



**NYSERDA**

# **New York Natural Resource Navigator**

**Summary Report**

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# **New York Natural Resource Navigator: Charting a Smart Future for a Changing Climate**

*Summary Report*

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## Notice

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## Preferred Citation

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NYSERDA. 2016. “New York Natural Resource Navigator,” NYSERDA Report 16-16s. Prepared by Rebecca Shirer, Kristin France, and Rebecca Benner. (The Nature Conservancy, Albany, NY). [nyserda.ny.gov/publications](http://nyserda.ny.gov/publications)

The full report is also available at the webpage listed.

# Abstract

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Our changing climate, and the consequences for natural resources, are already having wide-ranging impacts in New York State, including record droughts this year leading to agricultural losses and jeopardized water supplies. Major storms Irene, Lee, and Sandy wreaked havoc causing fatalities, thousands of lost homes, power disruptions to millions, and billions of dollars in damage. Statewide analyses, conducted by The Nature Conservancy (hereafter “the Conservancy”), of forest and stream conditions, threats, and climate change exposure and sensitivity reveal that the majority of New York State's natural resources, many of which we rely upon for our own protection from climate change, may not be resilient to climate change without greater attention. Outside of the Adirondacks, more than 70 percent of the State’s forests are not in condition to adapt well to climate change. Sixty percent of New York streams are at high risk from climate change, and while headwaters are in fairly good condition, most of the larger streams and rivers are not. Less than one-third of floodplains remain intact, highly functioning natural infrastructure. Moreover, the State’s protected areas are vulnerable with approximately a quarter of our protected areas at high risk, and over 30 percent needing restoration. These climate threats to nature jeopardize people and communities as New Yorkers depend upon natural resources for food, clean air and water, and more. Consequently, natural resource managers and community leaders face the urgent task of adapting policies and practices for effective management in a changing world, and immediately increasing the resilience of natural resources. However, interviews conducted by the Conservancy around the State revealed that managers lack sufficient access to information, concrete recommendations for how best to manage their natural resources, and time and resources to review and apply research, case studies, and data.

To help address these barriers, the Conservancy developed the Natural Resource Navigator (hereafter “the Navigator”). The Navigator is an online, interactive, mapping and decision support tool that uses the best available science to help managers sustain natural resources given the threats posed by climate change throughout the State. In a publicly accessible interface, the Navigator organizes a large variety of spatial data sets on resource conditions, non-climate threats, and climate change exposure and sensitivity to inform management of forest and stream resources within the State. Additionally, the Navigator provides a wide range of species models, carbon storage and nutrient retention services provided by

natural resources and some information on flood vulnerability. Furthermore, we have synthesized these data using a structured, repeatable, and tailorable framework to recommend where forests and freshwater should be maintained and improved, restored, or protected from threats in order to best facilitate their adaptation to climate change. Managers can begin with these recommendations and use the Map Tool and accompanying Guidebook and Tactics Toolbox to develop actionable site-specific strategies for new and existing resource management projects at a variety of scales. In this summary report, we present our recommendations of priority areas and actions for sustaining natural resources in light of climate change and explain how the Natural Resource Navigator can help facilitate these actions.

## **Keywords**

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climate change; natural resource management; adaptation; planning; decision support

# Acknowledgments

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Input from a Project Advisory Committee (PAC) helped to guide the development and ensure the usefulness of the Natural Resource Navigator. Members of the PAC included representatives from:

- Audubon New York
- County Conservation Districts
- Cornell University
- New York State Department of Environmental Conservation
- New York State Department of Parks, Recreation and Historic Preservation
- New York State Department of Transportation
- U.S. Geological Survey
- U.S. Fish and Wildlife Service
- Wildlife Conservation Society's Adirondack Program

The Natural Resource Navigator project team also extends its appreciation to the following individuals and organizations for their contributions to the development of the Natural Resource Navigator:

- Brad Compton, University of Massachusetts Amherst
- iMapInvasives
- Myrna Hall and Fenqing Weng, SUNY College of Environmental Science and Forestry
- Northeast Regional Climate Center
- Scenic Hudson
- Timothy Howard and Matthew Schlesinger, New York Natural Heritage Program
- U.S. Forest Service, Forest Inventory and Analysis Unit
- U.S. Forest Service, Sustaining Forests Unit

Finally, the authors recognize the hard work of all of the Conservancy staff and volunteers who have contributed to the success of this project:

- |                   |                   |                       |
|-------------------|-------------------|-----------------------|
| • Stevie Adams    | • Jessica Hoch    | • David Richardson    |
| • Analie Barnett  | • Mylene Lamme    | • Casey Schneebeck    |
| • Rebecca Benner  | • Cara Lee        | • Sumathee Selveraj   |
| • Gabe Chapin     | • Simcha Levental | • Tim Tear            |
| • Melissa Clark   | • Jessica Levine  | • Sheila Webb-Halpern |
| • Darran Crabtree | • Nicole Maher    | • Ellen Weiss         |
| • Bryn Davies     | • Arlene Olivero  | • Daniel Winters      |
| • Zach Ferdana    | • Andy Peck       | • Chris Zimmerman     |
| • Kimberly Hall   | • George Raber    |                       |

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# **1 Why Climate Adaptation is Needed: Critical Findings for Forests and Freshwater Resources in New York State**

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## **1.1 Climate change threatens New York State's natural resources and the communities that depend upon them**

With the growing threat of coastal flooding, sea level rise, larger and more frequent storms, increased drought risk, and changes in expected temperatures and precipitation, climate change is arguably the greatest challenge facing the sustainability of our world. Climate change poses numerous threats to the State's forests, wetlands, freshwater and coastal habitats, and diverse species of wildlife making living conditions difficult or unsuitable. These threats to nature affect people and their communities as well. New Yorkers depend on natural resources that provide clean air, clean water, protection from floods, stable and productive soils, food, and timber, among other benefits. The consequences of these changes for natural resources are already having wide-ranging impacts in the State, including record droughts this year leading to agricultural losses and jeopardized water supplies. Recent major storms Irene, Lee, and Sandy caused fatalities, thousands of lost homes, power disruptions to millions, and billions of dollars in damage. Consequently, the multiple forces of climate change are a growing concern, not only to those who look after forests and freshwater, but also to public and transportation policy experts, business leaders, city and town planners, and agricultural managers. All face the urgent task of adapting policies and practices for effective management in a changing world, and immediately increasing the resilience of natural resources.

## **1.2 Statewide analyses reveal that natural resources in New York State are quite vulnerable to climate change**

Our statewide analyses of forest and stream conditions, threats, and climate change exposure and sensitivity reveal that the majority of the State's natural resources may not be resilient to climate change without greater attention. The Navigator builds upon points raised in the Ecosystems and Water Resources chapters of the 2011 ClimAID report commissioned by NYSERDA about the

vulnerabilities of our forest and freshwater systems and species to climate change<sup>1</sup> by placing them in the context of spatial analyses of their current condition and non-climate threats. Our analysis adds strength to the previous messages contained in those reports and highlights the urgency of that report's adaptation recommendations.

### **1.3 The majority of forests in most regions of the State are in poor condition, making them vulnerable to the stressors of climate change like drought; increased frequency, severity, and diversity of pest and pathogen outbreaks; and extreme storms**

Our analysis that focused on the ability to adapt to climate change showed that most regions of the State have less than 30 percent of forest acres in overall “good” condition. None of the forests on Long Island are in good condition, and the Lake Plain region has just one percent of forest that falls in that category. The best-condition forests were in the Adirondack region, with 75 percent of forest areas scoring “good” or better. Forest conditions are hampered by legacies of past harvest practices that reduce diversity and simplify structure, as well as over-abundant deer, habitat loss and fragmentation, and invasions by non-native plants. These degraded forests are less capable of supporting wildlife, producing valuable timber, and protecting water supplies even without climate change, and they will be less able to sustain these services in the face of disturbances brought on by climate change. Improved forest management is needed to help these forests cope with stressors like drought, increased damage from pests and diseases, and extreme storms.

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<sup>1</sup> Rosenzweig, C., W. Solecki, A. DeGaetano, M. O'Grady, S. Hassol, P. Grabhorn (Eds.). 2011. Responding to Climate Change in New York State: The ClimAID Integrated Assessment for Effective Climate Change Adaptation. Technical Report. New York State Energy Research and Development Authority (NYSERDA), Albany, New York. [www.nysesda.ny.gov](http://www.nysesda.ny.gov)

## **1.4 Freshwater resources are at risk where people live and work, and where people rely upon them**

Although the headwaters that visually dominate maps of the State's stream networks are often in fairly good condition, larger streams and rivers (which are often sources for drinking water, irrigation, and industrial water uses) are hampered by impairments like flow alterations and disruptions of connectivity by dams, floodplain development, and water quality issues. These deficiencies limit their ability to respond well to the increased risk of droughts, storms, and warmer water temperatures ushered in by climate change.

Furthermore, the risks to stream resources are likely underestimated, because we could not incorporate information on the current condition of water quantity and in-stream flows, relative to what is needed by both aquatic biodiversity and people due to lack of readily available data. A comprehensive statewide and watershed specific picture of this, as well as projected changes to in-stream flows, is greatly needed. Current water withdrawals and concomitant altered flow regimes (both high and low flows) can compromise the long-term persistence of native fauna and economic development opportunities. Rising temperatures and greater likelihoods of seasonal drought will make both the wildlife and people that use the State's stream resources more vulnerable.

## **1.5 Floodplains have been developed around the State, with less than one-third remaining as high functioning natural infrastructure that could help reduce impacts of more frequent and severe storms**

Less than one-third of the State's floodplains remain as high functioning natural infrastructure that could help reduce impacts of more frequent and severe storms. Furthermore, they are under threat of development pressure, even with current regulations, as the land they occupy is often in demand for agriculture and moderate to high intensity commercial or residential enterprises. Nearly one-third of stream catchments in the State are projected to lose natural cover within their floodplains and riparian areas by 2050.

## **1.6 Even without taking current condition impairments into account, 33 percent of our forest resources and 60 percent of our stream resources are at high or very high risk from climate change**

Forests and stream networks are vulnerable to climate change where they are not complex (situated within a limited variety of soils, elevations, and other types of physical settings) or not connected. While the complexity, or variety of settings, underlying our habitats cannot be changed, we have substantially altered species' ability to access that variety by fragmenting forests and wetlands and disrupting stream networks with dams, therefore limiting their options for responding to changing conditions and associated disturbances. We may even be underestimating this climate risk for streams because we only considered dams as fragmenting features, not road-stream crossings, which can present substantial barriers to movement of aquatic species, including recreational fisheries such as salmon and trout.

## **1.7 Over 10,000 acres of natural habitat in New York State could be inundated by sea level rise, resulting in the loss of one-third of coastal habitats by 2050 if they cannot migrate inland**

As the Sea Level Rise Task Force Report<sup>2</sup> points out and the NY 2100 Commission Report reiterates, these coastal habitats “currently provide large-scale services, such as flood protection, storm buffering, fisheries habitat, recreational facilities and water filtration, at almost no cost.” Our analyses used the Sea Level Rise Task Force Report projections and are between the upper part of the “middle range” and “high range” estimates from the 2014 ClimAID supplement,<sup>3</sup> to err on the side of caution and reflecting increasing evidence that rapid ice melt will play a role in sea level rise even by the 2050s. While our sea level rise inundations should be interpreted with caution on a pixel-by-pixel basis (i.e., at very fine, hyper local scales) due to error margins of elevation data and the land cover data, the overall result that the State could lose up to one-third of its remaining natural protections within little more than a generation, or the length of a new 30-year mortgage, is sobering.

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<sup>2</sup> New York State Sea Level Rise Task Force. 2011. Report to the Legislature.

<sup>3</sup> Horton, R., Bader, D., Rosenzweig, C., DeGaetano, A. and Solecki, W. 2014. Climate Change in New York State: Updating the 2011 ClimAID Climate Risk Information. New York State Energy Research and Development Authority (NYSERDA), Albany, New York

## **1.8 While there are many places across New York State predicted to be resilient strongholds in the face of climate change and other disturbances,<sup>4</sup> less than one-third of the lower climate risk places in our analysis are protected, and many are jeopardized by current condition impairments**

Protected or not, 56 percent of forests and 34 percent of streams with low to medium climate risk are jeopardized by current condition impairments. While these resilient places have inherently complex characteristics and connectivity that should help them respond well to climate change, these characteristics will not be enough if the natural resources within them have serious condition impairments that are likely to be further exacerbated by climate change. For example, variety in the underlying bedrock and a broad elevational gradient to shift up in response to climate change will not help forests adapt if there are not enough seedlings around to turn into mature trees because they have all been eaten by deer. Similarly, while connected stream networks might provide mobile species access to cooler conditions, that will not help if they need to pass through long segments with poor water quality or no shade to get there.

## **1.9 Our protected areas are more vulnerable than expected**

Seventeen percent of currently protected lands (those where development is prohibited or restricted and use is managed) are at high or very high risk from climate change due to a lack of sufficient connectivity, low variety in the landscape, low diversity, and/or other elements making them highly sensitive to climate change. Nearly one-third of those protected lands with lower climate risk are in marked need of restoration, further limiting their capacity to respond well to climate change. These legal protections, while important, cannot provide these places with everything they need in order to adapt—restoration, adaptive management, and attention to the landscape context they occur within will be needed.

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<sup>4</sup> Anderson, M. G., Clark, M., & Sheldon, A. O. (2014). Estimating Climate Resilience for Conservation across Geophysical Settings. *Conservation Biology*, 28(4), 959. Also see update Anderson, M.G., Barnett, A., Clark, M., Ferree, C., Sheldon, A. O. and Prince, J. 2016. Resilient Sites for Terrestrial Conservation in Eastern North America. The Nature Conservancy, Eastern Conservation Science.

## **1.10 Overall, 88 percent of modeled rare species in New York State will lose more than half of their suitable habitat due to projected climate and land use changes**

Although about half of the rare species modeled by NY Natural Heritage also gain new suitable habitat, in most cases, expansion into new areas will not be sufficient to counteract losses. This results in 36 percent of rare species at risk of extirpation from the State, and another 51 percent with net declines in suitable habitat area. It may be wise to invest resources in species that could persist in the State if able to expand into habitat that may become even more suitable in the future, and, when possible, rethink investments in highly vulnerable species with extremely limited options. Given how greatly these rare species are impacted, it is critical that we learn more about projected impacts on the survival of other more common species critical for crop pollination, pest and disease vector control, as well as the potential expansion of species that are disease vectors, so we can develop long-term strategies to maintain diversity and ensure resilience.

## 2 What can be done?

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Climate impacts are being felt and we must act now to protect and improve the ability of our natural systems to adapt to change. Fortunately, there are a number of actions policy makers and natural resource managers can take to improve resilience of our natural resources, and the communities that depend upon them. Chapter 6 of the ClimAID report discusses strategies that can help reduce the impacts of climate change on ecosystems.<sup>5</sup> The Community Risk and Resiliency Act mandates that the effects of climate change and extreme weather events be considered in certain State permitting and funding programs, including protection of waters, wetlands, and natural resiliency measures. Our analyses support the importance of the following considerations and adaptation actions.

### 2.1 Restore forests and streams in otherwise resilient areas and/or where people are most reliant on resources

Habitats currently in poor condition are going to be less able to adapt to climate change. Sixty-five percent of our forests and 36 percent of our streams are hampered by elements of poor condition that will limit their ability to adapt. Consequently, habitat restoration is vitally important for sustaining natural resources into the future in light of climate change. For the greatest chances of success, these restoration activities should be prioritized in areas where climate risk is lowest (Figure 1, Restore category) and/or people are most reliant on the resources.

For forests, this includes:

- Control overabundant deer and invasive species, particularly in areas disturbed by harvests or natural events, to improve the diversity and abundance of young trees.
- Limit the introduction and spread of invasive plant species and forest pests and pathogens.
- Reduce fragmentation and improve connectivity by reforesting cleared areas and by removing or mitigating critical barriers to wildlife movement, particularly in areas critical for connectivity now and in the future (Figure 2).
- Support active forest management and implement best practices for timber harvests in order to improve physical forest structure and promote the full diversity of species and age classes.

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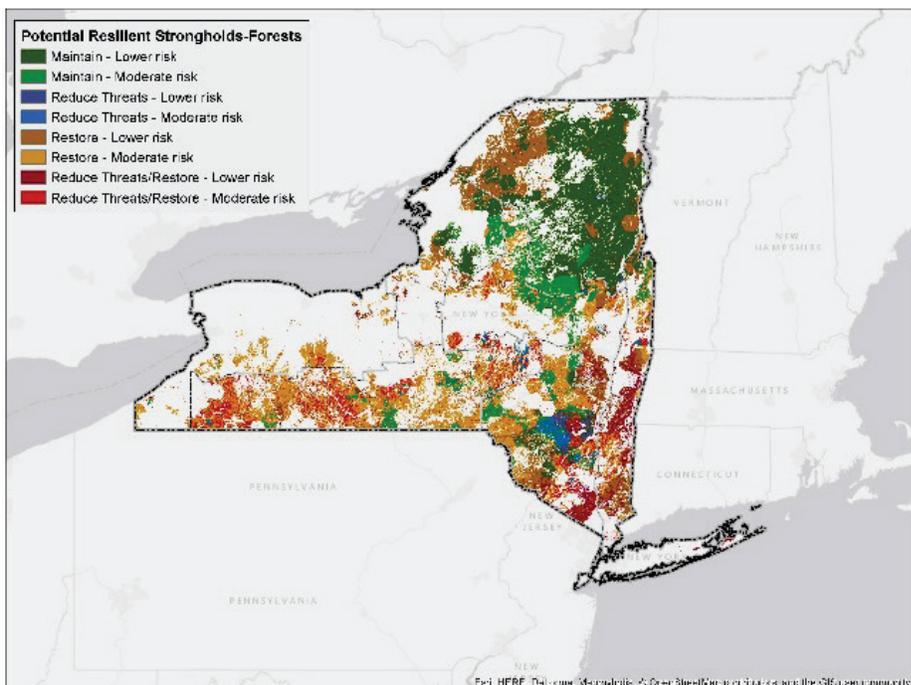
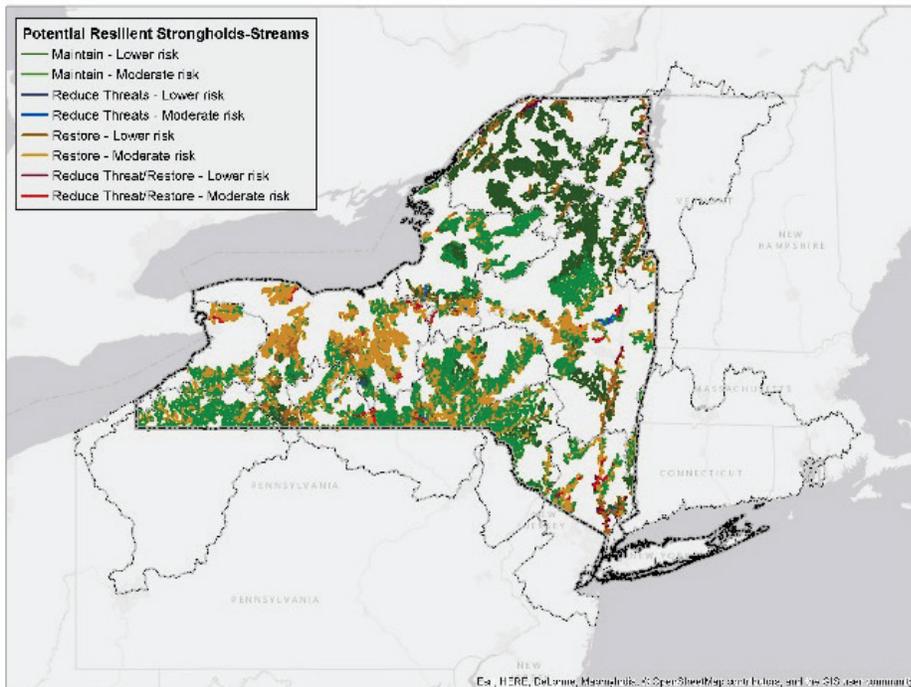
<sup>5</sup> Wolfe, D., Comstock, J., Menninger, H., Weinstein, D., Sullivan, K., Kraft, C., Chabot, B., Curtis, P., Leichenko, R. and Vancura, P. 2011. Chapter 6 Ecosystems. *In* Rosenzweig, C. et al. 2011 *Ibid*.

For streams, this includes:

- Reconnect streams to their floodplains where possible, and restore floodplains to improve their ability to absorb water, slow flood flows, and retain nutrients and sediment, abating downstream impacts.
- Improve permeability of surfaces in urban and suburban areas and improve design and management of road and agricultural ditch networks, anticipating more frequent and intense storm events.
- Remove or secure hazardous pollution sources in floodplains.
- Mitigate where nutrients, in combination with rising temperatures, may lead to harmful algal blooms that jeopardize the health of aquatic communities as well as the safety of recreational use and drinking water supplies.
- Also address nutrient pollution where it contributes to limits to the extent and function of habitats that provide storm protection or important fisheries (oysters, seagrass etc.).
- Improve stream network connectivity at road-stream crossings and around dams.
- Adopt an evidence-based, systems approach to water resource management which addresses challenges at meaningful scales for people and nature (e.g., watershed).
- Utilize up-to-date data, models, tools, learning materials, and relevant social connections (networks) to support the effective dialogues necessary for effective water resource decision-making.

**Figure 1. Recommended objectives for natural resource management in stream (top) and forest (bottom) habitats.**

Recommendations are based on current condition, future non-climate threats, and climate exposure and sensitivity. The shading within each color group indicates the level of climate risk that creates uncertainty around management outcomes. Darker shades indicate greater confidence due to lower risk; lighter shades indicate places where it will be more critical to incorporate climate change uncertainty into management decisions. Only low to moderate risk areas are shown.



## 2.2 Maintain and protect resilient strongholds

As worsening storms, expanding droughts and rising temperatures threaten to destabilize many natural areas in the State, scientific evidence shows that certain naturally resilient landscapes are robust enough to continue providing habitat to a variety of plants and animals while also serving as an essential resource for community food and water.<sup>6</sup> These aptly named “strongholds of natural resilience” are characterized by traits such as “complexity” (containing a diversity of landforms and topography that foster and maintain microclimates) and “permeability” (affording fauna and flora the opportunity to move across the landscapes and within networks of streams unobstructed by roads, dams, fragmentation or other barriers). The most complex and permeable landscapes offer the greatest potential to withstand climate impacts and maintain healthy natural systems.

While many of these terrestrial areas are already protected, particularly in alpine areas in the Catskills and Adirondacks, there has been less success in protecting resilient sites at low elevations and on geophysical settings such as fertile limestone and silt or coarse sandy coastal soils critical to providing strongholds for the full spectrum of biodiversity within New York. These low-elevation, fertile sites are necessary for providing connections among existing protected lands, and more broadly for protecting linkages up and down the eastern seaboard.

As part of a comprehensive program for addressing climate change, efforts should focus on protecting naturally resilient strongholds across the wide range of geophysical settings found in New York, and securing connections among them. This would facilitate adaptation of the greatest number of species and increase nature’s chance of providing the spectrum of ecosystem services that we rely upon, such as water filtration and supply, flood abatement, crop pollination, and timber provision. These natural strongholds must be shielded from damaging development, pollution, and other negative actions or they could lose their ability to protect nature from climate impacts. Furthermore, as previously mentioned, some need urgent restoration in order to realize their resilience potential (Figure 1).

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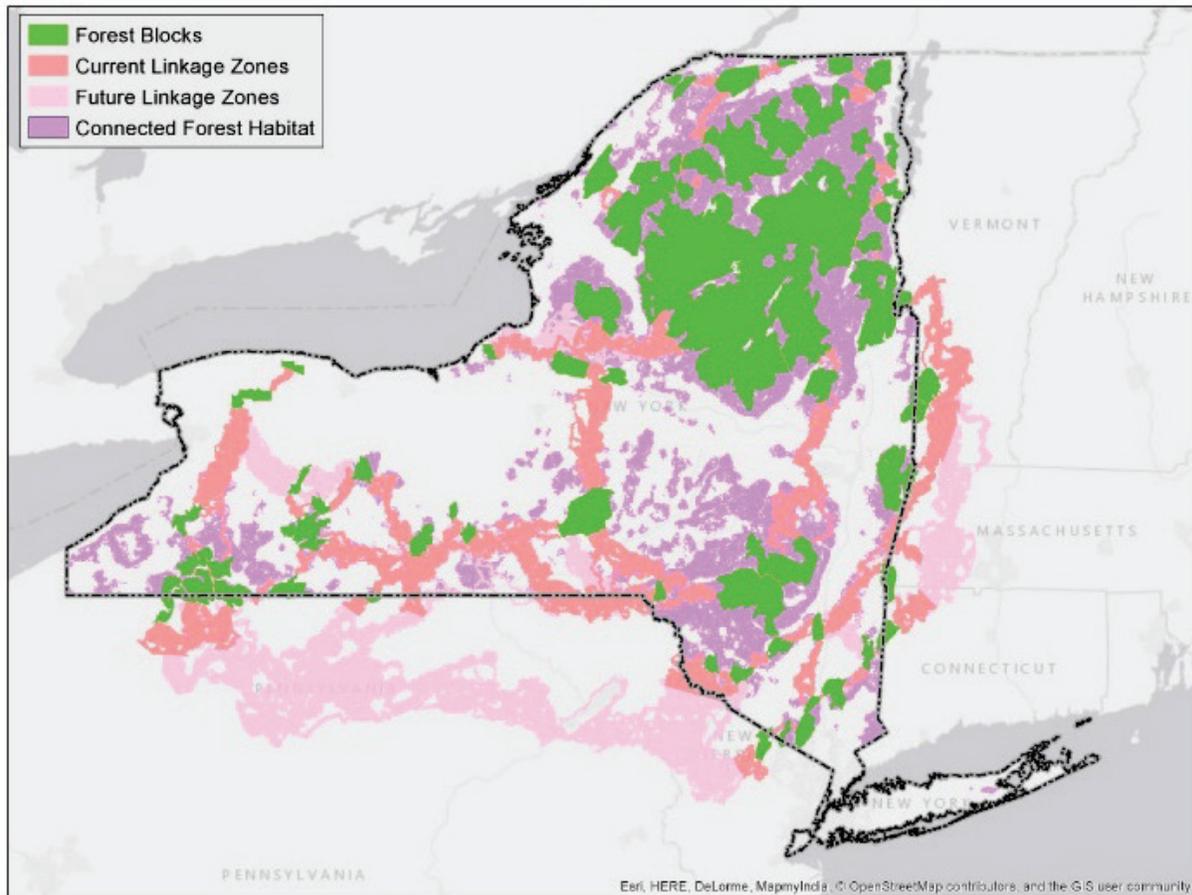
<sup>6</sup> Anderson, M. G., Clark, M., & Sheldon, A. O. (2014). Estimating Climate Resilience for Conservation across Geophysical Settings. *Conservation Biology*, 28(4), 959.

## 2.3 Maintain and improve connectivity

Along with conserving these climate-resilient landscapes, we must ensure healthy natural corridors connect them together so species can move between them as their traditional habitats become unlivable due to climate change. Existing large and well connected patches of contiguous habitat should be maintained, as well as the areas of relatively higher forest cover that provide wildlife with opportunities to move between them (Figure 2). Areas that are currently potential barriers to movement (roads and fragmented/converted habitats) should be restored or mitigated. Particular areas in the Mohawk and Hudson Valleys, as well as the Southern Tier, are priorities (Figure 2). The limited areas in the Southern Tier and the Hudson Valley that currently support connectivity, particularly those that are at risk of conversion, are also priorities for potential zoning or other non-acquisition strategies to prevent conversion.

**Figure 2. Priority Areas to Support Connections Among Forested Habitats.**

Large unfragmented forests, least-cost linkages between them, and a well-connected landscape are all part of an important connected network.



## **3 Adaptation Challenges Facing Natural Resource Managers**

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### **3.1 While the recommended actions noted above will substantially increase the chance of sustaining New York State's natural resources into the future, natural resource managers face on-the-ground implementation challenges**

Planning and managing for the complexities of climate change is a daunting task. Interviews conducted by The Nature Conservancy found that while most natural resource managers feel it is important to plan for climate change, no one thought that they had the information necessary to make adaptation decisions. Most voiced a strong desire for site specific information and recommendations. While it is vital to make informed decisions about climate adaptation, data and recommendations for best practices are not readily available to most decision makers. What has previously been accessible is far too general to facilitate concrete adaptation action in the real world. Managers lack tangible recommendations for where, and under what circumstances, to pursue particular strategies like restoring floodplains, protecting potential migration corridors and guarding against future forest pests and pathogens. Furthermore, managers, decision-makers, and communities face limited resources and insufficient time to sift through the information and apply it to their circumstances and decisions they need to make.

### **3.2 A new tool developed by The Nature Conservancy, the Natural Resource Navigator addresses these challenges**

As complex as climate change is, we have the data needed in order to effectively respond in time. The Navigator brings together the best available scientific data, used to create the analyses and recommendations shown and discussed above, in a comprehensive online mapping tool. Furthermore, it uses these data to recommend what broad conservation actions are needed in specific places to conserve forest and freshwater natural resources to prepare us, and provides decision-making support tools to help natural resource managers develop and implement adaptation strategies suited to their places and responsibilities.

## 4 How can the Natural Resource Navigator help?

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### 4.1 What is the Natural Resource Navigator?

The Natural Resource Navigator (the Navigator):

- Hosts an on-line, interactive map tool with a wealth of information (>1000 datasets) about forest and water resources, and the vulnerability of these resources to climate change.
- Structures and compiles these data into useful summaries of current condition, future threats, climate change sensitivity, and climate change exposure.
- Recommends basic conservation objectives (Maintain, Restore, Reduce Threats) for places based on these data.
- Provides decision support worksheets to help natural resource managers refine their approach in light of climate change and document the rationale for their decisions.
- Filters potential tactics for responding to climate change based on data and decisions reached by users.

The Navigator consists of three main components, accessible from the website [www.naturalresourcenavigator.org](http://www.naturalresourcenavigator.org), which serves as a portal to the tool as well as background information about the project (including this report) and other resources:

#### 4.1.1 Map Tool

- Starts users with our spatial recommendations for what basic conservation approach to pursue (maintain and improve condition, reduce future threats, restore) given conditions on the ground or in the water, along with information about the relative risk climate change presents to work in those places.
- Map Layers tree organizes >1,000 datasets.
- Habitat Explorer tool helps users explore data behind the recommendations.
- Species Explorer tool generates a list of species potentially present in an area, with information on climate change vulnerability and shifts.
- Save and Share enables users to save, share, and print their custom maps.
- Provides easy links to Data Documentation for more information on sources and methods for each dataset and recommendations.

### 4.1.2 Guidebook

- Guides users through an interactive decision support process that helps them use these spatial data to determine where to work and what to do for climate smart natural resource management.
- *Wayfinder* section helps users get started with the Map Tool based on their needs and interests.
- *Course Adjustment Worksheets* help users refine the basic conservation course (or objective) we have recommended on our maps for their area to more specific strategies tailored to their circumstances, using data in the Map Tool as well as their own knowledge and judgment.

### 4.1.3 Tactics Toolbox

- Database of specific tactics managers can use to realize the conservation objectives recommended through the Map Tool and Guidebook and ensure their efforts are climate smart.
- Identifies resources for learning more, many of which are available on the website's library and soon to be cataloged through the NY Climate Change Clearinghouse.

**Table 1. Highlights and Benefits of the Natural Resource Navigator**

<b>Navigator Highlights</b>	<b>Benefits to Decision-Makers</b>
<ul style="list-style-type: none"><li>• Comprehensive online mapping resource for New York's natural resources data, with user-friendly interface, consistent statewide coverage, accessible to all.</li><li>• Provides mapped recommendations for where to invest in protection, restoration and connectivity to sustain natural resources in light of climate change, as well as interactive way to evaluate specific climate-related impacts.</li><li>• Helps guide decision-makers through a process of determining the best course of adaptation actions on a particular site.</li><li>• Makes complex science accessible and useful.</li></ul>	<ul style="list-style-type: none"><li>• Provides a platform for collaboration and coordination across jurisdictions and organizations and for use with the general public.</li><li>• Shows where to concentrate efforts in order to have effective results; provides means to make the case for resource allocation based on climate change impacts.</li><li>• Chance to prepare for climate change impacts and adapt management of lands to ensure greater resilience.</li><li>• Enables scientific, data-based decision making by a wider audience, not just those with very technical knowledge or software.</li></ul>

## 4.2 What are some questions that the Navigator can help answer?

- What is the current condition of the State's forest and water resources?
- What are the risks these resources face from climate change?
- What potential actions are best to reduce these risks in different places?
- Are there general patterns across the State that could be improved through policies or local land use decisions?
- What is predicted to happen to species given climate change?
- Are there unique natural resources at risk in my community?
- What areas of my community could be protected or restored to help reduce flooding impacts?

### **4.3 Users can come away from the Navigator with:**

- High quality graphic maps and worksheets documenting the data underlying their decision process to use in internal planning and outreach communications.
- Basic components of a work plan for making their day-to-day work climate smart.
- Links to resources, including case studies and learning networks, to help them do this adaptation work.
- Greater confidence in the likelihood of success of their management strategies.
- Downloaded spatial data to use alongside their own data.

### **4.4 Who can use the Navigator?**

This free, web-based tool is available for the public to use. However, it is especially useful for natural resource decision-making by:

- State and federal agencies at state and local levels.
- Municipal planners, particularly if supported by regional planners.
- Floodplain and forest managers.
- Land trusts.
- Watershed groups.
- Other not-for-profit organizations.
- Land developers and industries interested in reducing impacts on natural resources.

The recommendation maps can provide a snapshot of where protection, threat reduction, and restoration are useful in light of climate change across the State or within a region. For diving further into the decision support, brief training is helpful. Over 50 people have been trained in basic use of the Navigator through an introductory workshop (over 150 attendees) and multiple presentations done since the initial launch, and we will continue to offer training and support.

## **4.5 Examples of the Navigator in Action**

### **4.5.1 State**

#### ***4.5.1.1 Highlighting areas to focus resources***

First and foremost, analyses from the Navigator are used to highlight the vulnerability of our forests and streams, demonstrate the urgent need for restoration and coordinated adaptive management, and recommend places most important to protect, connect, and restore in order to help sustain natural resources into the future. The maps in this report (Figures 1-2), and others, are easily accessible on-line for agencies and other funders trying to determine where to best deploy resources for climate change adaptation.

### **4.5.2 Municipalities**

#### ***4.5.2.1 Open space planning and programming***

Municipal governments, or planning consultants who assist them, can use the Navigator to help inform their own open space planning and programming. Although the State provides guidance, many community level or local governments do not have data and information readily available to make the best choices. The Navigator helps fill this gap with publicly viewable maps of high functioning floodplains, connectivity corridors, and highly resilient forests that should be maintained and might benefit from protection.

#### ***4.5.2.2 Floodplain management and risk assessment***

The Navigator Map Tool shows areas potentially exposed to flooding, including both Federal Emergency Management Agency (FEMA) mapped 100 and 500 year floodplains as well as "Active River Areas" that might be prone to flooding, ponding, and changes in stream channel locations in response to extreme events, in areas where there is no FEMA map coverage. Alongside these maps, it can help characterize aspects of community vulnerability, like historic flood frequency, the number of properties and repetitive losses in the floodplain, and projected increases in extreme rainfall events. Residents and municipal officials who help communicate and manage risk to residents can use the Navigator to help convey this risk, and can also use it to identify functioning floodplains to protect and areas of impervious cover that could be restored to reduce runoff rates. Being able to visualize these vulnerabilities in an interactive map can help communicate risk and facilitate floodplain management that reduces risks to people and their livelihoods as well as benefit freshwater resources.

### **4.5.3 Regional level state agency planning**

#### ***4.5.3.1 Delineating mitigation areas***

For the Department of Transportation and other agencies that delineate mitigation areas, the results of the Navigator and the Map Tool can help select areas for mitigation that have multiple values including potential resilience to climate change.

#### ***4.5.3.2 Transportation***

The Navigator identifies areas particularly important for forest and stream connectivity now as well as into the future, which should not be disrupted with new roadways or other fragmenting features, and where improving connectivity for wildlife over bridges and through culverts might be most beneficial.

### **4.5.4 Land trusts:**

#### ***4.5.4.1 Identifying resilient strongholds to prioritize for permanent protection***

Several datasets with the Navigator are useful for land trusts to consider when identifying candidate lands for fee or easement acquisition: 1) areas highlighted on the Navigator recommendation maps as important places to “maintain”, particularly those where climate change presents a lower risk to conservation success; 2) lands in zones important for current or future connectivity between forest areas; and 3) lands that have important geophysical settings (like underlying geology and elevation) that are currently underrepresented in the State’s protected lands.

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