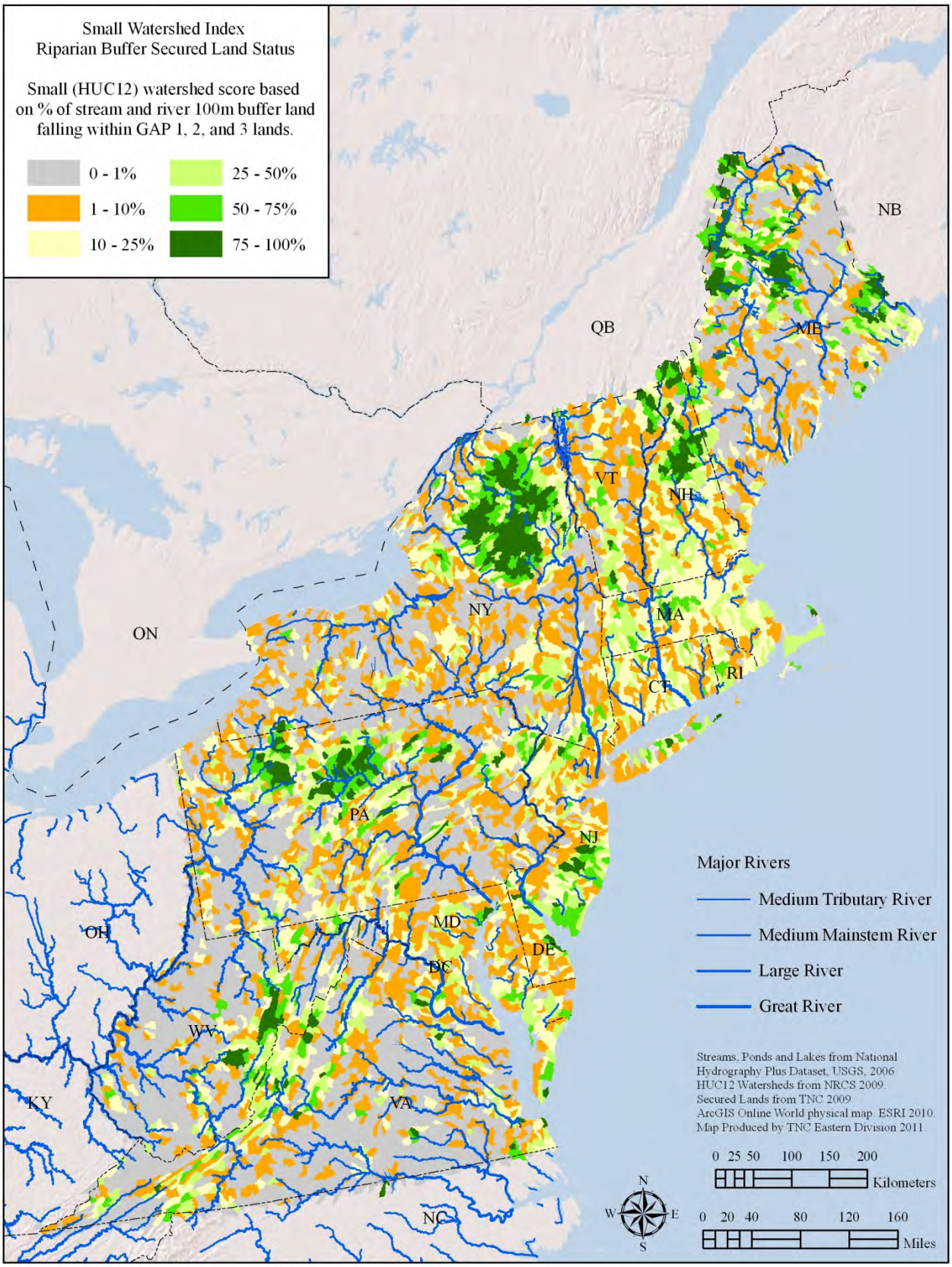
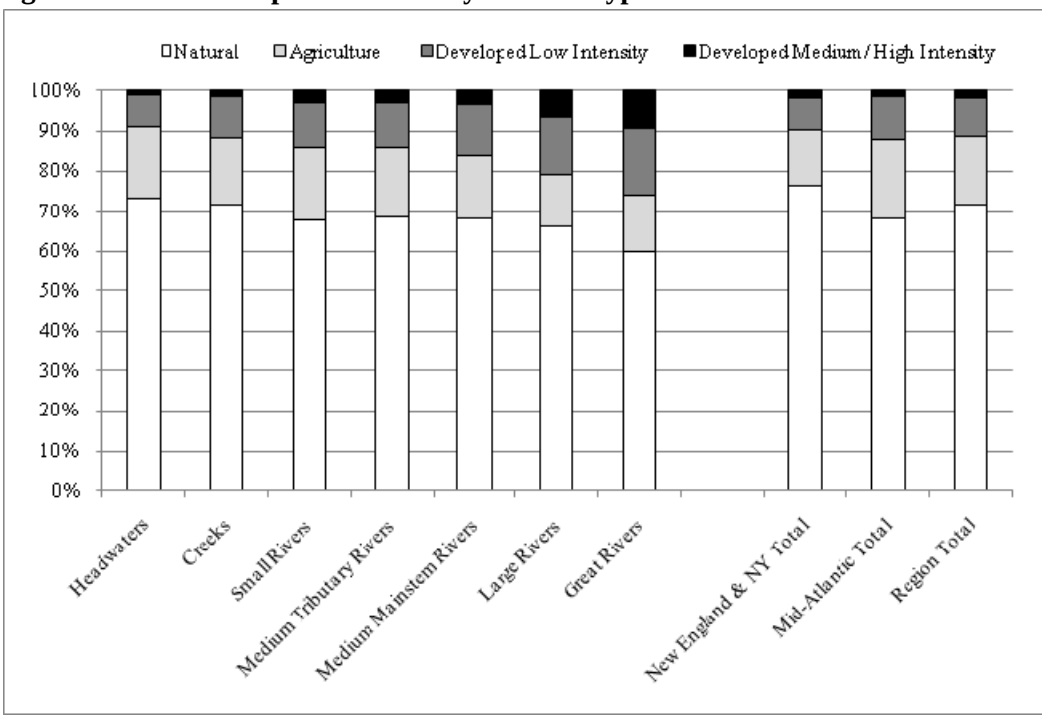


**Figure 5. Percent of riparian buffer by land use type .**



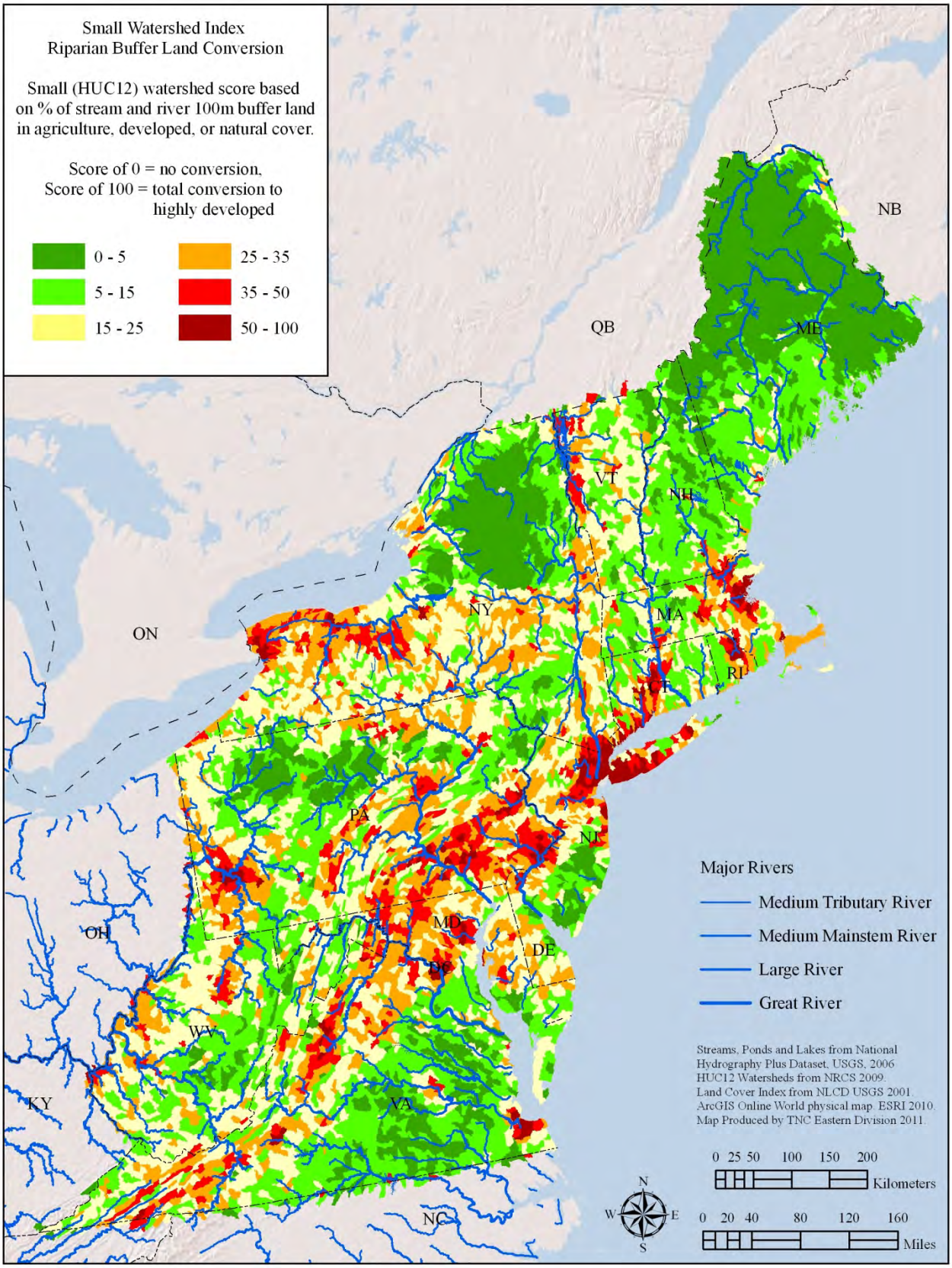

To see the spatial distribution of riparian buffer impacts, we developed a summary small watershed index. For each HUC12, we transformed the land cover information into a numeric impact index by summing the percent of development and agriculture in the buffer zone, and weighting the effect of high intensity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

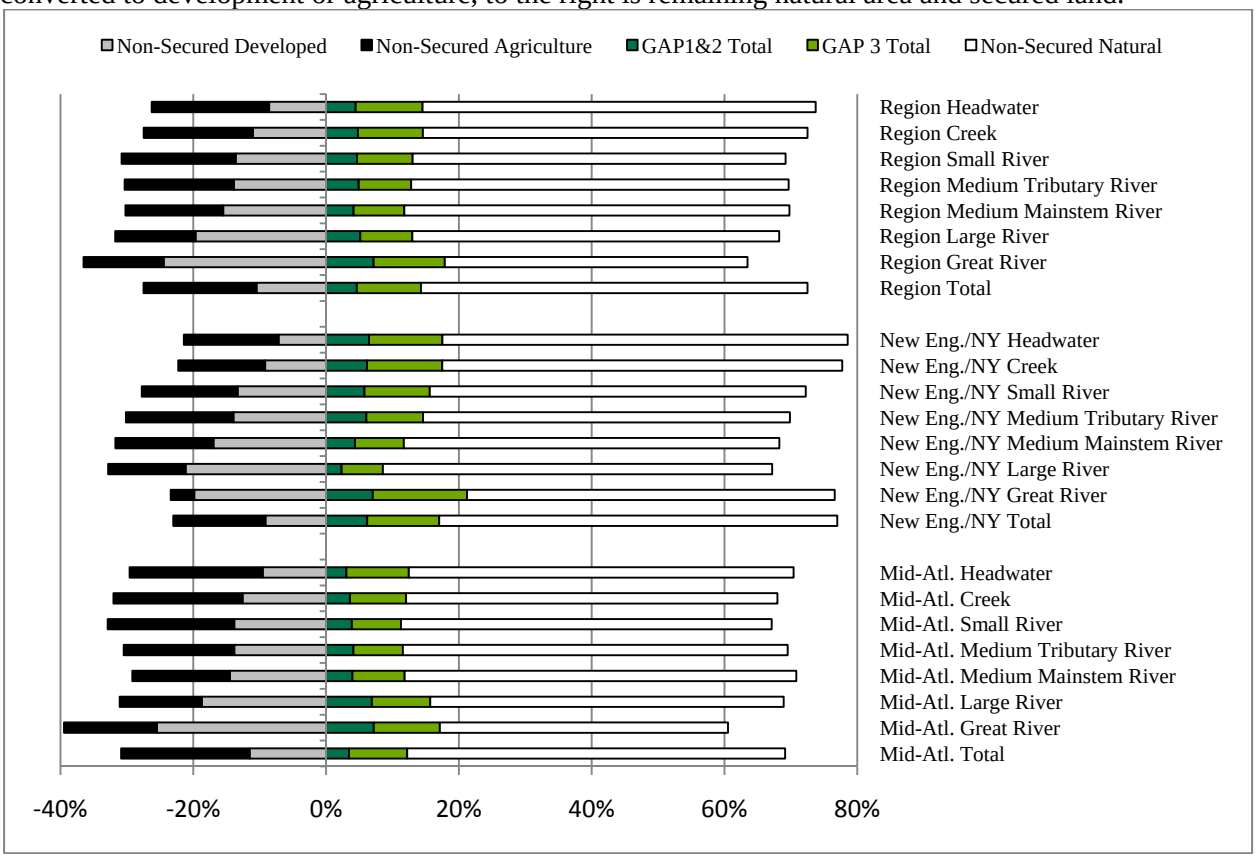


**Table 2. Land use and conservation status of the riparian buffer area for all rivers and streams in the region.** The units are acres in the 100 m riparian buffer. State by state details are in appendix 7-1.

| | | 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.**

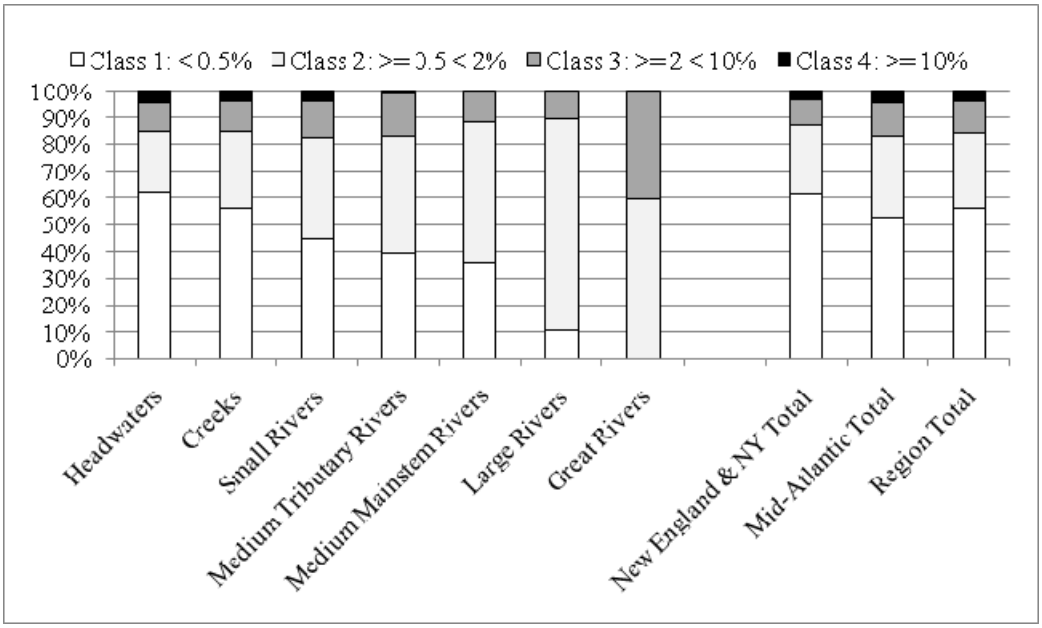



**Table 3. Percent of stream miles by upstream impervious surface class.**

| 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.

Stream Barriers: 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.**

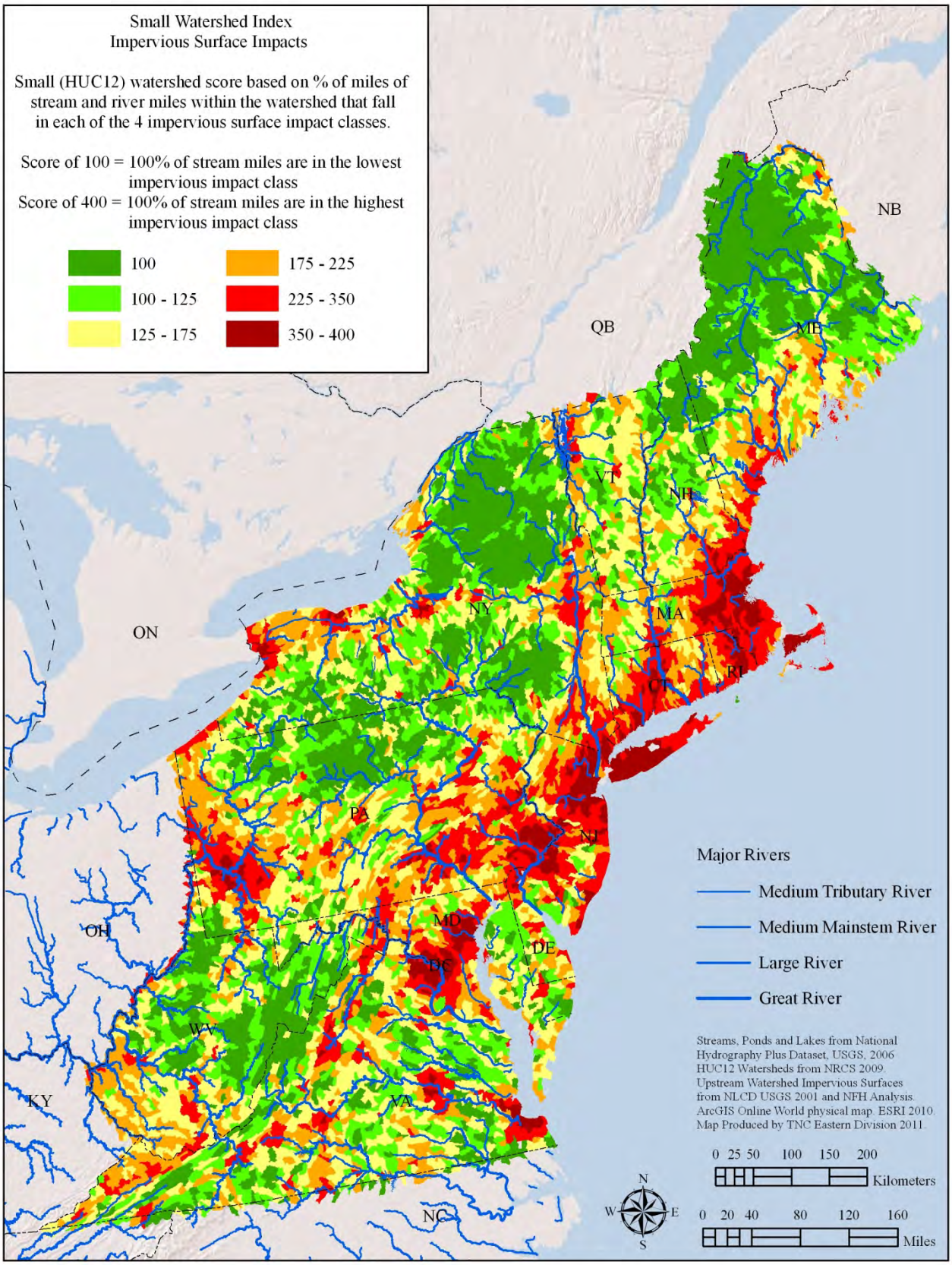
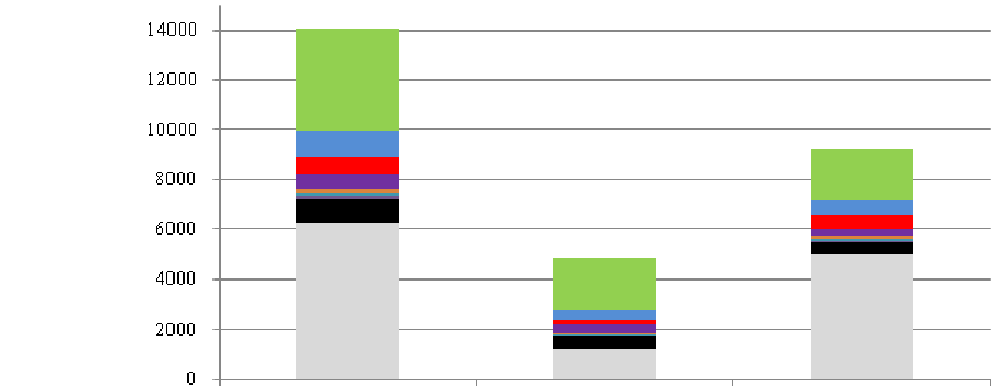
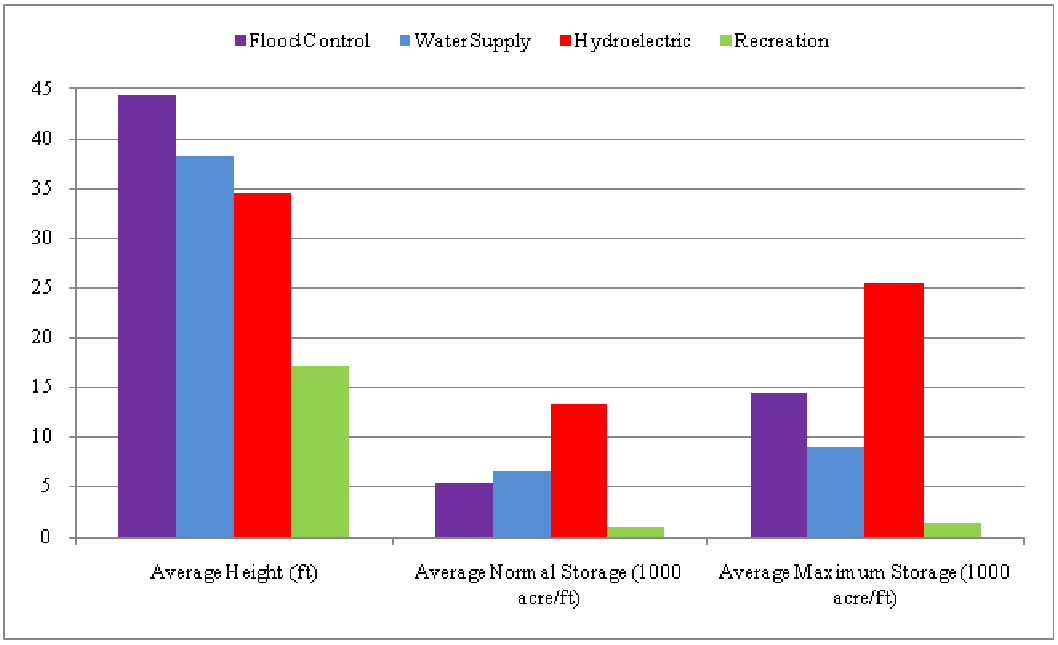


**Figure 8. Number and type of dams on streams with a drainage area over 1 square mile.**



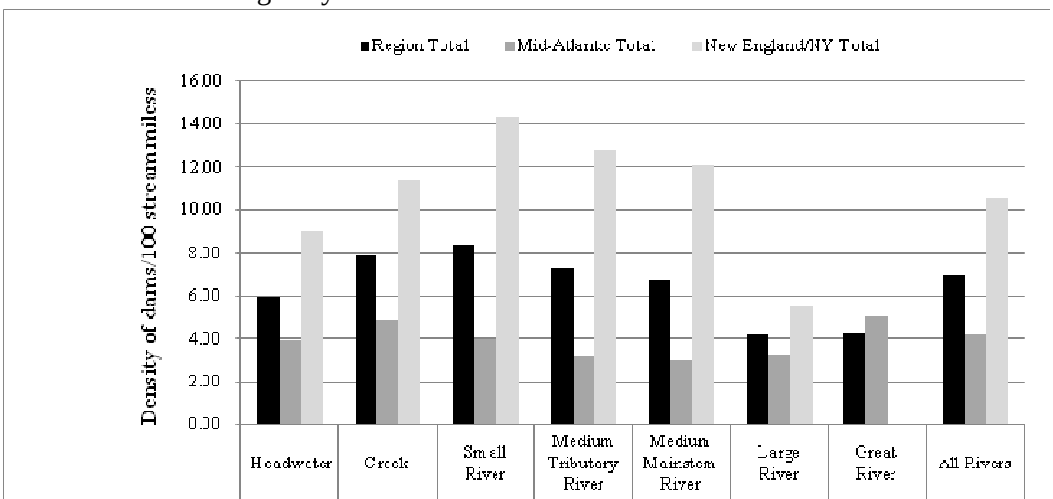

| | Region | Mid-Atlantic | New England |
|---|---|---|---|
| Total | 14034 | 4837 | 9197 |
| Recreation | 4105 | 2102 | 2003 |
| Water Supply | 1034 | 401 | 633 |
| Hydroelectric | 668 | 110 | 558 |
| Flood Control | 636 | 341 | 295 |
| Irrigation | 172 | 91 | 81 |
| Navigation | 85 | 34 | 51 |
| Fish 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.**



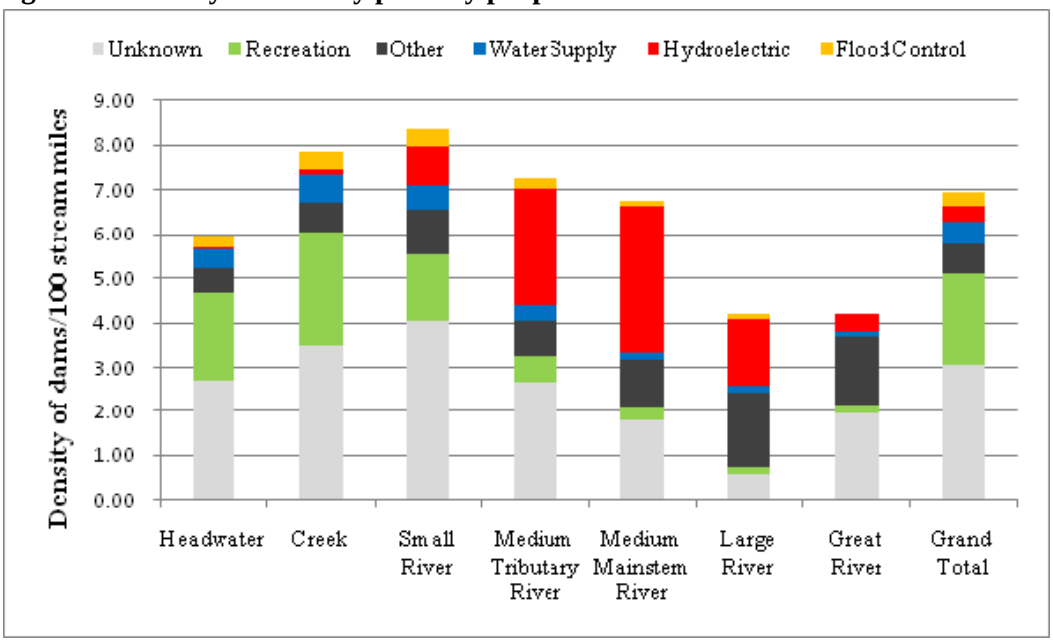
On average, there were 7 dams for every 100 miles of streams and rivers in the region. The density of dams in the northern subregion was 2.5 times the density in the Mid-Atlantic (Figure 10). The density of dams was highest on small rivers, 8 per 100 stream miles, and was even higher in the New England 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.

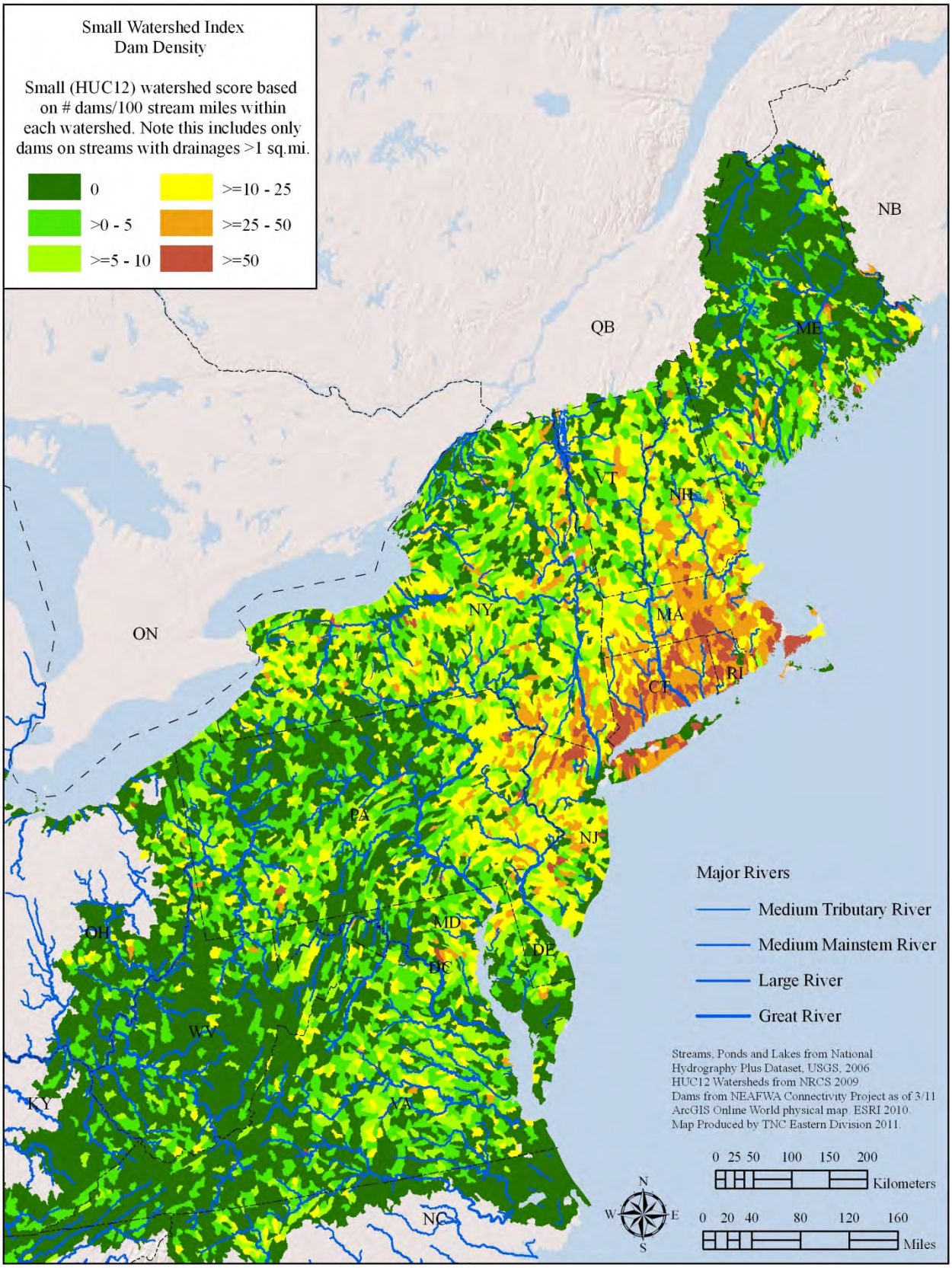



| | Headwater | Creek | Small River | Medium Tributary River | Medium Mainstem River | Large River | Great River | All Rivers |
|---|---|---|---|---|---|---|---|---|
| Region Total | 5.96 | 7.84 | 8.38 | 7.25 | 6.74 | 4.20 | 4.21 | 6.94 |
| Mid-Atlantic Total | 3.88 | 4.84 | 3.97 | 3.23 | 2.93 | 3.27 | 5.08 | 4.18 |
| New England/NY Total | 8.99 | 11.36 | 14.23 | 13.74 | 12.13 | 5.54 | 0.00 | 10.62 |

**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.

Connected Stream Networks: 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.

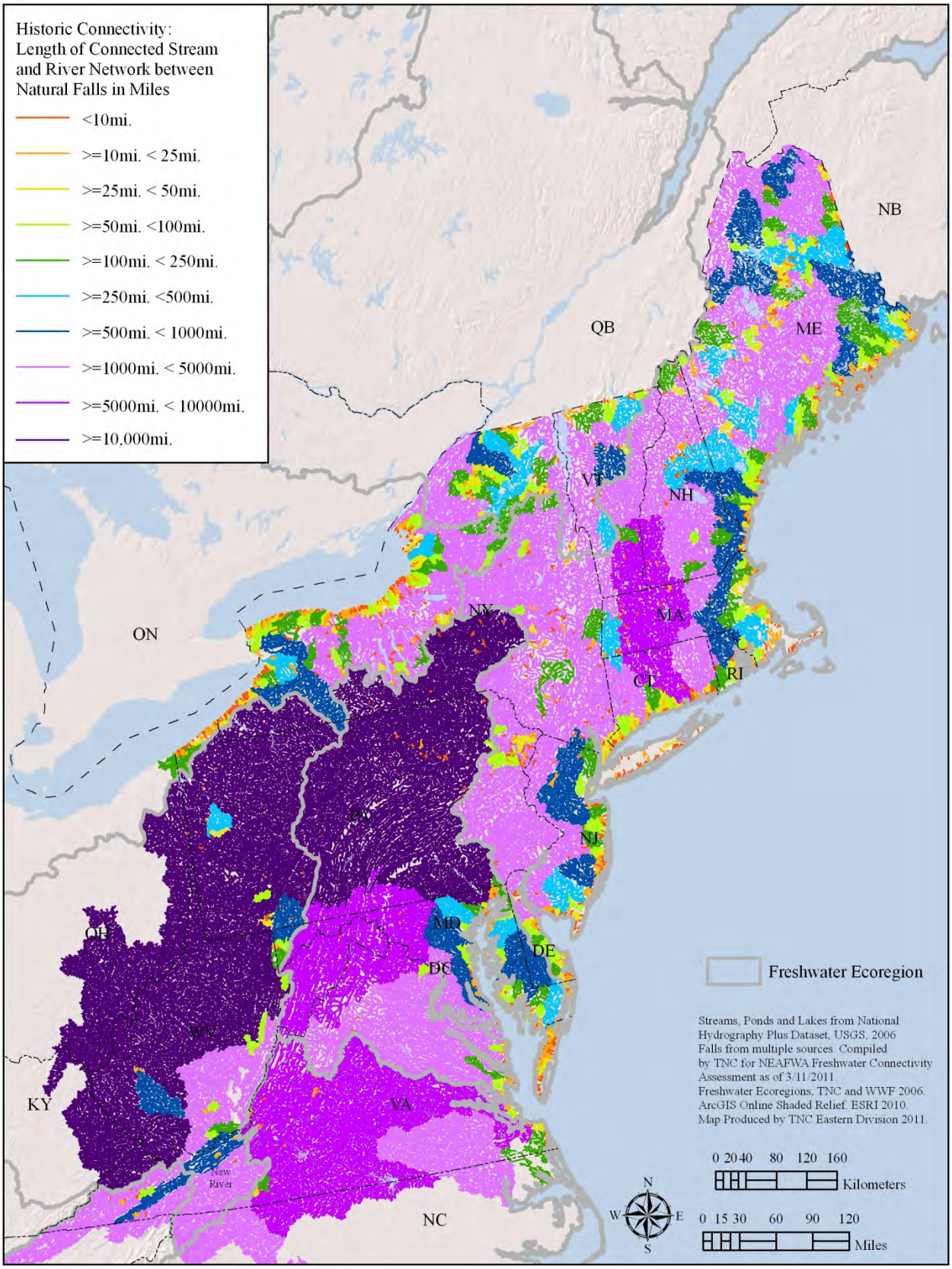
Resident fishes also move extensively throughout the freshwater network, to access seasonal habitats for feeding and spawning, to find refuge during times of stress, and to colonize new areas. Some species of trout and sucker, for example, regularly move 1 to 10 km within a stream network to spawn. Barriers 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.**

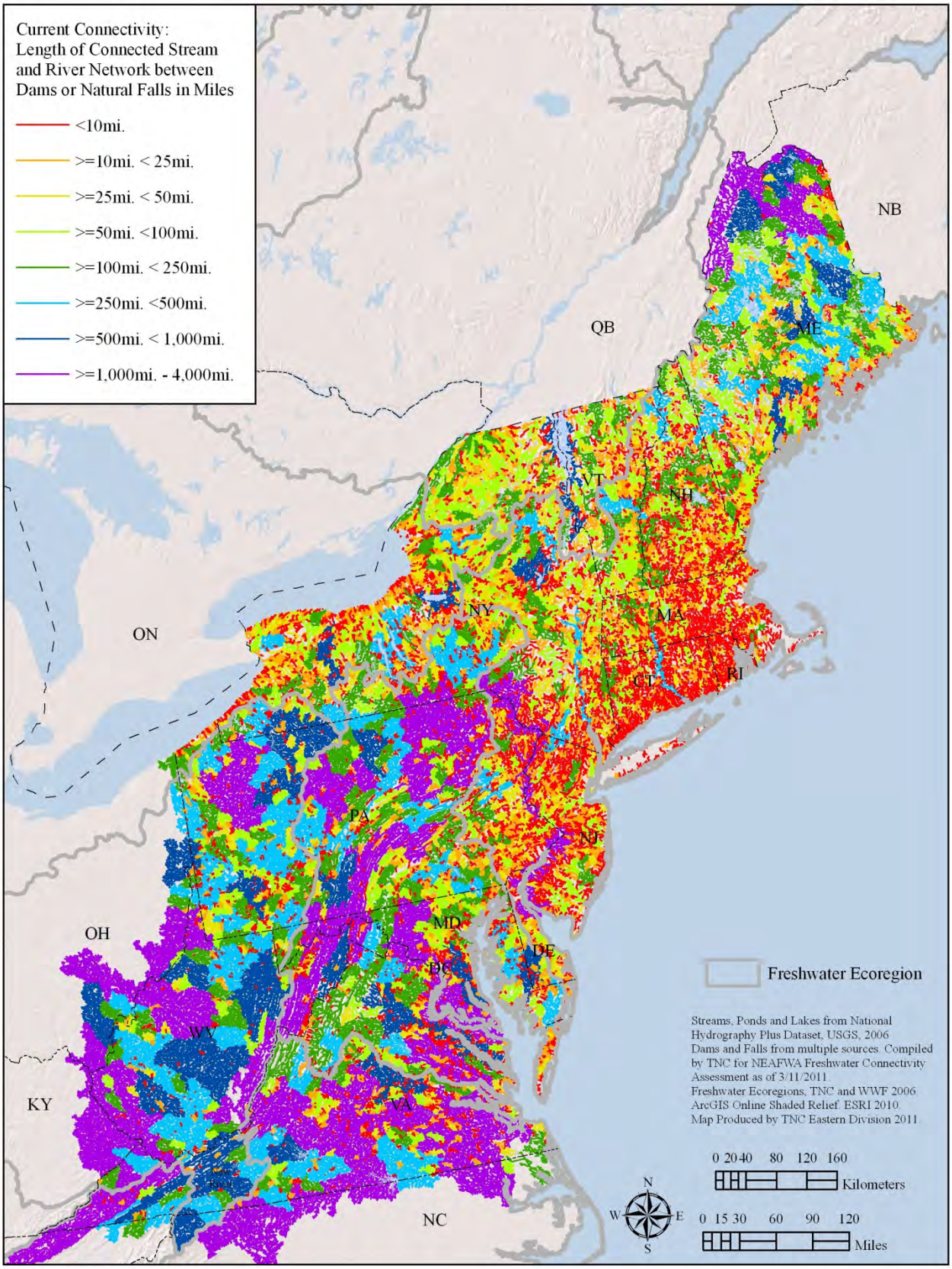
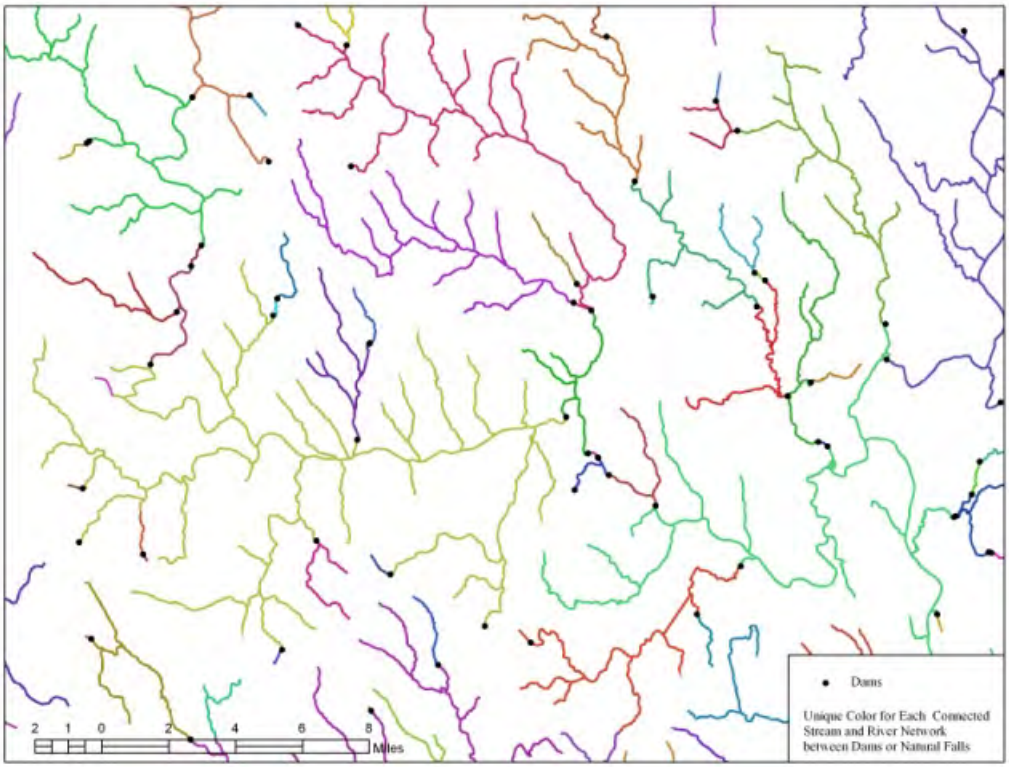
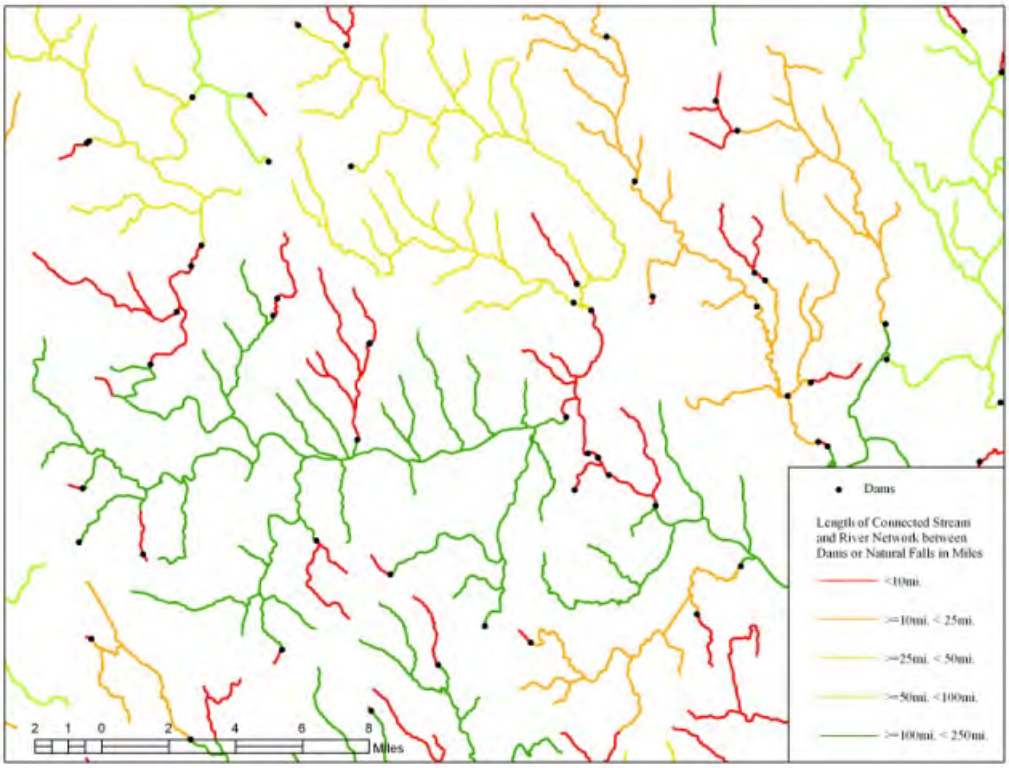


**Figure 12 (a, b). Example of functionally connected stream networks.** Each network is bounded by dams and/or the topmost extent of headwater streams.

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.

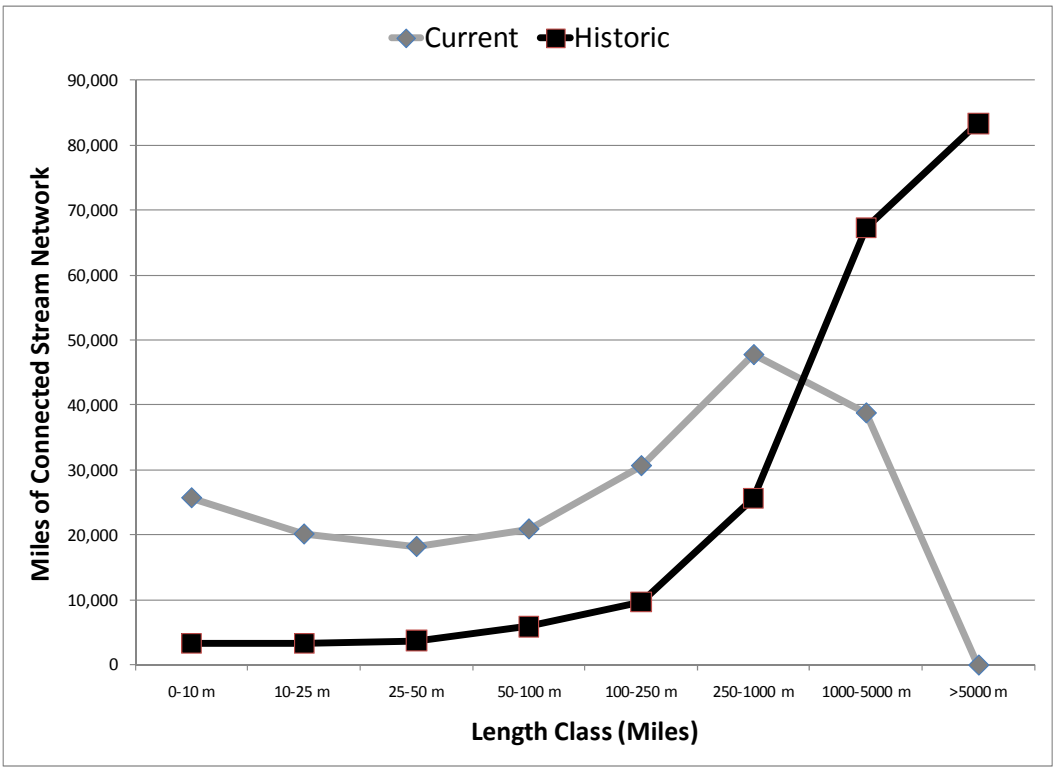
Comparing the current to the historic connected networks revealed a striking loss of large networks and a corresponding gain of smaller networks (Table 5, Figure 13, Map 6 and 7). Historically 83 percent of stream miles were part of connected networks over 500 miles in length; currently only 29 percent 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.

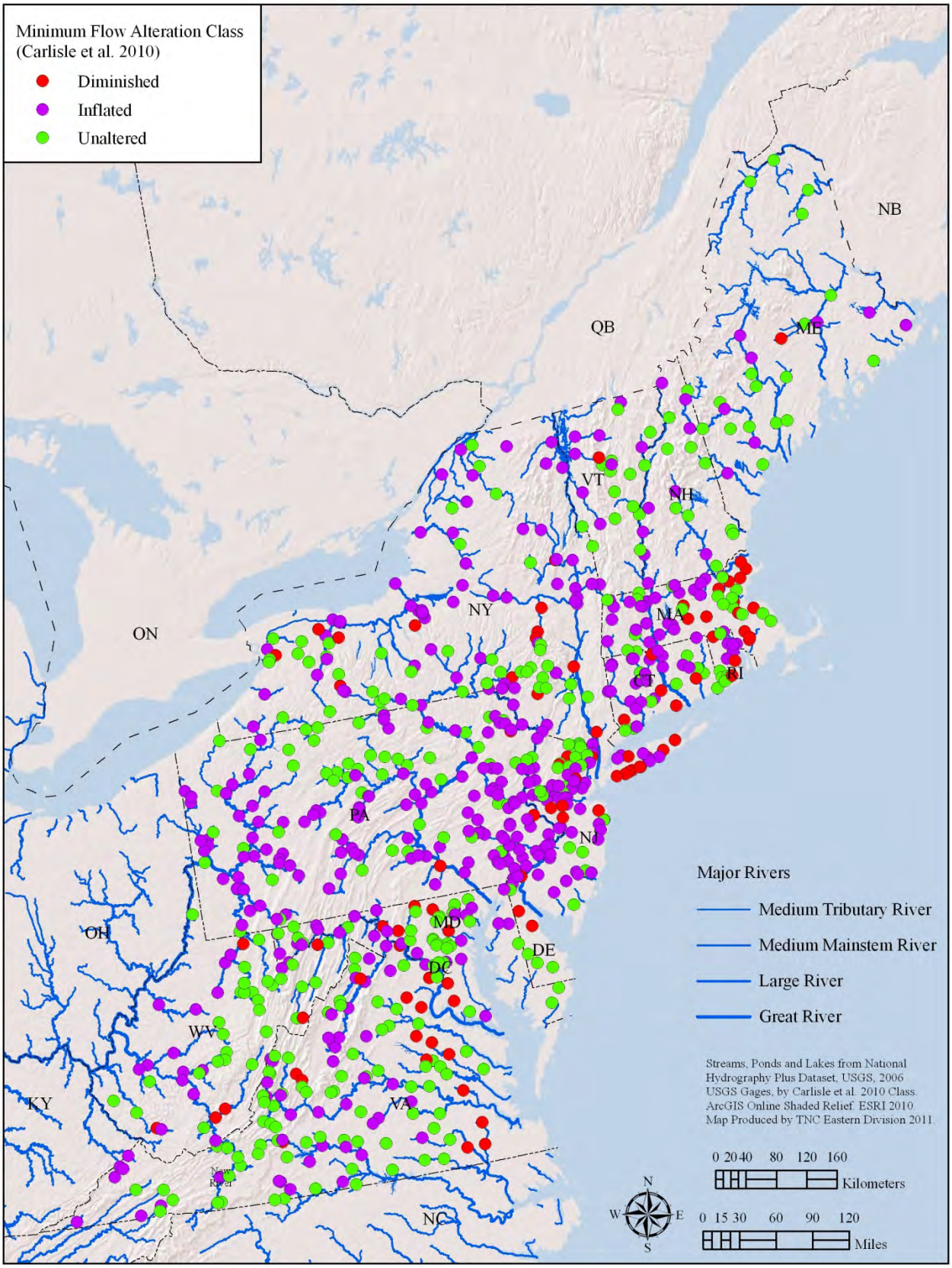
Results for the 807 gages in our region showed that 66 percent of the sites had either altered minimum flows, altered maximum flows, or both; 34 percent were unaltered (Table 6). Minimum flows were the most effected: 49 percent had inflated minimum flows, 11 percent had diminished minimums and 40 percent 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.

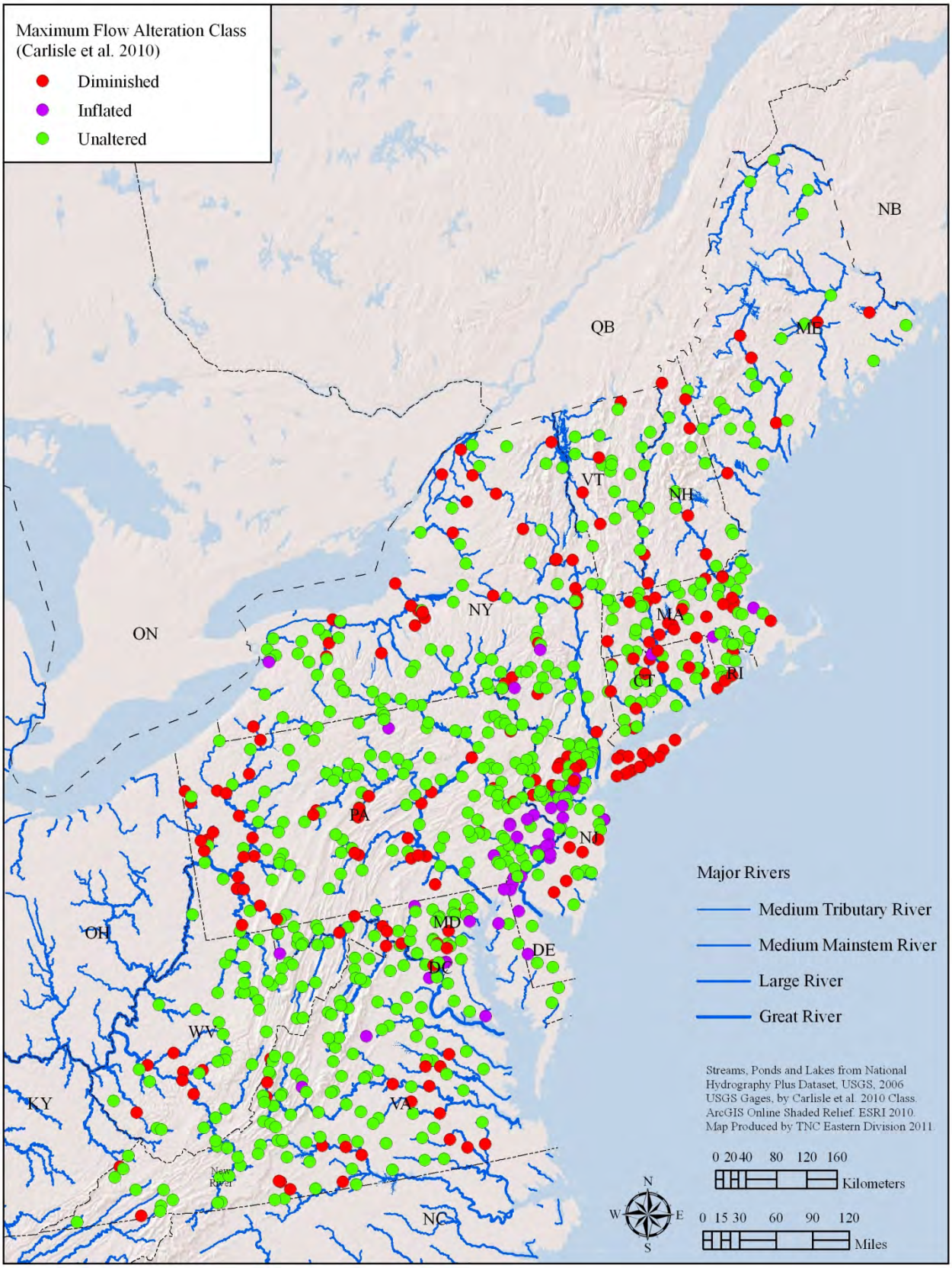
**Table 6. Streams and rivers by size class, region or subregion, and flow alteration class.**

| | | 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.

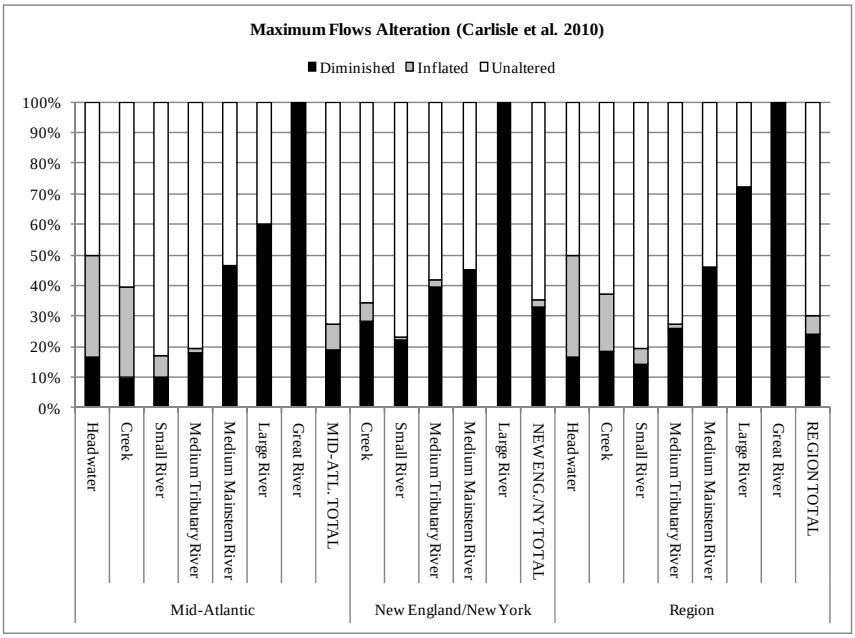
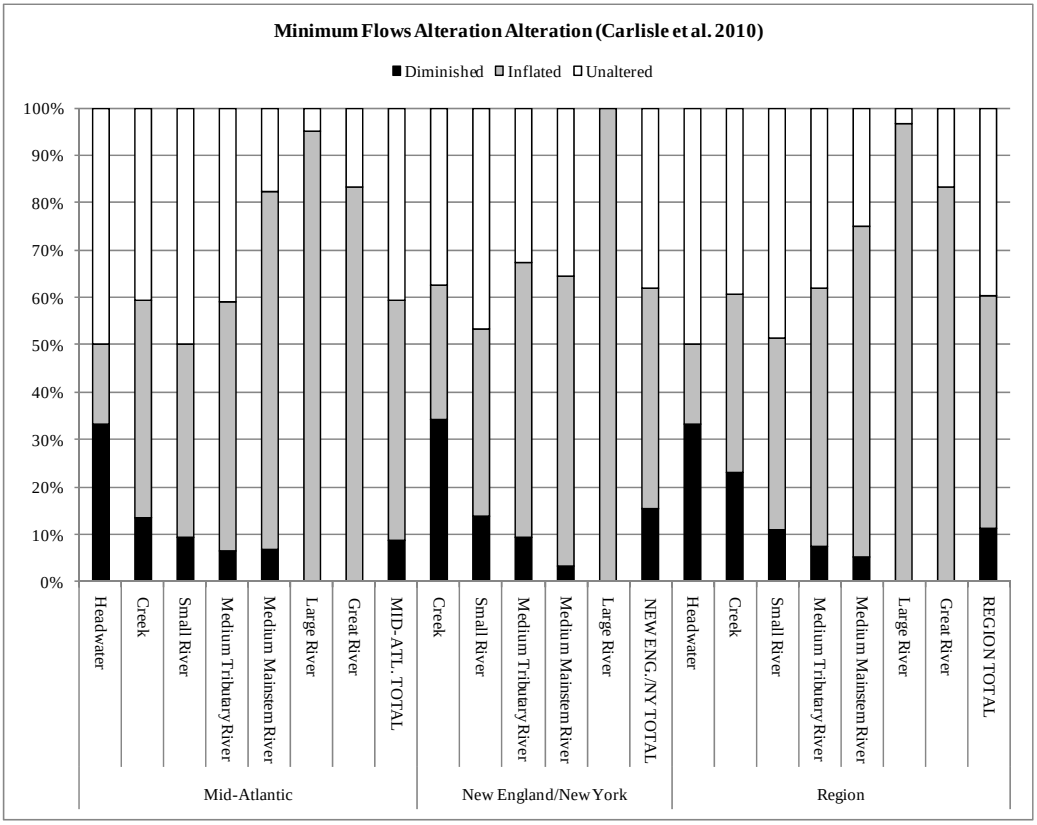


**Figure 15. Minimum Flows:** percent of altered minimum flows in streams by size class, and region.




## 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.**

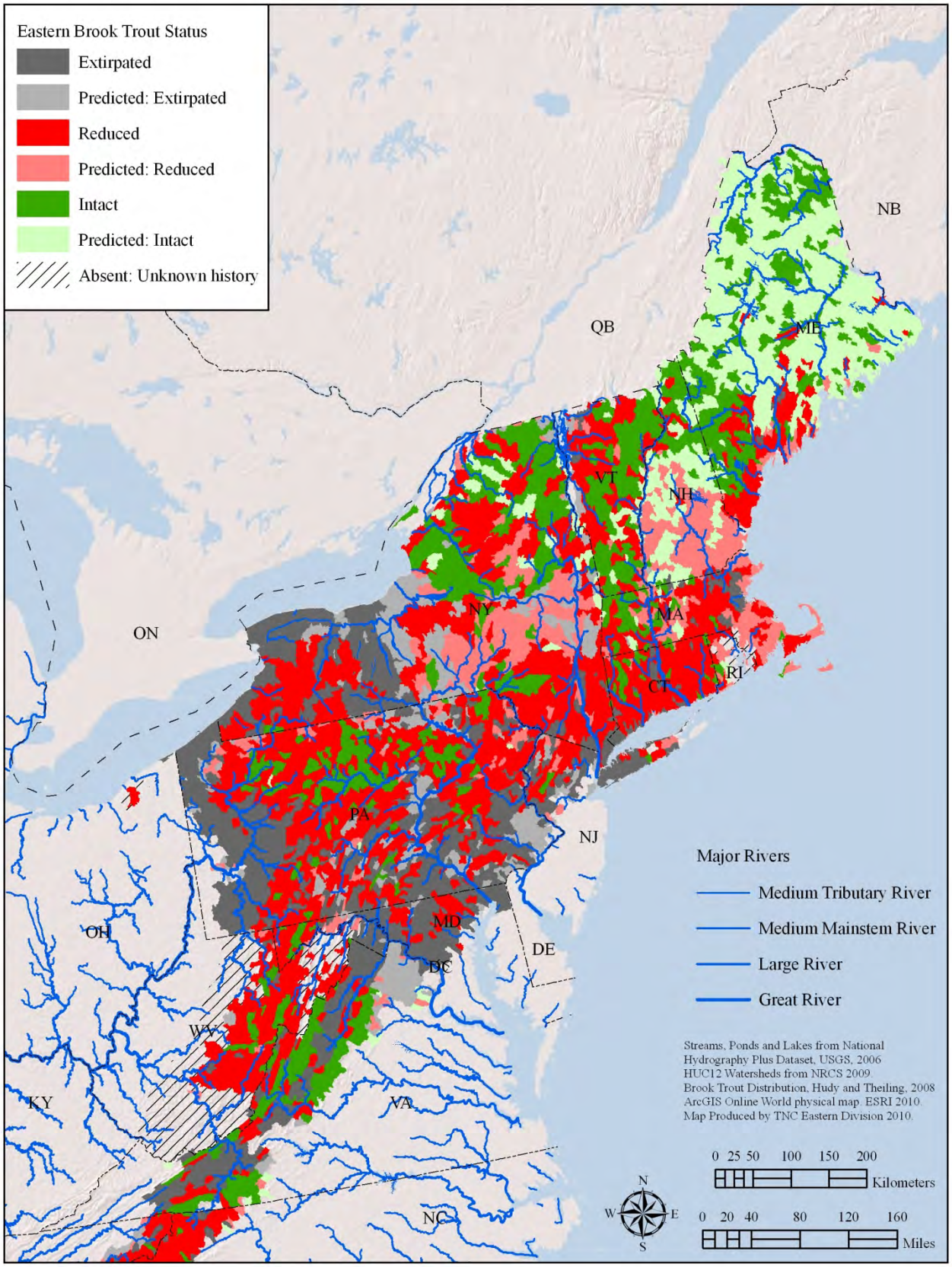
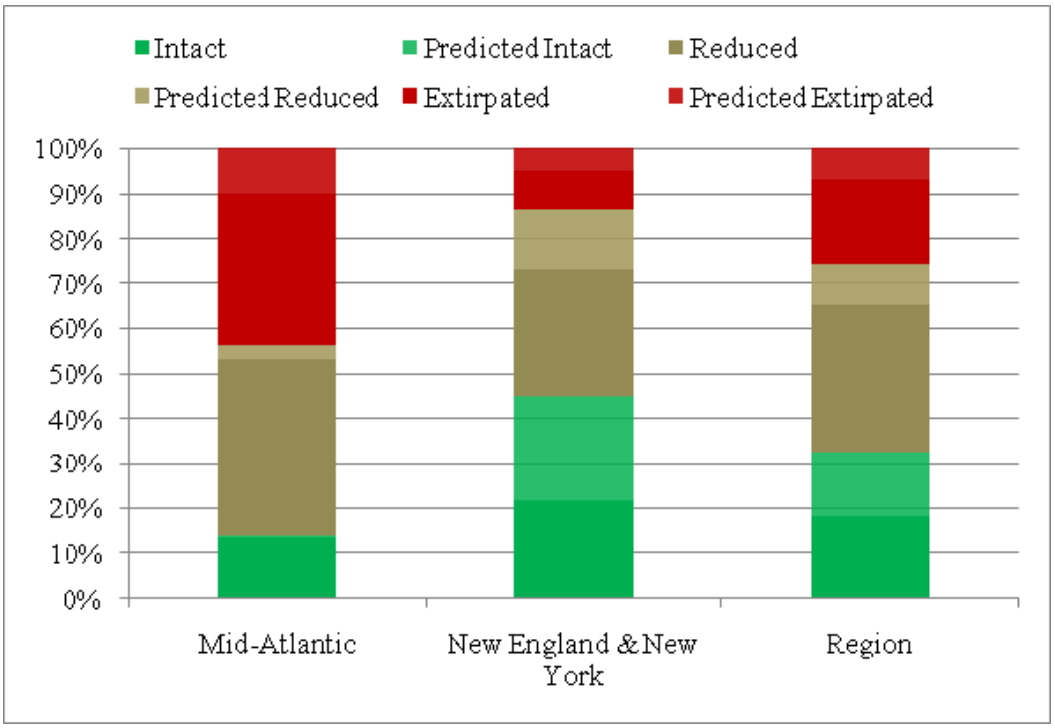


**Figure 16. The Percent of the historic brook trout range by current status.**

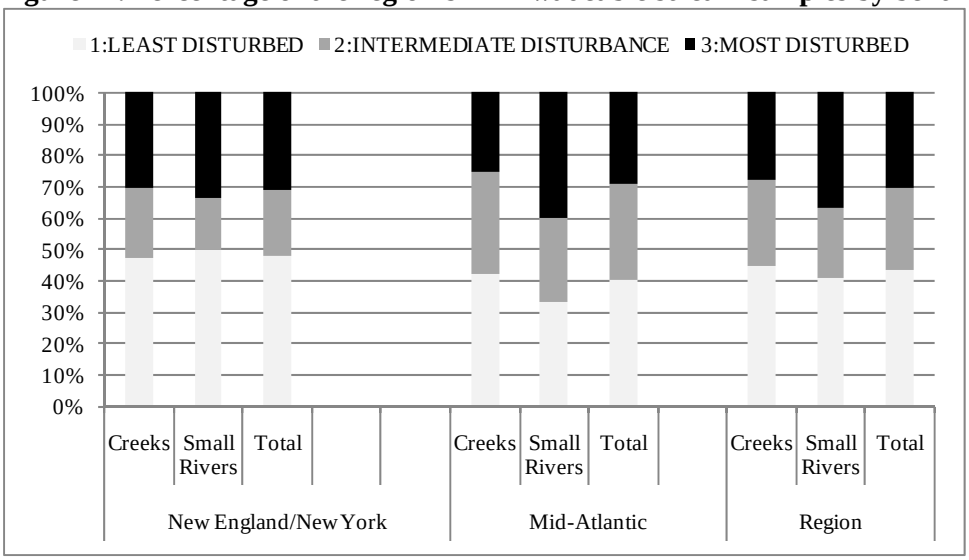



Index of Biotic Integrity: The biological condition of water resources can be assessed by analyzing the characteristics of the benthic organism communities. These characteristics include the composition and relative abundance of key macro-invertebrates that reflect the quality of their environment and 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.

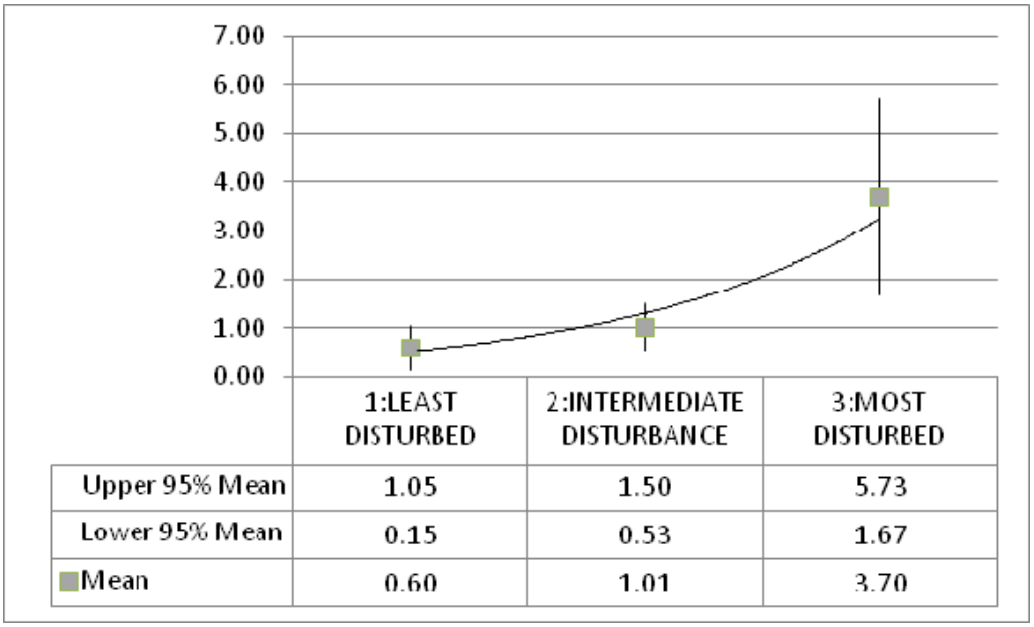
For this region, the EPA results indicated that 44 percent of creeks and small rivers were in the undisturbed class, 26 percent in the intermediate disturbance class and 30 percent in the most disturbed class. Creeks appear to be slightly less disturbed than small rivers (Figure 17). In New England and 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.**

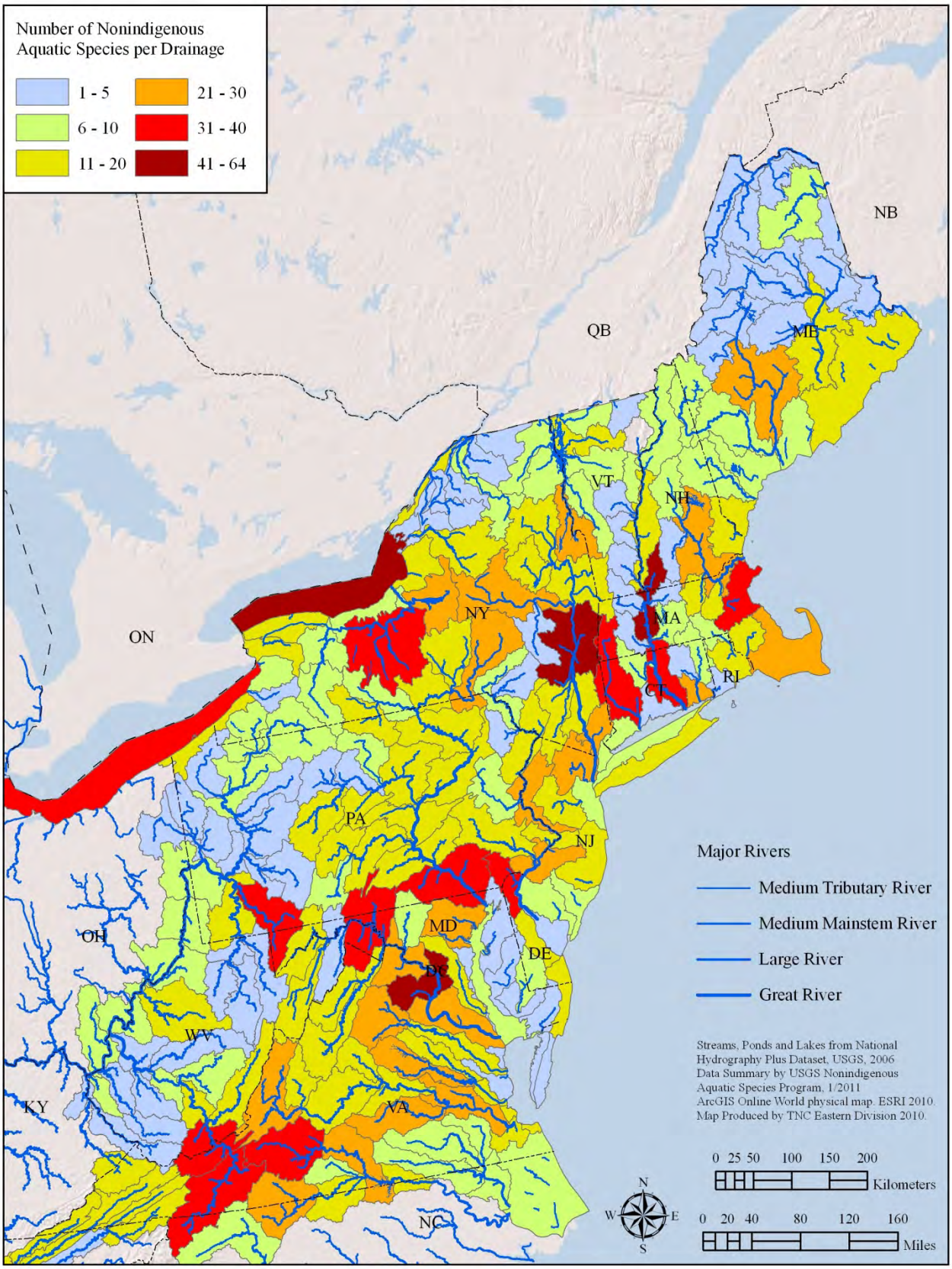


**Figure 19. Non-indigenous Aquatic Species**. The charts show the major taxonomic groups for the full region and both sub-regions.

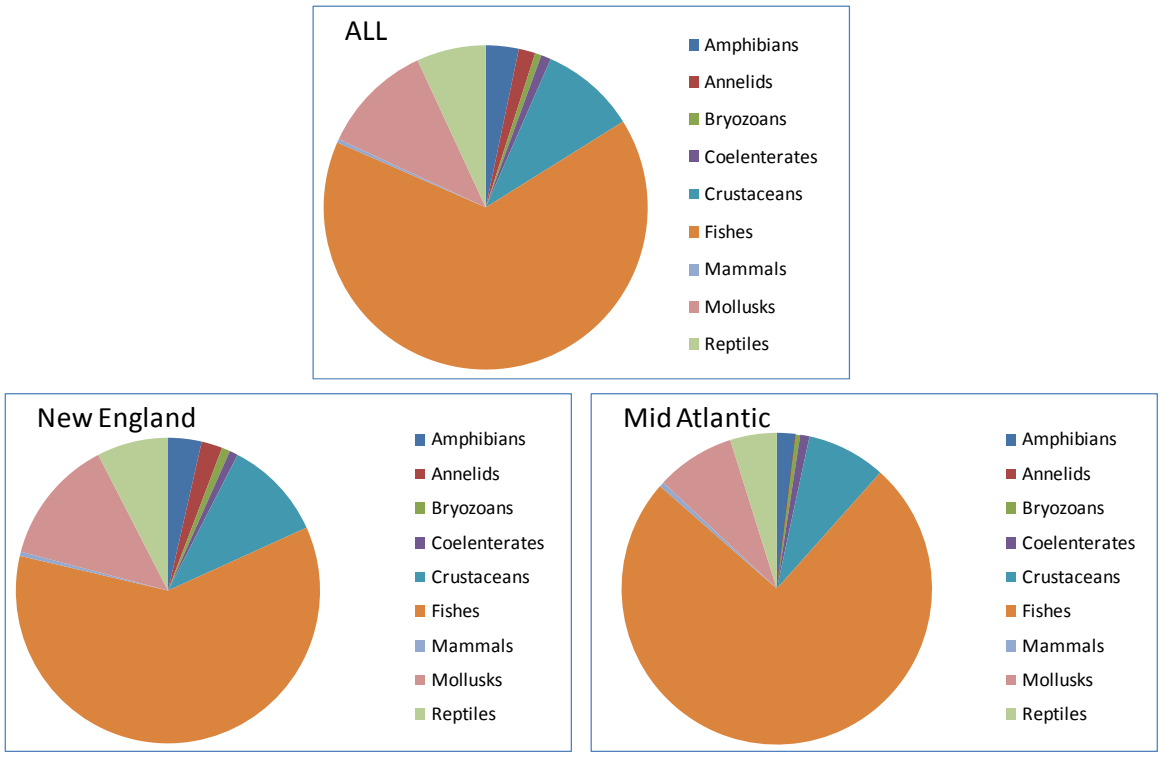



**Figure 20: Major pathways of non-indigenous aquatic species introductions.**

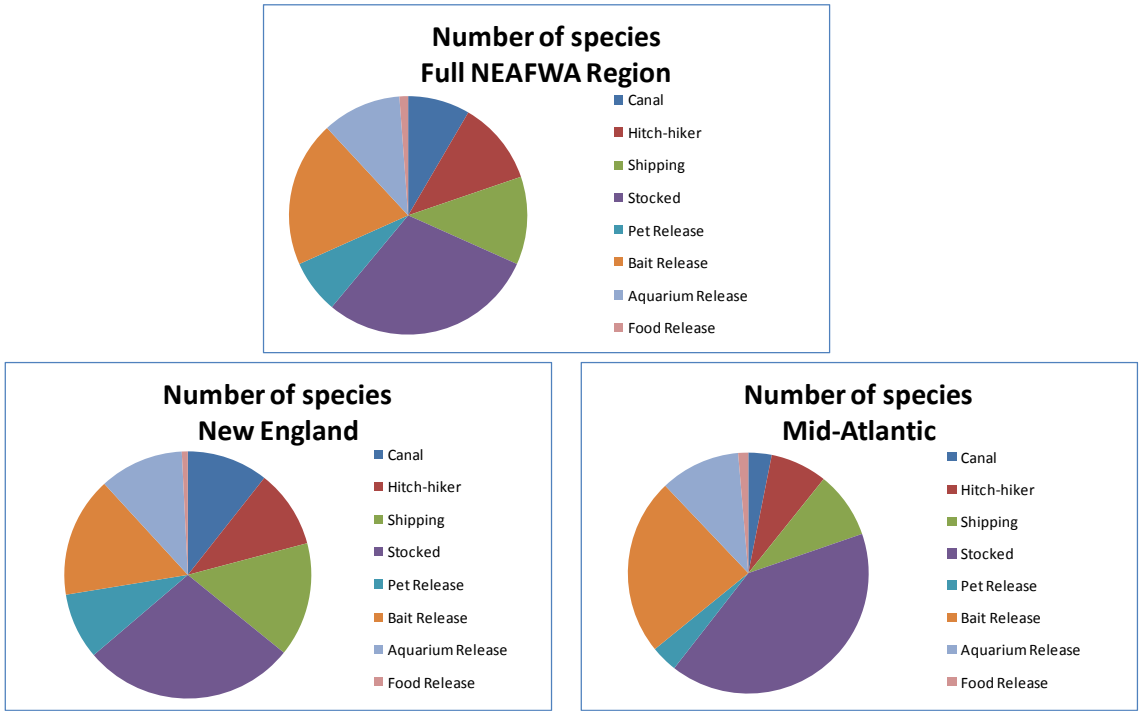
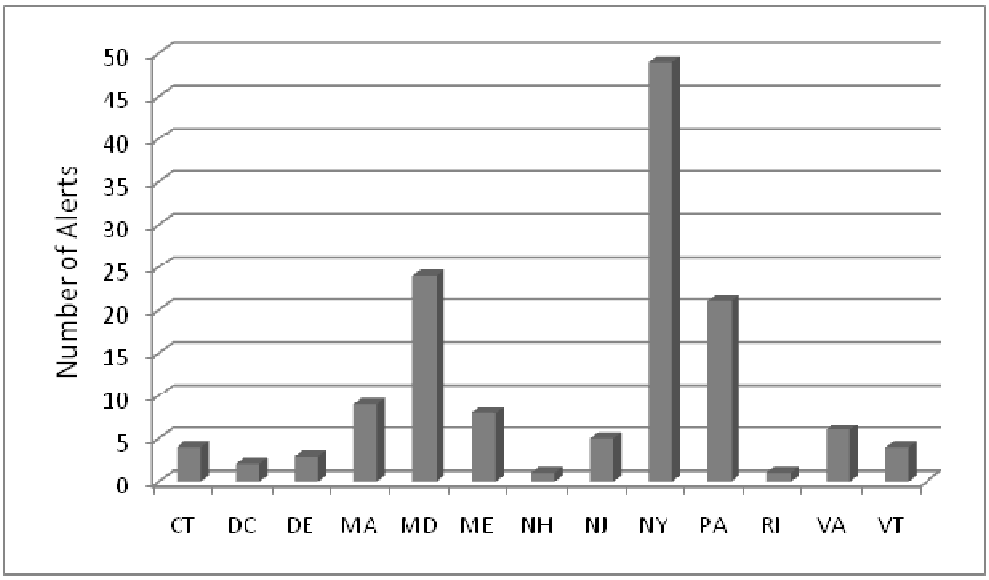


**Figure 21. Number of non-indigenous aquatic species alerts by state in alphabetical order.**



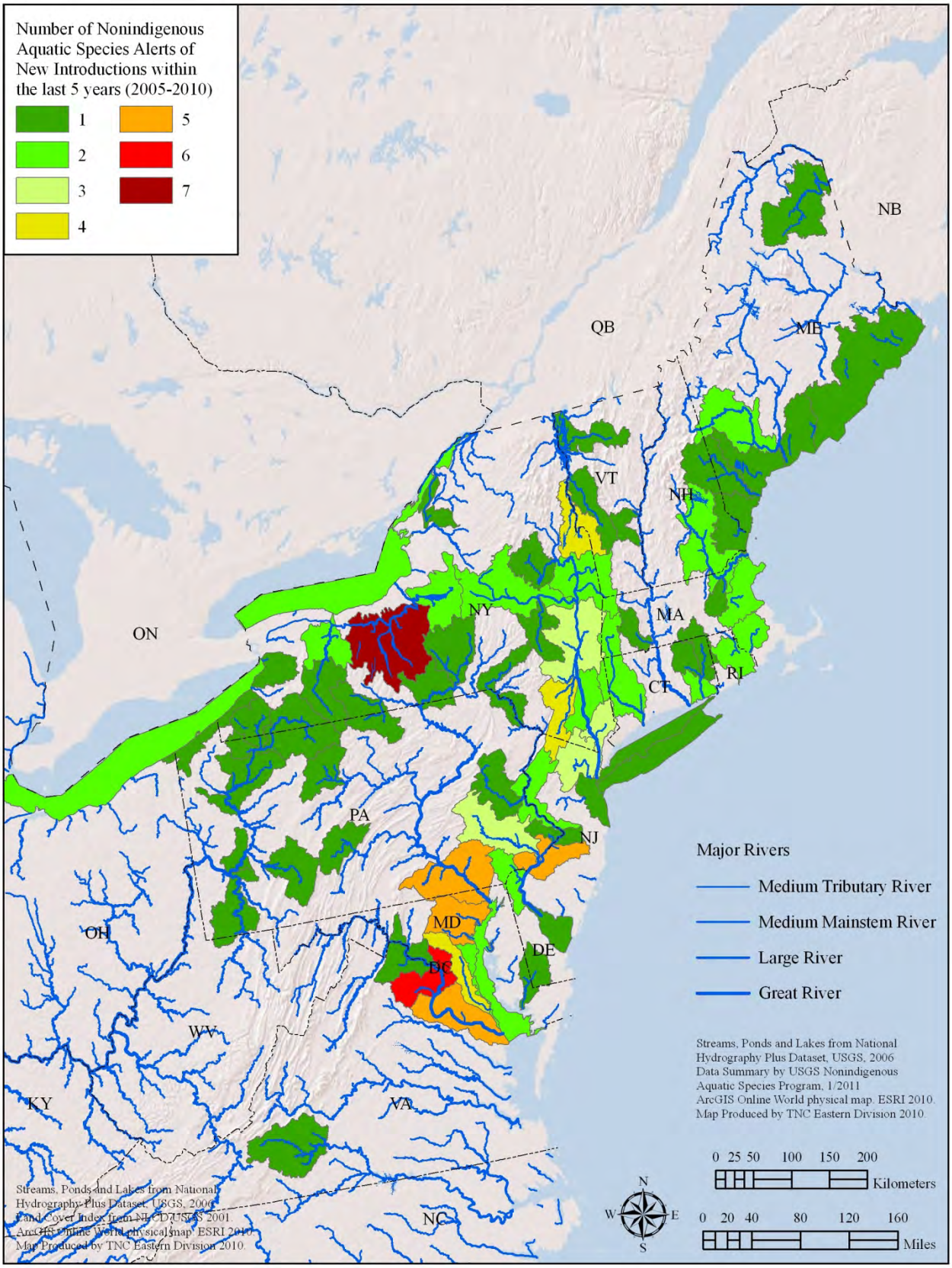

The spatial distribution of alerts by HUC8 watershed (Map 12), shows that watersheds with more than three alerts seem to be associated with the lower mainstems watersheds of large rivers such as the Potomac, Susquehanna, Delaware, and Hudson and in the watersheds of the Finger Lakes and Southern Lake 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:

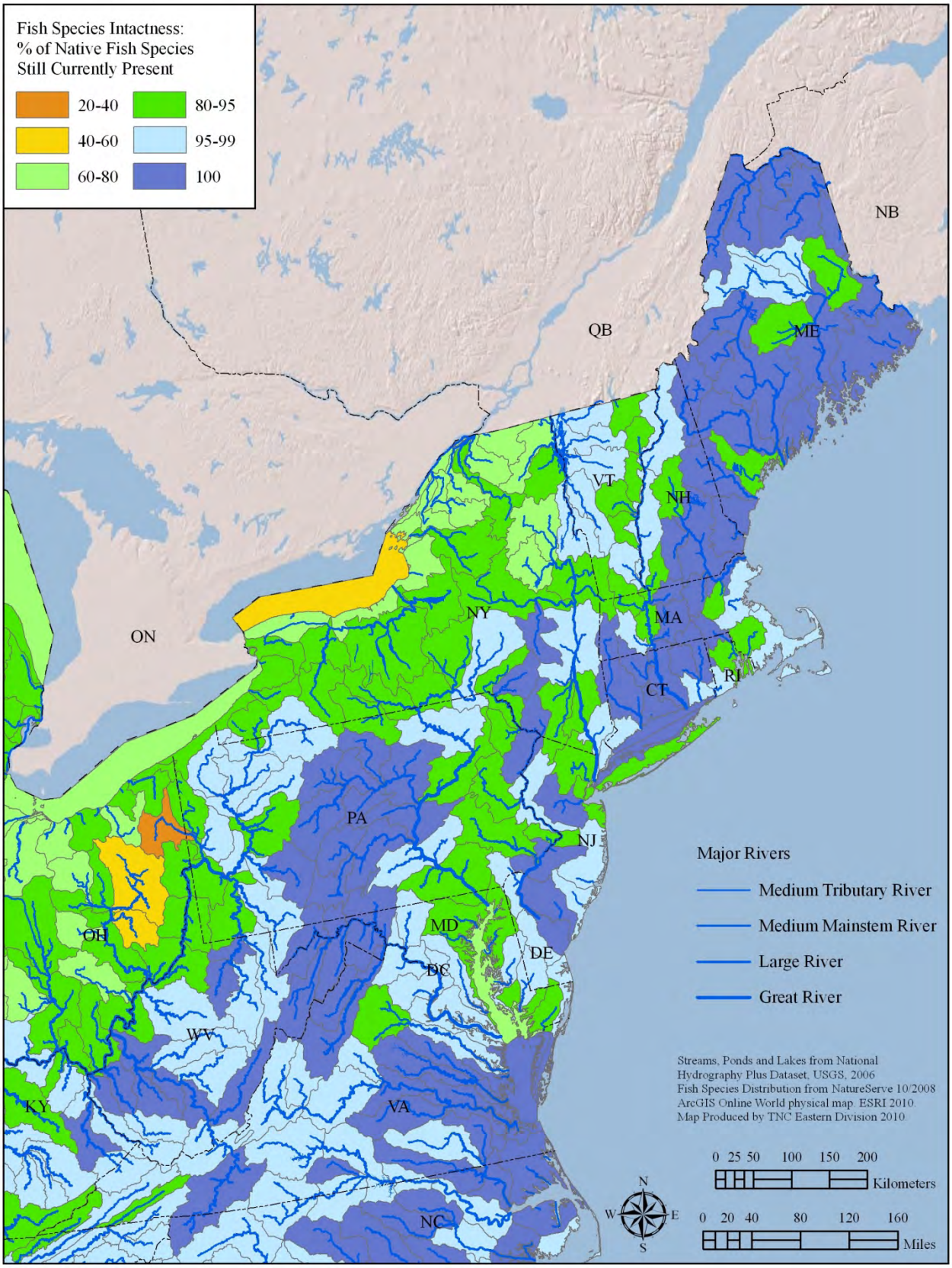
*Fish Faunal Intactness = (# of current native species / # of historic native species * 100)*

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.**



## 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.**

Center for Watershed Protection (CWP). 2003. Impacts of Impervious Cover on Aquatic Systems. Watershed Protection Research monograph No. 1.

Carlisle, D. M., Wolock, D.M., and Meador, M.R. 2010. Alteration of stream flow magnitudes and potential ecological consequences: a multiregional assessment. Frontiers in Ecology and the Environment. Doi: 10.1890/100053

Fuller, P. 2011. Nonindigenous Aquatic Species Northeast Summary. USGS Nonindigenous Aquatic Species Program, Gainesville, FL

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.

Hudy, M., T.M. Thieling, N. Gillespie and E.P. Smith. 2008. Distribution, status, and land use characteristics of subwatersheds within the native range of brook trout in the eastern United States. North American Journal of Fisheries Management **28**(4)**:**1069-1085.

King, R.S. and M.W. Baker. 2010. Considerations for analyzing ecological community thresholds in response to anthropogenic environmental gradients. Journal of the North American Benthological Society. **29**(4)**:**998.

Langdon, R., J. Andrews, K.Cox, Fiske, S., Kamman, and N., Warren, S 1998. A Classification of The Aquatic Communities of Vermont. Prepared by The Aquatic Classification Workgroup for The Nature Conservancy and the Vermont Biodiversity Project.

NatureServe. 2008. Watershed Distribution Maps of Freshwater Fishes in the Conterminous United States. Version 2. Arlington, VA. U.S.A.

Olivero, A. P. and M.G. Anderson. 2008. Northeast Aquatic Habitat Classification System. The Nature Conservancy, in Collaboration with the Northeast Asssociation of Fish and Wildlife Agencies. 88p.

Palone, R. and Todd, A. 1997. Chesapeake Bay Riparian Handbook: A Guide for Establishing and Maintaining Riparian Forest Buffers. Chesapeake Bay Program 1997.

Stuart, C. et al. 2003. Living Waters Technical Report. Natural Heritage and Endangered Species Program. 103p.

The Nature Conservancy. 2011. Northeast Regional Dam Dataset Version 3/1/2011. The Nature Conservancy Eastern Conservation Science Office. Boston, MA.

The Nature Conservancy. 2009. Eastern U.S. Secured Lands. Various scales.

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

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/

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.

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.

USGS and USEPA. 2006. National Hydrography Dataset Plus (NHD-Plus). 100,000.

USGS. 2009. Geographic Names Information System (GNIS) 1.2009.

Vannote, RL,G. W. Minshall, K. W. Cummins, J.R. Sedell, and E. Gushing 1980. The river continuum concept. Can. J. Fish. Aquat. Sci. 37: 130-137.

Walsh, M., Deeds, J. and Nightengale, N. 2007. User's Manual and Data Guide to the Pennsylvania Aquatic Community Classification. Pennsylvania Natural Heritage Program and Western Pennysylvania Conservancy.

Welsch, D.J. 1991. Riparian Forest Buffers. U.S. Forest Service Northeastern Area State & Private Forestry. Radnor, PA. NA-PR-07-91. 20 pages.

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.

# Appendix 7-1

## Acres of Land within 100m buffer of Streams and Rivers

| | | Non-Secured Agriculture | Non-Secured Developed | Non-Secured Natural | GAP 1&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 Development | Non-Secured Natural | GAP 1&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 | [illegible] | Non-Secured Natural | [illegible] | GAP 3 Total | Total |
|---|---|---|---|---|---|---|---|
| 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** |
| 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

M. Anderson and A. Olivero Sheldon

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.

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.**

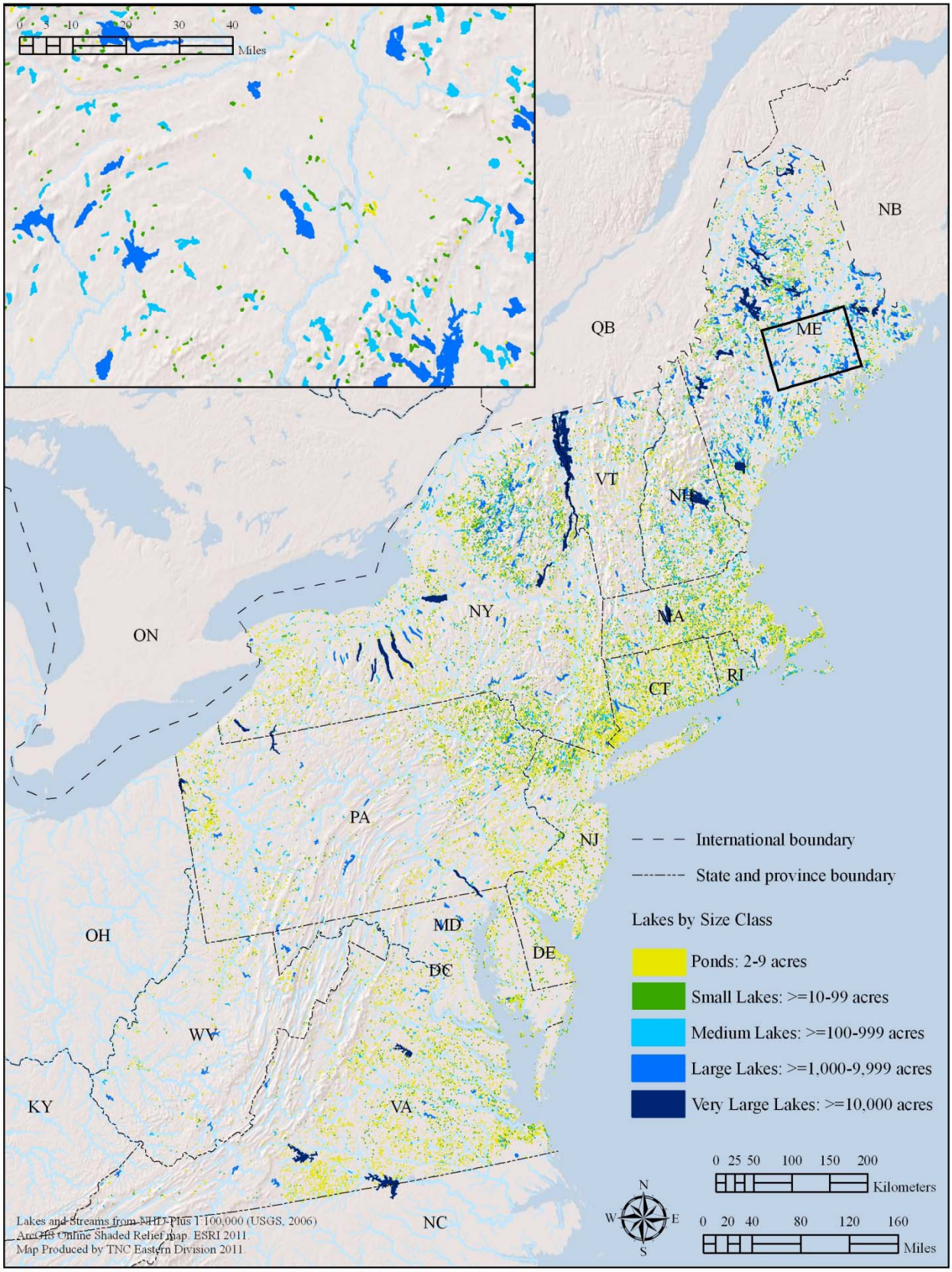


**Figure 1. The area of lakes and ponds (in acres) in the region and sub-regions.**

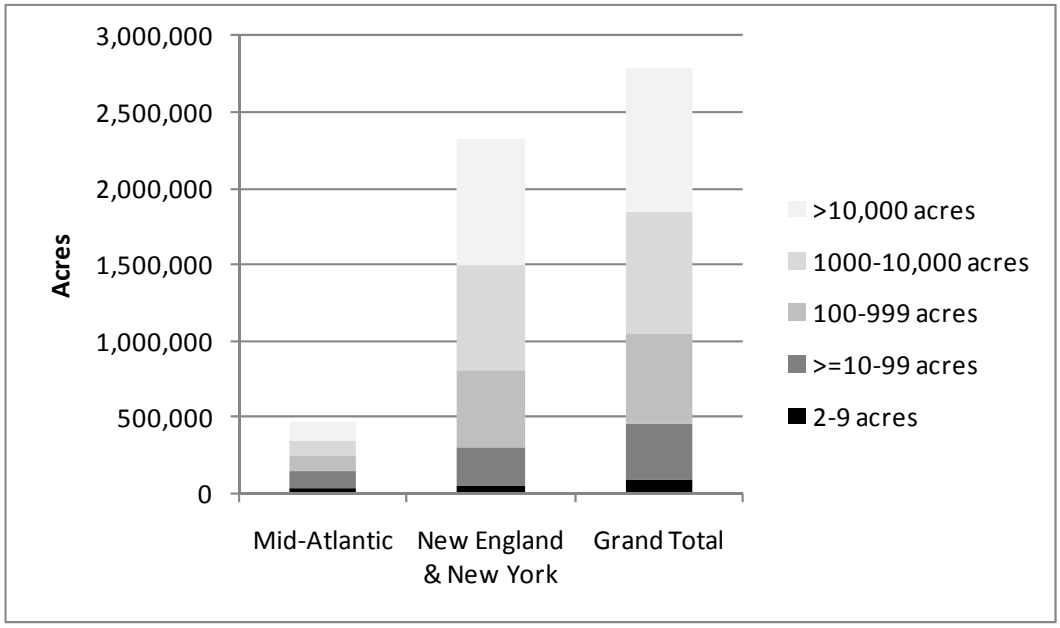



**Table 1. Number and acreage of lakes and ponds in the region (also see Map 1).**

| | 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 secured for nature, 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 secured for nature than of ponds (Map 2).

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

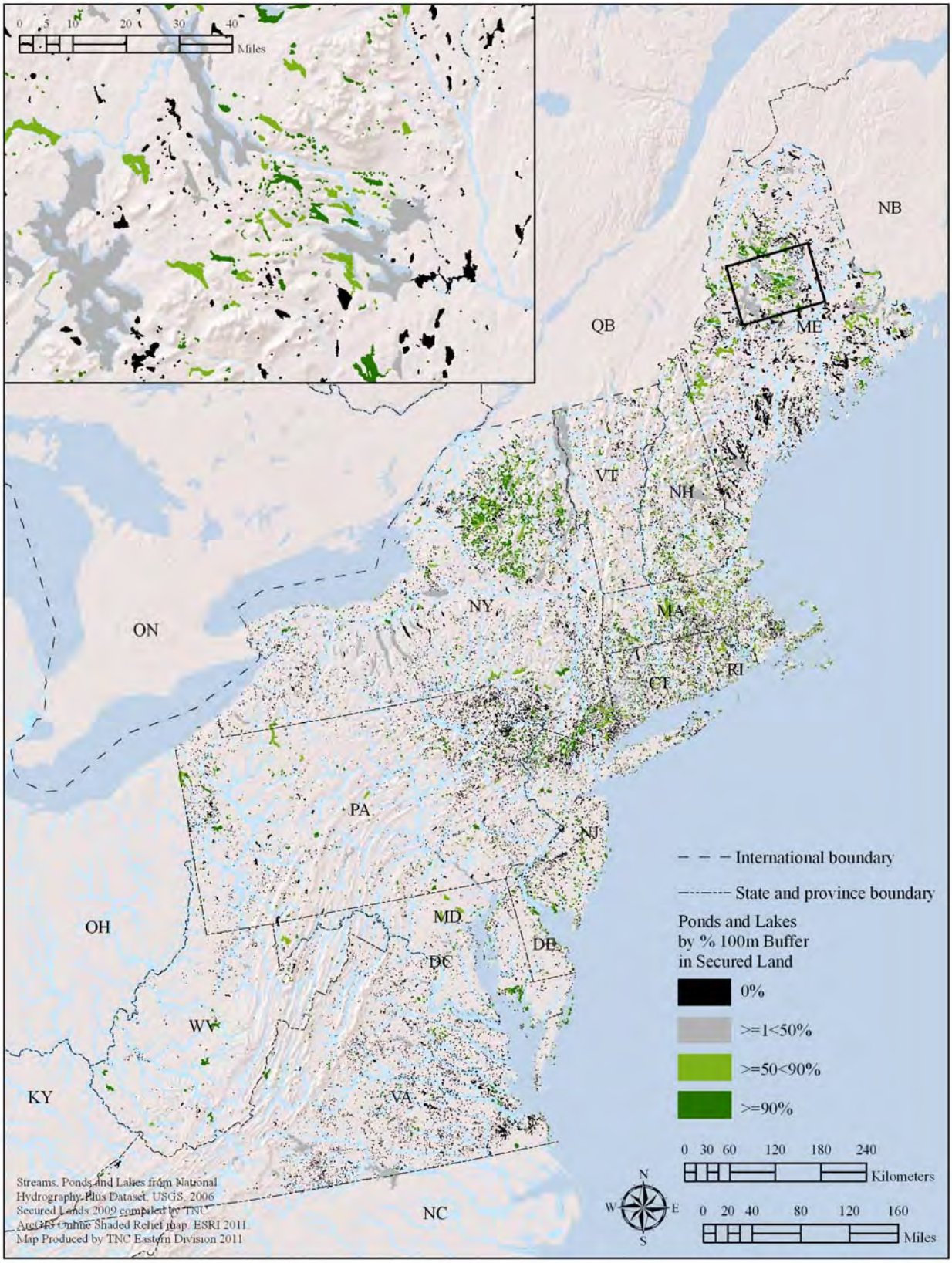
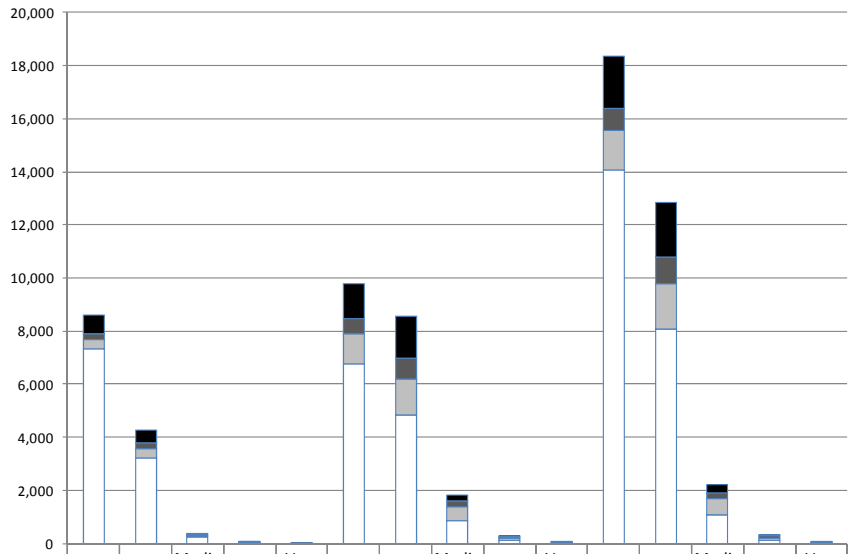


**Figure 2. Conservation status of lakes and ponds by individual occurrences.** Note that water bodies do not always fall completely inside or outside the secured land boundaries. For our purposes a feature may be considered secured if greater than 50-90 percent of the buffer is within secured land. 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).

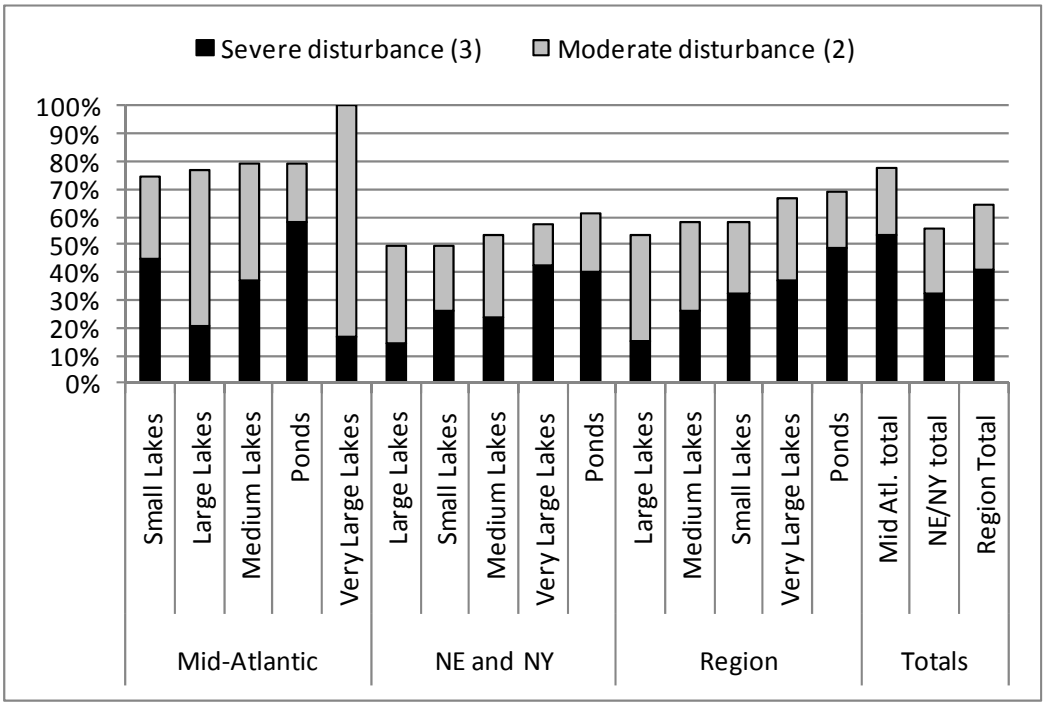
The summed impact index ranged from 100 for a lake with its shoreline completely developed, to 0 where the shoreline was completely composed of natural cover types. To develop classes, we compared the impact index scores against the field measured scores of shoreline human disturbance for 188 lakes

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):

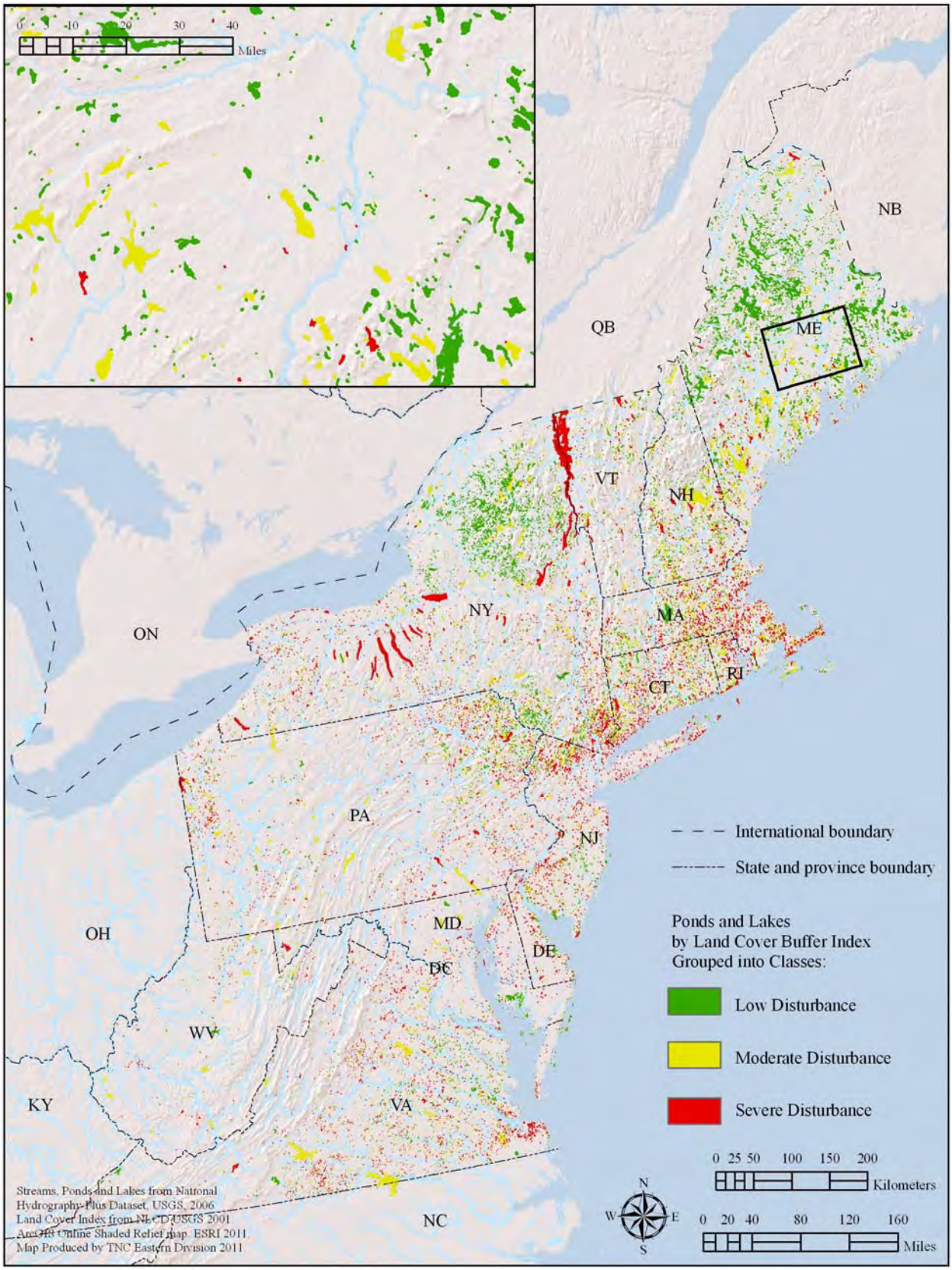
1. Low disturbance: impact index 0 < 3.7 (mean 1.3)
2. Moderate disturbance: impact index >= 3.7 < 15.0 (mean 8.4)
3. Severe disturbance: impact index >=15.0 (mean 26.2)

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.**

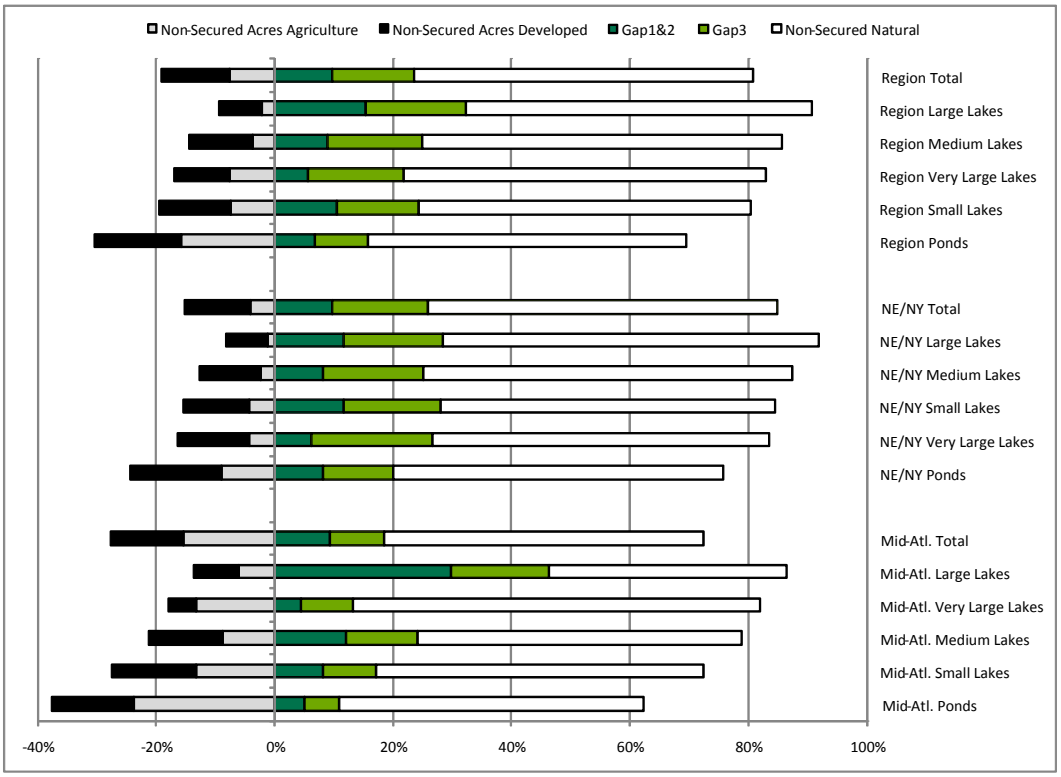


Conversion Versus Securement: To test whether conversion or securement dominated in the shoreline buffer zone, we contrasted the amount of agriculture and developed land with the amount of secured land within the buffer using the two datasets previously described. In general, conversion decreased and 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 securement primarily for nature. 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).

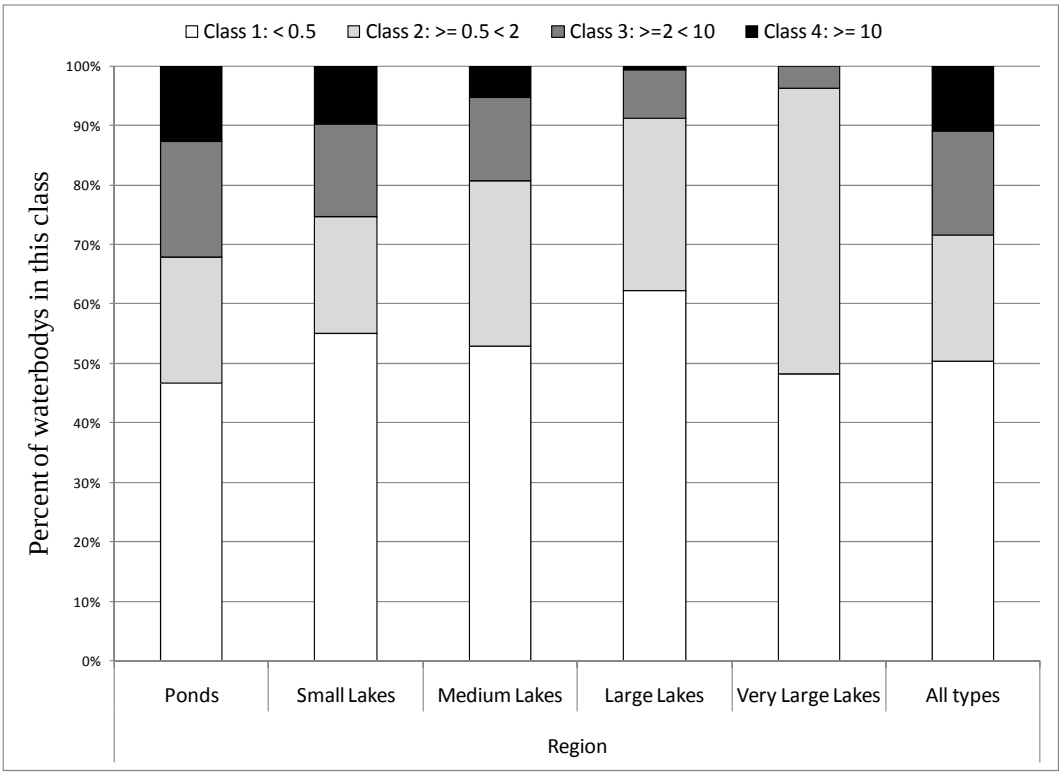
To create this metric, we overlaid the USGS 2001 National Land Cover Impervious Surface Dataset (Yang 2002) on the upstream watershed area of each waterbody and tabulated the amount of impervious surface present. For lakes that were connected to streams, we used the impervious surface of their entire 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.**

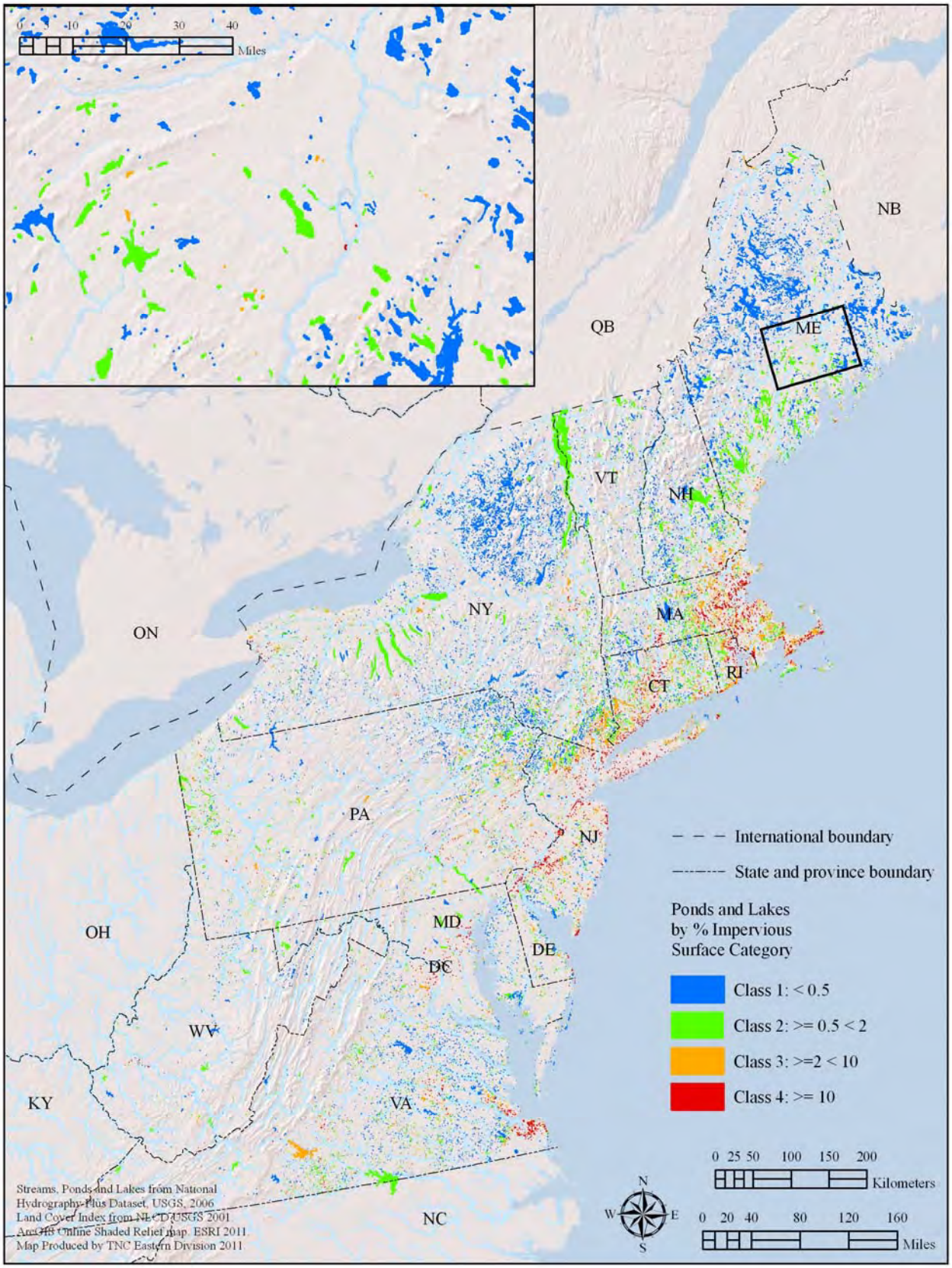


**Table 3. Percent of Lakes and Ponds by Upstream Impervious Class**

| | | 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.**

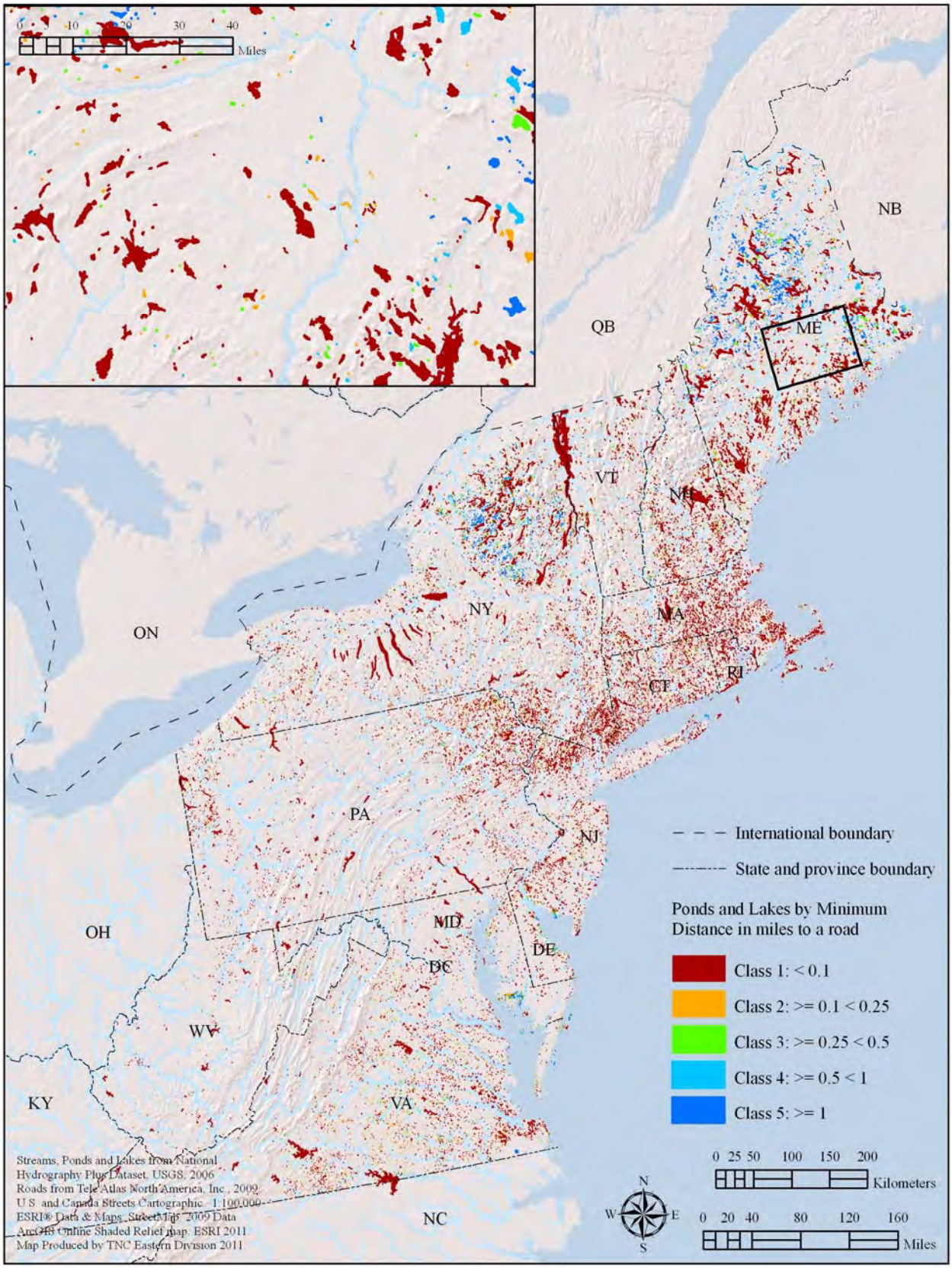
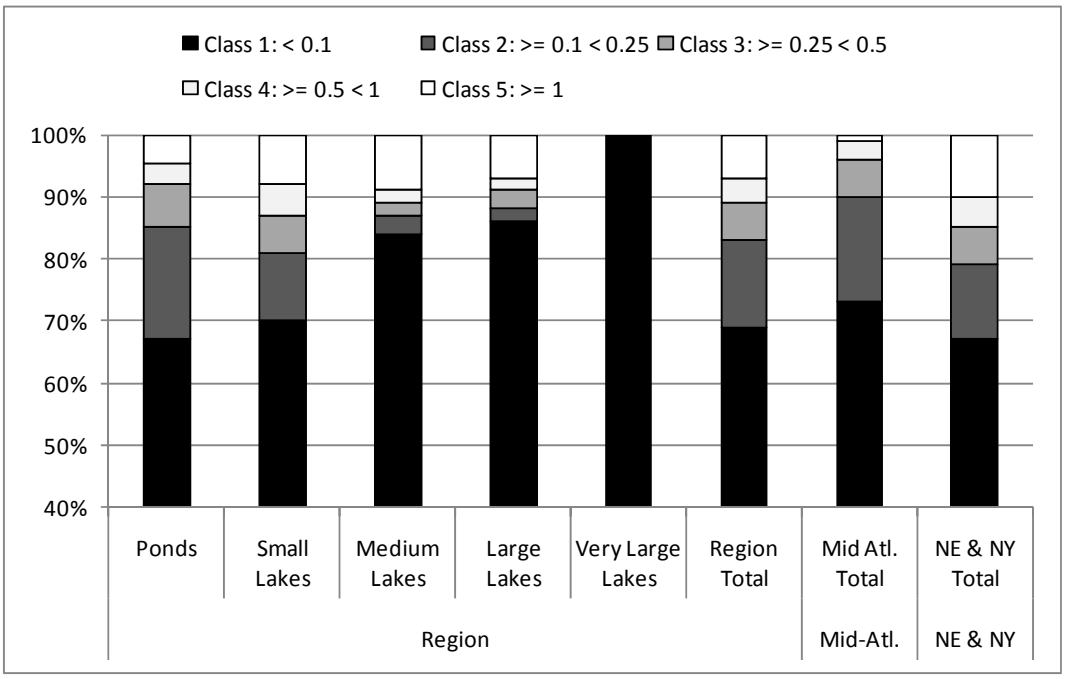


**Figure 5. The proportion of each lake type in each distance to road class (in miles**). Few lakes and ponds are over 1 mile from a road (Class 5, 7 percent). Most are less than one tenth mile from a road (Class 1, 69 percent).




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.**

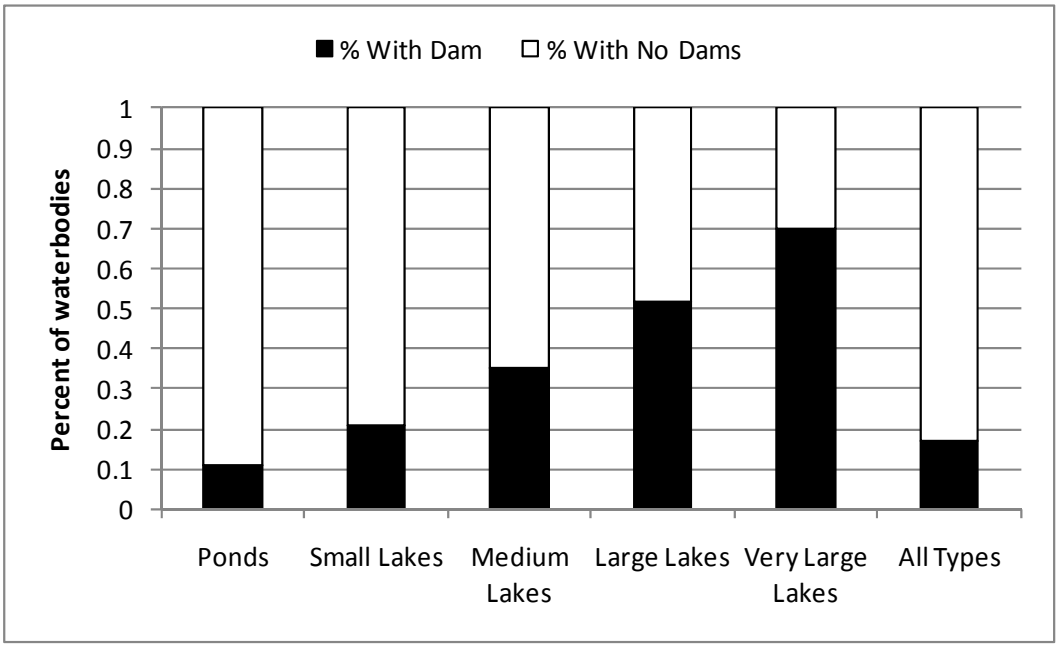



**Table 4. The percentage of lakes with upstream or downstream dams, arranged by type and sub-region**.

| | 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.

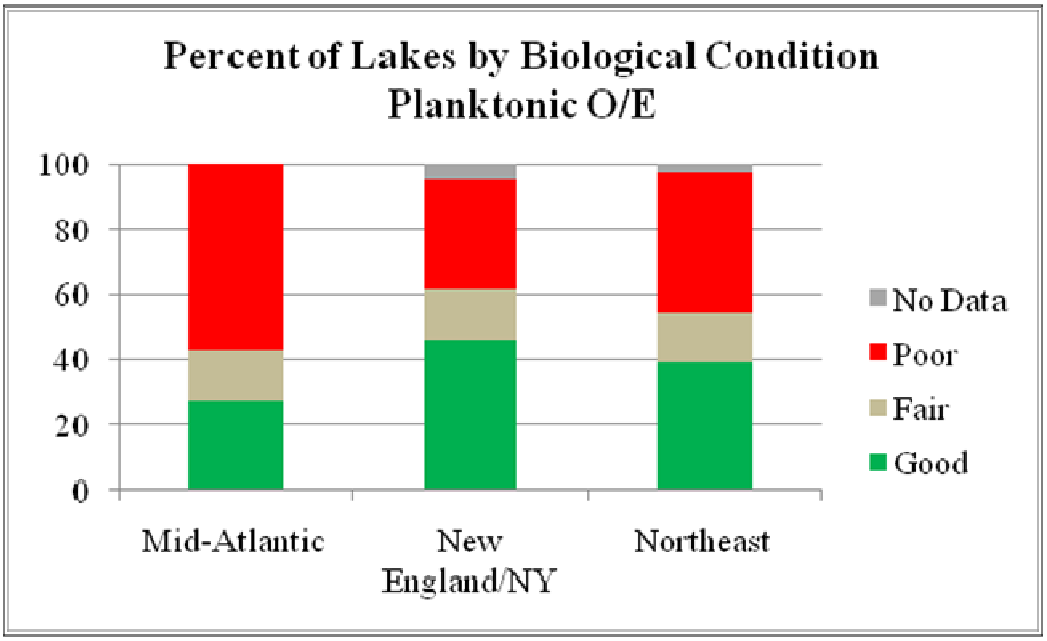
In the NLA, the biology of each lake was characterized in terms of the diversity and abundance of fish, insects, plants, and other organisms, and this information was used as a direct measure of a lake's biological health. The primary measure used was an index of taxa loss applied to the phytoplankton 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).**



Correspondence between Taxa Loss and Lake Condition: 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).

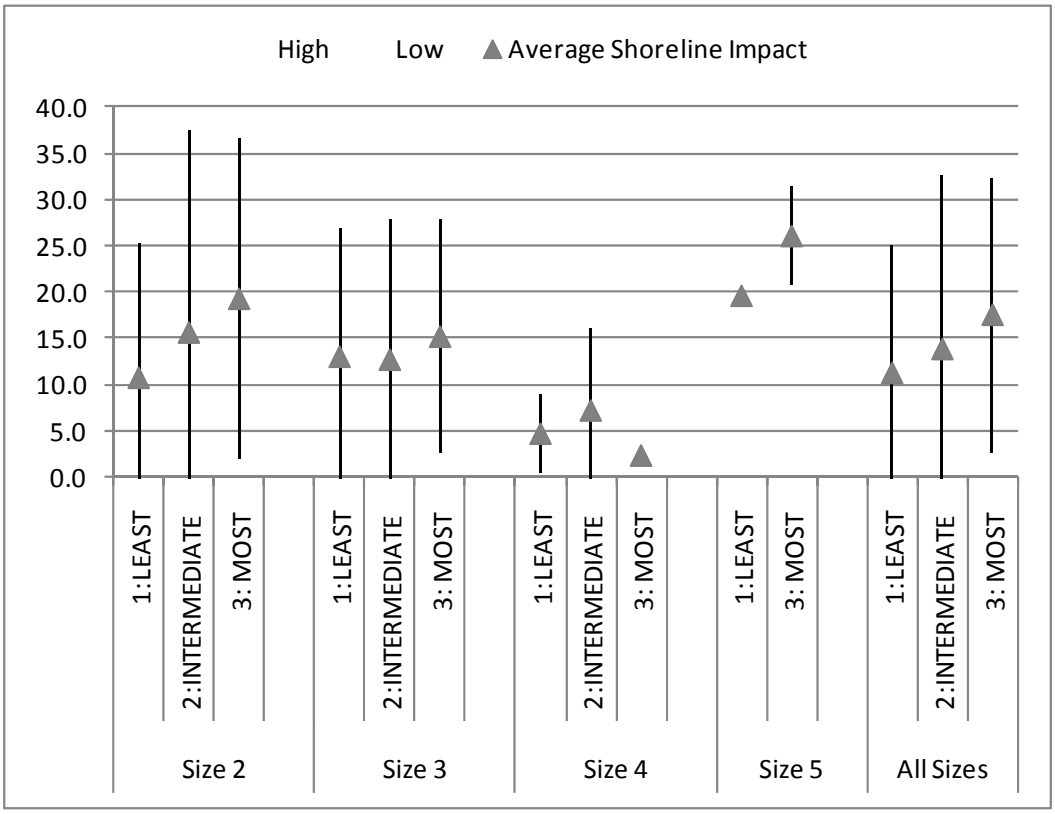
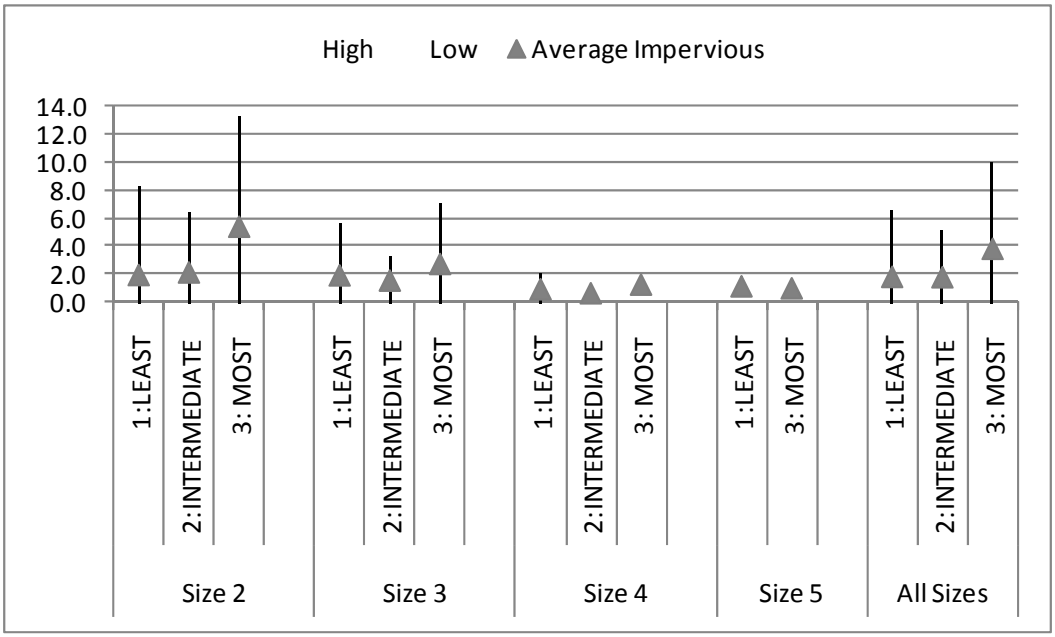


**Figure 9. Correspondence between the index of taxa loss (O/E) and the amount of impervious surface in the watershed.** Across all sizes severe loss is associated scores over 3 percent but there is wide variation and the groups are not statistically different (P = 0.20).

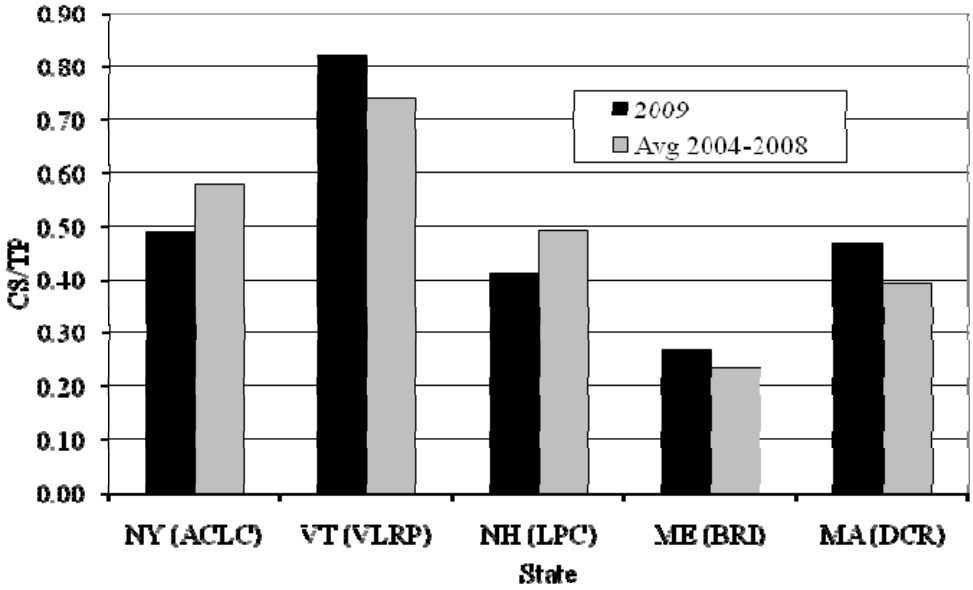



Trends in Loon Abundance: Loons (Gavia spp.) are generally considered to be indicators of high quality lake habitats and have been used as indicator of aquatic health and landscape-level alterations in aquatic environments (Evers 2004). As a top predator in the aquatic food chain of many lakes, the common 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.**



## 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.**

Capiella, K., and T. Schueler. 2004. Crafting a lake protection ordinance. Technical Article in Urban Lake Management **:**751-768.

Center for Watershed Protection (CWP). 2003. Impacts of Impervious Cover on Aquatic Systems. Watershed Protection Research monograph No. 1.

Evers, D. C. 2004. Status assessment and conservation plan for the Common Loon (Gavia immer) in North America. U.S. Fish and Wildlife Service, Hadley, MA.

Hilderbrand, R. H, Utz, R.H., Stranko, S.A., Raesly, R.L. 2010. Applying thresholds to forecast potential biodiversity loss from human development. Journal of the North American Benthological Society. **29**(4)**:**1009.

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.

Janson R., C. Nilsson, B Renofalt. 2000. Fragmentation of riparian floras in rivers with multiple dams. Ecology **81**(4)**:**899-903.

Jiffry, F. 1984. Loss of freshwater shellfish and some ecological impacts after water drawdown in Lake Sebasticook. MS thesis edition. University of Maine, Orono,

King, R. S. and M.W. Baker. 2010. Considerations for analyzing ecological community thresholds in response to anthropogenic environmental gradients. Journal of the North American Benthological Society. **29**(4)**:**998.

Minns, C. K. 1989. Factors Affecting Fish Species Richness in Ontario Lakes. Transactions of the American Fisheries Society **118**(5)**:**533-545.

Olivero, A. P., and M. G. Anderson. 2008. Northeast Aquatic Habitat Classification System. The Nature Conservancy, in Collaboration with the Northeast Asssociation of Fish and Wildlife Agencies.

Silk, N., and K. Ciruna. 2005. A Practioner's Guide to Freshwater Biodiversity Conservation. Island Press., Washington, DC.

Southerland, M. T., and S. A. Stranko. 2008. Fragmentation of riparian amphibian distributions by urban sprawl in Maryland, USA. in J. C. Mitchell, R. E. Jung Brown and B. Bartholomew, editors. Urban Herpetology. Society for the Study of Amphibians and Reptiles, Salt Lake City, Utah.

Stranko, S. A., R.H. Hilderbrand, R.P. Morgan III, M.W. Staley, A.J. Becker, A. Roseberry-Lincoln, E.S. Perry, and P.T. Jacobson. 2008. Brook trout declines with land cover and temperature changes in Maryland. North American Journal of Fisheries Management **28**(4)**:**1223-1232.
The Nature Conservancy. 2009. Eastern U.S. Secured Lands. Various scales. Compiled from multiple sources.

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

The Nature Conservancy. 2011. Northeast Regional Dam Dataset Version 3/1/2011. The Nature Conservancy Eastern Conservation Science Office. Boston, MA.

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.

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.

Tonn, W. M., and J. J. Magnuson. 1982. Patterns in the species composition and richness of fish assemblages in northern wisconsin lakes. Ecology **63**(4)**:**1149-1166.

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.

U.S. Geological Survey (USGS) and Environmental Protection Agency (USEPA). 2006. National Hydrography Dataset Plus (NHD-Plus). 100,000.

Vaux, Peter. 2005. Maine Aquatic Biodiversity Project. Unpublished report.

Vogel, H. 2010. Northeast Loon Population and Reproductive Success. Northeast Loon Study Working Group.

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.

# Appendix 8-1

Acres of Land within 100m buffer of Ponds and Lakes

| | Size Class | GAP 1&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 | GAP 1&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 secured primarily for nature 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 secured primarily for nature.

**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).



The Nature Conservancy • Eastern Conservation Science • Eastern Division • 99 Bedford St • Boston, MA 02111

## 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.

| | **Low Responsibility** | **High Responsibility** | | |
|---|---|---|---|---|
| | **Found in 4+ states** | **Found in 2-3 states** | **Found in 4+ states** | **Total** |
| **Low Concern** | | | Low concern, High responsibility (39:7:0) | |
| **Moderate Concern** | | Limited distribution, High responsibility (53:26:26) | Moderate concern, High responsibility (22:10:2) | |
| **High Concern** | High concern, Low responsibility (78:54:36) | | High concern, High responsibility (15:9:5) | |
| **Widespread Concern** | Widespread concern, Low responsibility (117:98:80) | | Widespread concern, High responsibility (36:31:28) | |
| **Total Species** | 195:152:116 | 53:26:26 | 112: 57:35 | 360: 235: 177 |

## 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.

**Species of Widespread Concern and High Regional Responsibility:** 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) and 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 secured primarily 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 secured primarily for nature (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 secured primarily for nature (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 |

**Species of Limited Distribution and High Regional Responsibility:** 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 secured primarily for nature (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 secured primarily for nature (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 secured primarily for nature (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** |

**Species of High Concern and Low Regional Responsibility:** 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 secured primarily for nature (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 land in the Northeast and Mid-Atlantic states. The number of individual species per group is given in parenthesis.

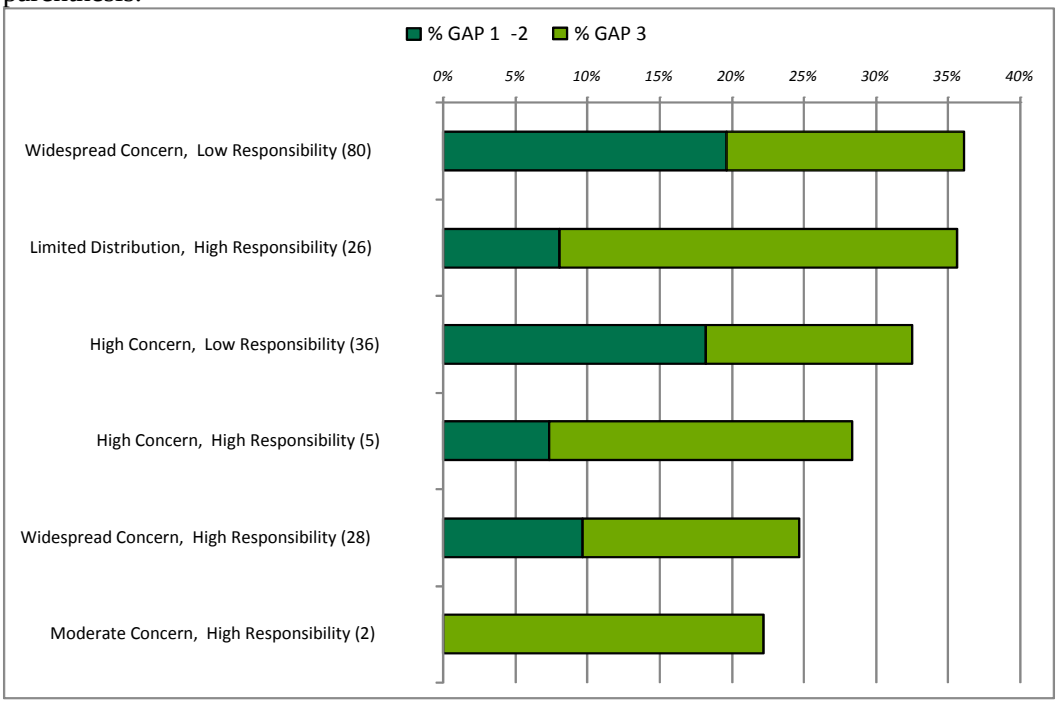


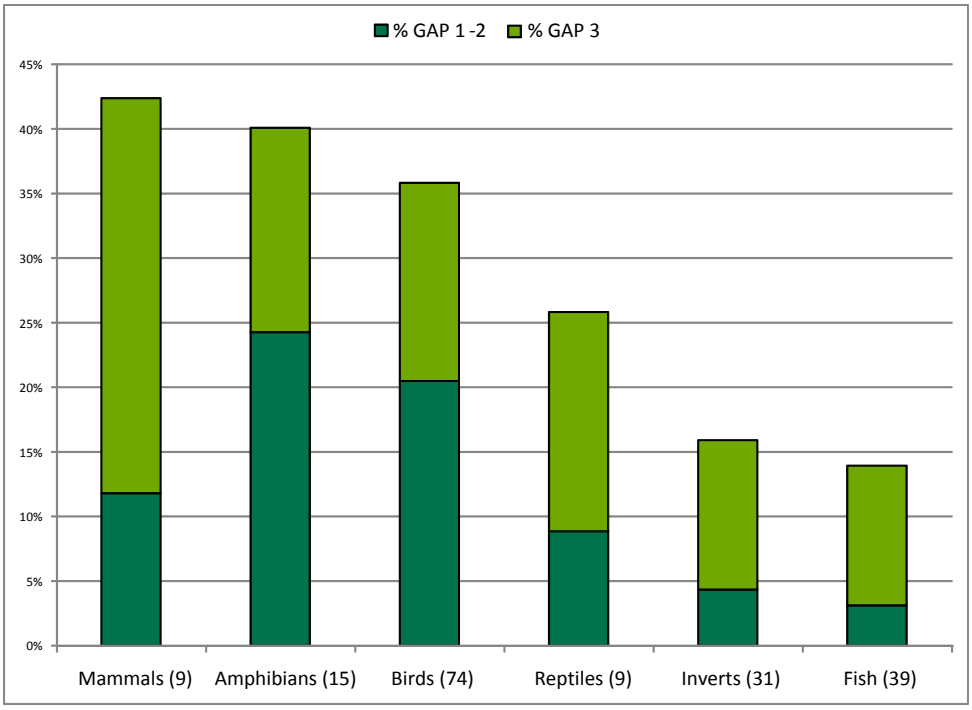
**Table 10: Summary of species by taxonomic group, global rank, and securement status.** Species with sufficient precise element occurrences in the northeast were used to calculate the percent of occurrences falling on land secured for multiple uses (GAP 3) or land secured primarily for nature (GAP 1-2). 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 secured 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.**

Kantor, J. 2007. Northeast State Wildlife Action Plan, Comprehensive SGCN List, 13 states plus DC. Draft 03/28/2007

NatureServe Explorer (2011-ongoing) Online encyclopedia of plants, animals and ecosystems of the U.S. and Canada. Available: http://services.natureserve.org/index.jsp.Accessed: 2011 January.

Northeast Partners in Amphibian and Reptile Conservation (NEPARC) Wildlife Action Plan Working Group (2008).

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

**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 | 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, Low 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.

| | | | | 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 |
| 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 | |
| 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 | | | | | | | | | | | | 2 | | | 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 | 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 | | 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

A

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

B

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

## Rivers

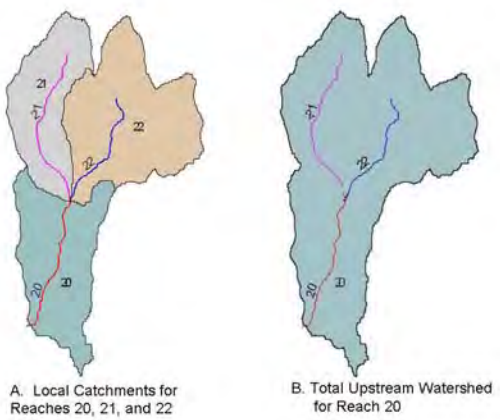
**How did we map rivers and streams?** The 2006 National Hydrography Dataset (NHD-Plus), a widely available 1:100,000 GIS dataset, was used as the base hydrology dataset for this project. This dataset provides greatly improved hydrographic features compared to all previous USGS 1:100,000 hydrology products. 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




**<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<br><br>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:

$$\text{Moist_index} = \ln [(\text{flow_accumulation} + 1) / (\text{slope} + 1)]$$

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.

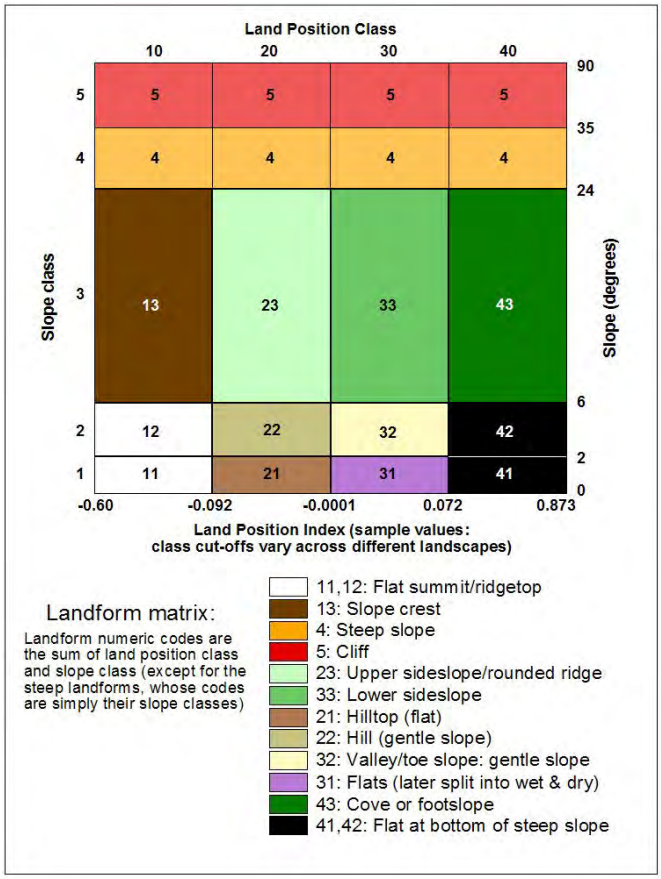
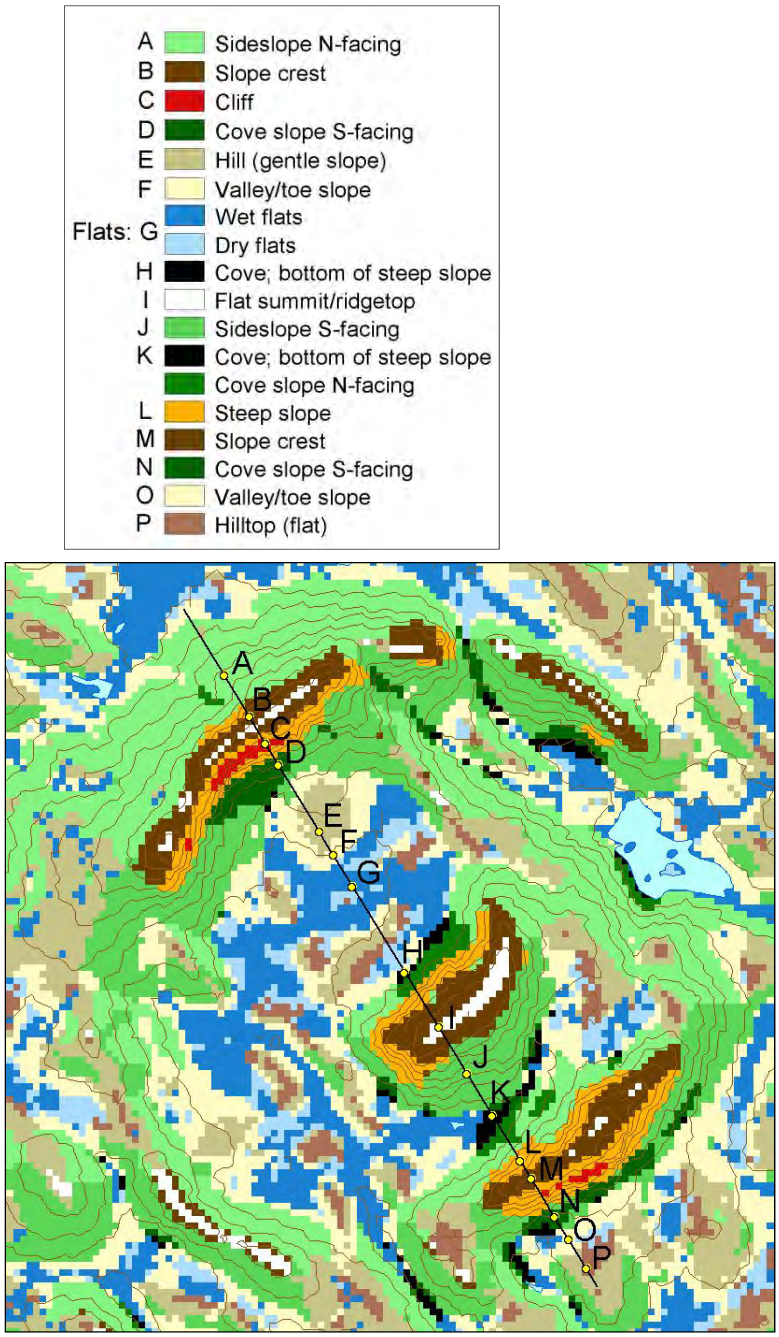


Fig. 2: Landforms in Pawtuckaway State Park, NH




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**

| | | |
|---|---|---|
| 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.

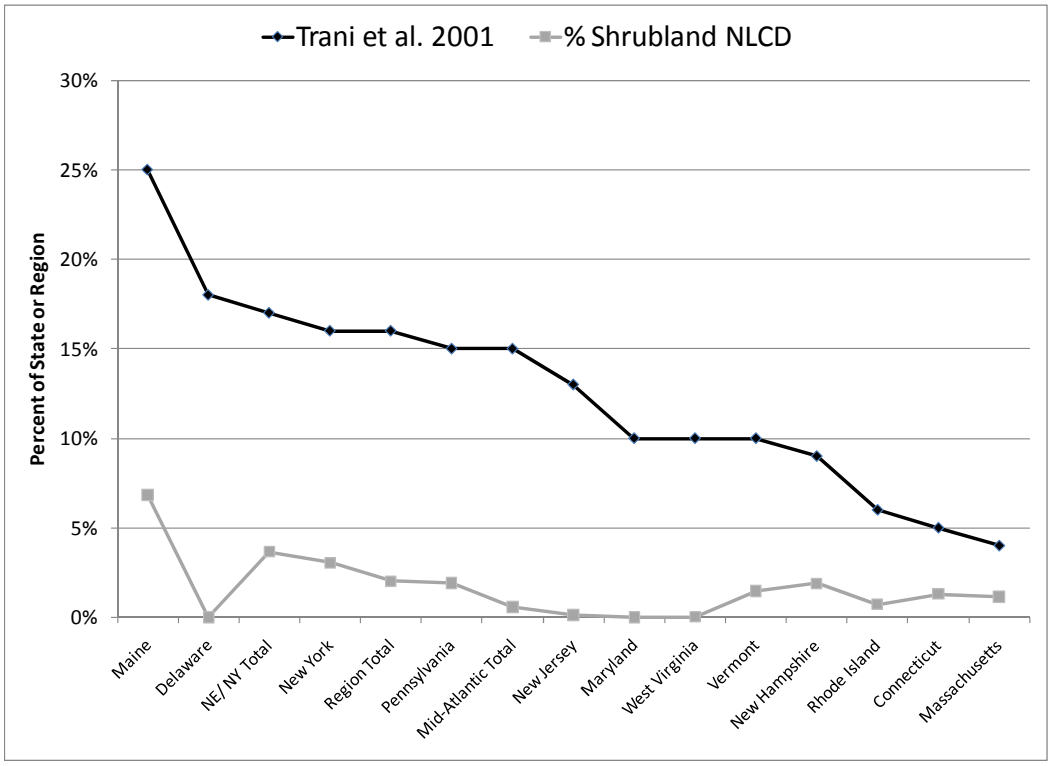
## Estimates of Distribution and Conservation Status

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.**

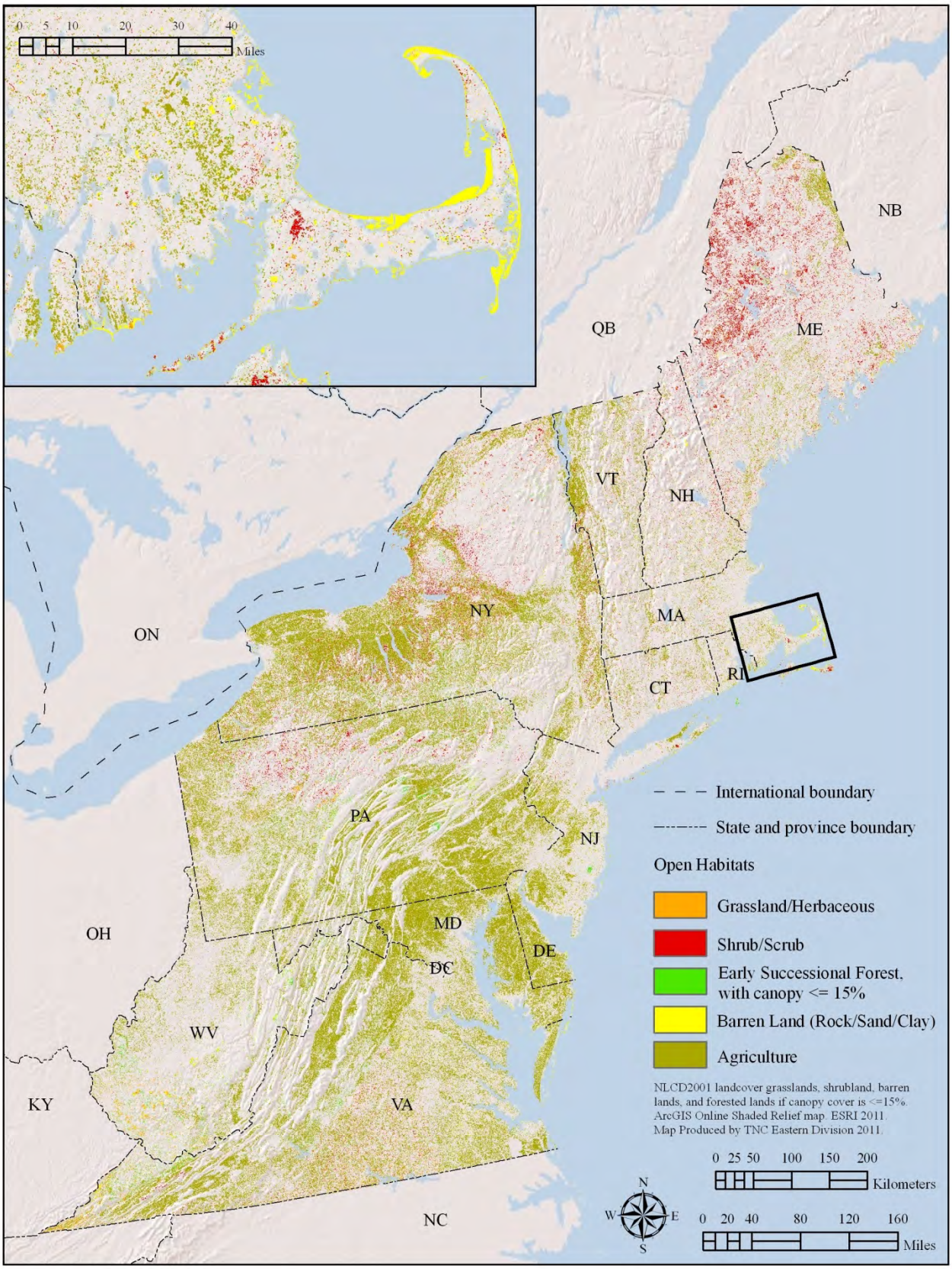
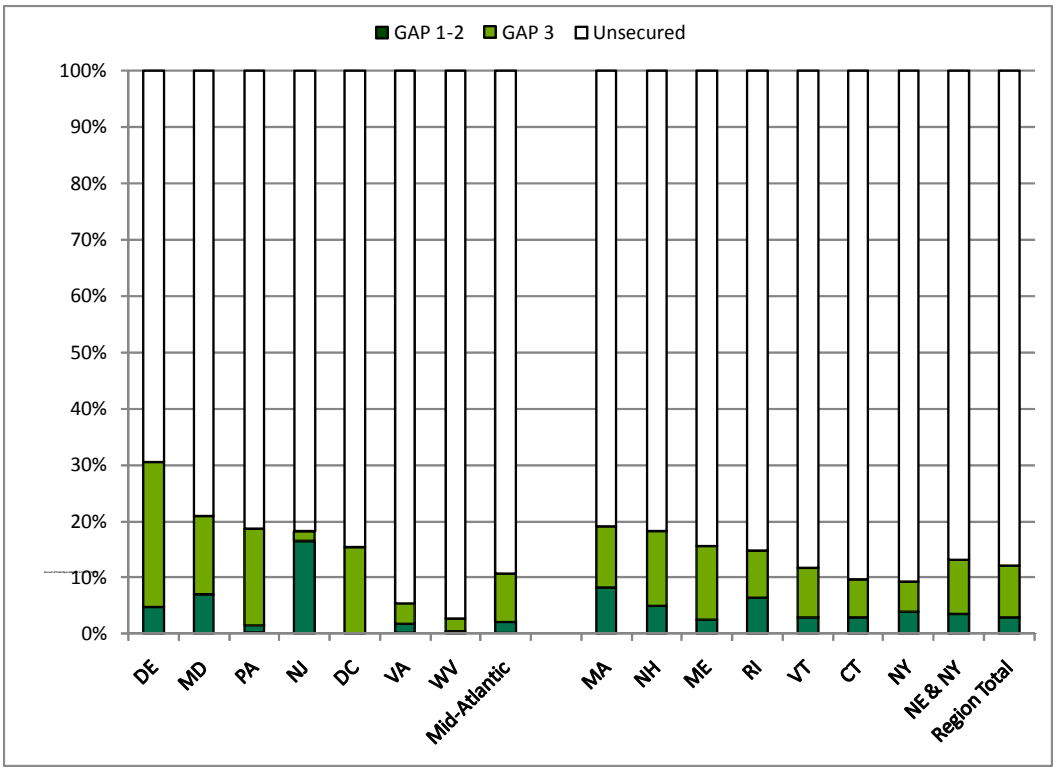


**Table 1. Estimates of grassland, shrubland, barren, open forest, and agricultural lands for each state and region.** The data source is the National Land Cover data set (Homer et al. 2004). Open forests were defined and canopy cover less than 15%. Trani et al (2001) is an independent estimate of the percent of shrubland and young forest in the state.

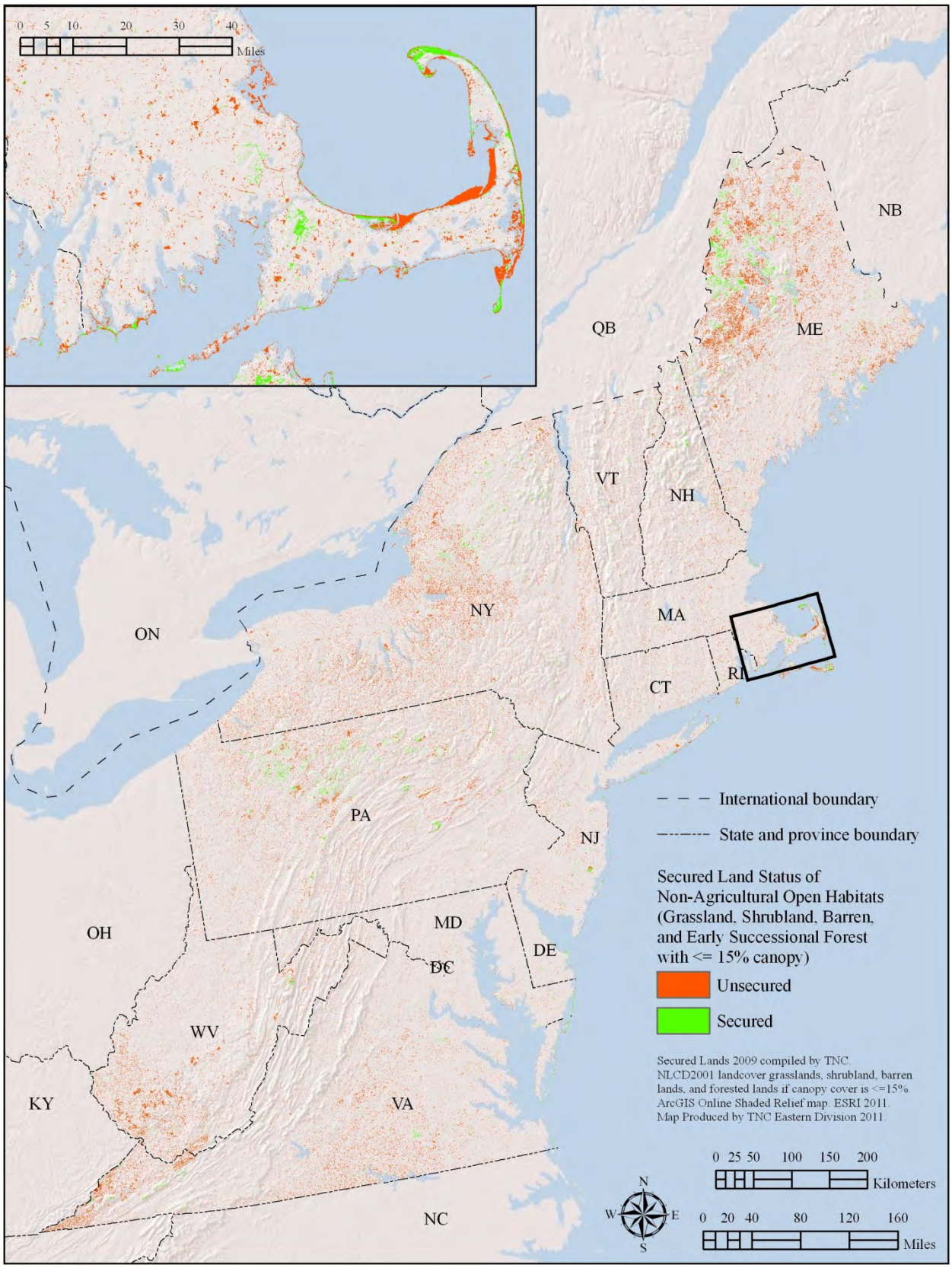
| STATE | Grassland | %G | Shrub | %S | Barrens | %B | Open Forest | %F | Total | Total Acres | % of State /Region in Open Non-Agriculture Habitats | Trani et al. 2001 | Acres Agriculture | % Agriculture in Region |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| District of Columbia | | 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 |

Early Successional Forest: 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.**

DeGraff, R. M., and M. Yamasaki. 2001. New England Wildlife: Habitat, Natural History and Distribution. University Press of New England, Hanover, NH.

Gill, F. and A. Poole (eds). 1992-ongoing. The Birds of North America Online. Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/

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.

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.

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.

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

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.

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.