# Geospatial Conservation at The Nature Conservancy

SCIENCE OF RESILIENCE

# 2024 Annual Report & Map Book

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### About the Cover

At The Nature Conservancy our conservation planning process has evolved with rapidly changing technology, particularly our ability to generate biodiversity and climate data. As an organization with a 75-year history, TNC predates the advent and widespread adoption of geospatial technology. Our journey starts with priority conservation areas drawn on paper maps, then ecoregional plans identifying these priorities with spatial data in Geographic Information Systems (GIS), to today incorporating modeling and Earth observation technologies that relate ecological conditions to climate change. This rendition of various maps and data products on the cover conveys the progression of our work through ever more sophisticated spatial analysis and scientific modeling techniques.

**THIS PAGE:** Aerial image of sphagnum moss at The Nature Conservancy's Spring Pond Bog Preserve in the Adirondacks © Charlie Reinertsen/TNC Photo Contest 2023

**PHOTO:** Playing with water, Indonesia © Sanghamitra Sarkar/TNC Photo Contest 2022

PROLOGUE

# Redefining the Meaning of Resilience

**Jeremy Rifkin**

The excerpts below are adapted from
*The Age of Resilience: Reimagining Existence on a Rewilding Earth*

Resilience, be it in human or ecological communities, has been generally misconstrued as the ability to respond to massive disruptions with sufficient robustness to bounce back to the initial equilibrium. But what we are learning is that in society, nature, and the universe, when agencies interact, they never return to where they were because the interactions themselves change the dynamic regardless of how slight that may be. Anyone who has ever experienced trauma can attest that one can never go back but only forward to a new sense of agency that comes from the emotional and cognitive lessons learned.

The point is that resilience never means reasserting the status quo. The flow of events and the passage of time is always changing the patterns, processes, and relationships that make up existence, no matter how small the footprint, in both nature and society.

To complicate matters, resilience is often seen as a way to overcome vulnerability. Yet, to be vulnerable does not always mean being endangered. It also speaks to our ability to be open to the other. To be vulnerable can also mean to take risks, to leave one's comfort zone, and enrich one's sense of personal agency by experiencing the unknown and nurturing more diverse relationships and patterns of living and new venues of embeddedness.

This is the juncture where humanity grabs hold of "adaptivity" as the means to reestablish its relationship with nature from one of expropriation to reharmonization, taking us from the Age of Progress to the Age of Resilience. The idea of adaptation comes with an entirely different approach to scientific inquiry that leaves behind the conventional approaches steeped in inductive and deductive scientific inquiry in favor of pragmatic scientific inquiry. The pragmatist scientists of the late 19th and early 20th century—John Dewey, William James, Charles Sanders Peirce, and George Herbert Mead—were of a different mind when it came to science. Dewey "viewed knowledge as arising from an active adaptation of the human organism to its environment" and argued that adaptivity is a keystone attribute of all of nature.

Pragmatic scientific inquiry—under the banner of complex adaptive social-ecological systems modeling—reintegrates our species back into the patterns, processes, rhythms, and flows of an animated living planet and is fast becoming the go-to methodology of a younger generation of ecologically sensitive scientists. While inductive and deductive scientific inquiry were the lynchpins of a now dying Age of Progress, abductive science is becoming the popular moniker of the emerging Age of Resilience. In short, we and all of our fellow creatures are of nature.

Jeremy Rifkin's new book, *Planet Aqua: Rethinking Our Home in the Universe*, has been published simultaneously in all the principal world languages. Jeremy Rifkin is the best-selling author of 23 books translated into 35 languages. He is a principal architect of the European Union's and China's economic plans for transitioning into a Third Industrial Revolution to address climate change, and he served as an advisor to Senate Majority Leader Charles Schumer on the U.S. infrastructure plan. He is listed among the top ten most influential economic thinkers in *The Huffington Post*'s global survey of "The World's Most Influential Voices."

# Creating a Resilient and Connected Network

## FOR THE UNITED STATES

**Jan Glendening**
Executive Vice President,
North America, Caribbean and Micronesia

In all my roles at The Nature Conservancy (TNC)—from state director to division director to executive vice president of North America, the Caribbean and Micronesia—I have understood that science and data are foundational to TNC's success. How else do we measure conservation progress, highlight and celebrate achievements, or identify areas for improvement? Science guides us to effective and realistic solutions for the challenges faced by nature and people, while data allows those solutions to be shared with the specificity needed to create meaningful change. TNC's Resilient and Connected Network is a shining example of how science and data can drive powerful conservation outcomes.

The Center for Resilient Conservation Science (CRCS, crcs.tnc.org) is one of TNC's premier geospatial ecology teams. The team is responsible for completing a unique spatial analysis that enabled TNC to map a nationwide network of lands and waters with the potential to sustain a vast array of plant and animal species, as well as critical habitats, amidst a changing climate.

This Resilient and Connected Network map empowers TNC and others to implement protection and restoration strategies in the most impactful places. Thanks to the efforts of our CRCS team, Leveraging our Lands program and staff across all 50 U.S. states, TNC has conserved 1 million acres of the Resilient and Connected Network through direct action and partnerships with over 140 organizations in the last six years. In his 2020 "Call to Action for Land Conservation in America," Andrew Bowman, former CEO of the Land Trust Alliance, referred to the Resilient and Connected Network as a "paradigm shift in how we think about conservation."

Using TNC's geospatial science to inform their decision making, agencies and non-governmental organizations (NGOs) have conserved an even greater portion of the Resilient and Connected Network. Today, tech companies, Indigenous Nations, solar developers, winery owners and soil farmers are engaging with TNC's spatial data to help identify their own priorities and support their decisions.

I am incredibly proud of the Resilient and Connected Network and all it has achieved—it was no small feat. TNC's CRCS team worked with over 350 conservationists, meeting regularly with staff from six federal agencies, 17 state agencies, 22 NGOs, 17 academic institutions and TNC staff across all 50 states. Together, they planned, synthesized, mapped, reviewed and tested the data that was to become the Resilient and Connected Network. Their process has been diligently captured in nine reports and four published papers.

TNC's visions of a livable climate, healthy communities and thriving nature will be realized, in no small measure, because of geospatial science.

**PHOTO:** Trail at Brown's Lake Bog Preserve, Ohio © Emily Speelman



# Resilience Science

## ENSURING NATURE THRIVES INTO THE FUTURE

Mark Anderson and the CRCS Team
Graphics by Marta Ribera

There is a scene in the 60s classic *Butch Cassidy and the Sundance Kid* in which Sundance is asked to hold still and shoot a distant rock. He misses. Not even close. The asker walks away in disappointment, and Butch rolls his eyes. Sundance mumbles, "Can I move?" With a twist and a leap, Sundance fires again, knocking the rock into the air and then splitting it in half with a second shot. "I am better when I move," he says.

That scene is Resilience Science in a nutshell. Science, planning and action to ensure that nature can move, adapt and thrive! It begins with an understanding that the Earth is alive and dynamic, and that plants and animals need space to flourish. This premise leads to meaningful conservation that, when done well, provides the enabling conditions for resilience, adaptation and a healthy natural world.

Our path into Resilience Science has been an adventure, and like any journey we've relied on maps—a lot of maps—to navigate the twists and turns. On the next pages, you'll find a synthesis of some of the geospatial data and maps that expanded our awareness: from the distribution of topographic microclimates to the locations of thousands of stream barriers to the vast flows of movement along climatic gradients. Each map tells its own story, but don't be fooled by their beauty. Behind those maps are millions of data points, thousands of hours of modeling and testing, and hundreds of reviewers who have ground-checked the results. These layers of hidden ingredients make TNC's maps and data some of the most trusted and widely used in the conservation world.

We have also relied on collaboration. Like the building blocks that formed our Resilient and Connected Network, collaboration is a beginning, not an end. The journey of Resilience Science is on the following pages. We invite you along to explore our principles and the path we've taken to conserve critical lands in the United States while creating a method that can be replicated in other countries and territories.

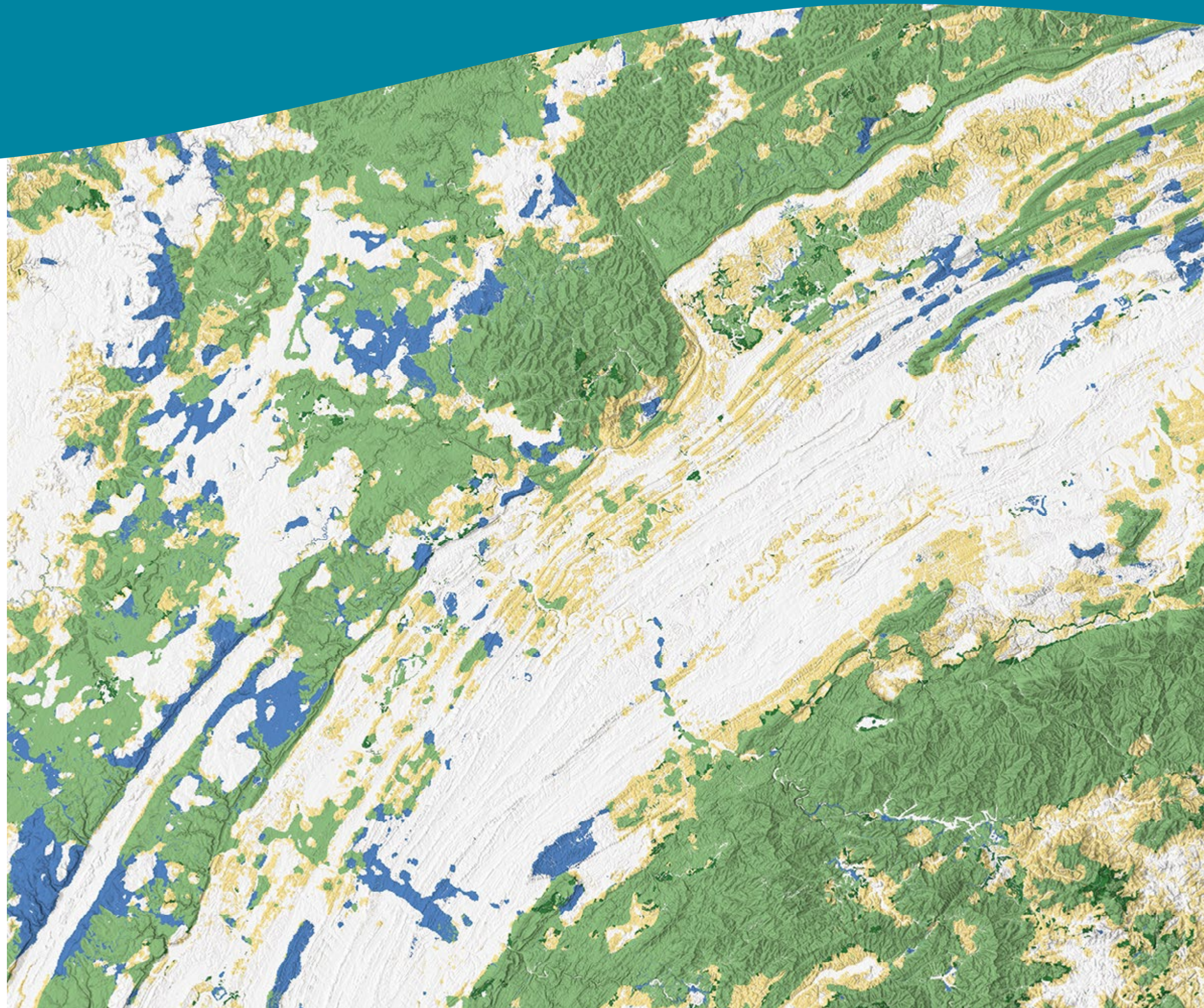
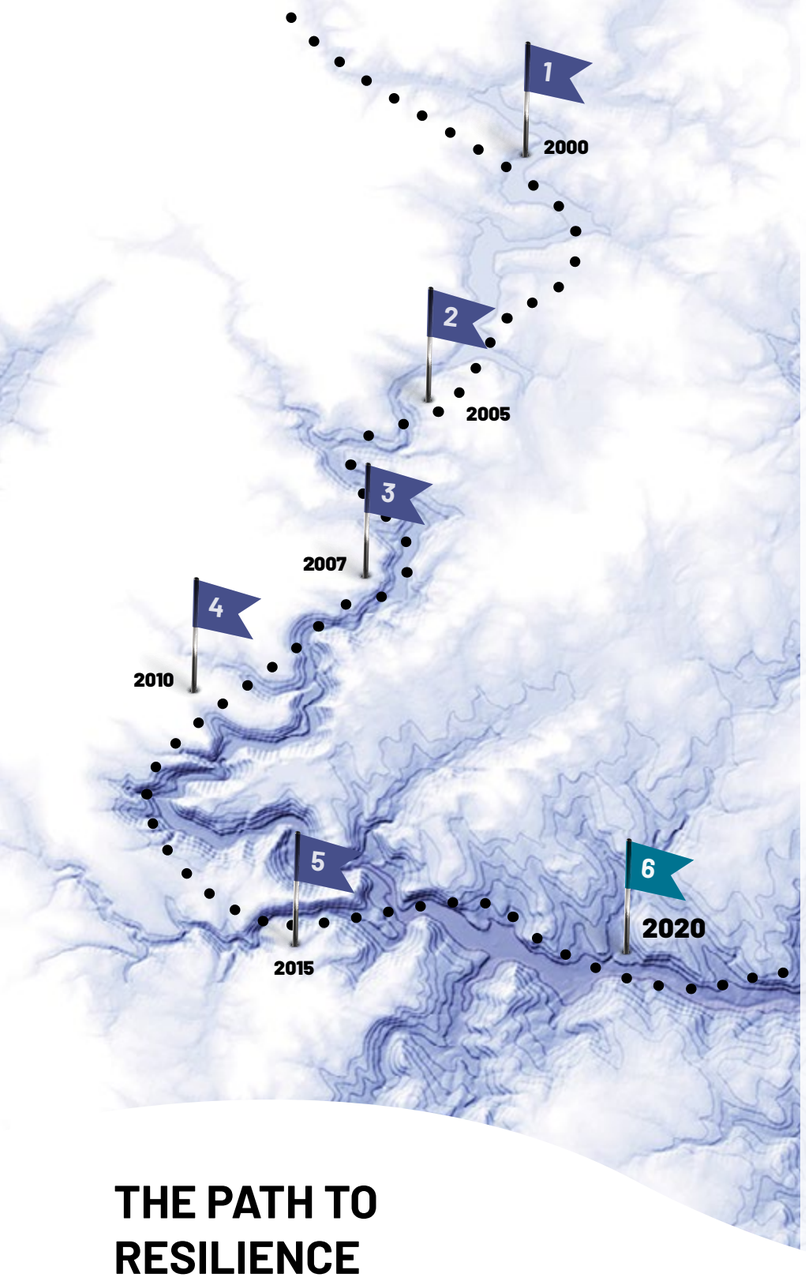


**IMAGE:** Resilient and Connected Network map

**SOURCES:** Center for Resilient Conservation Science, Esri




1. **Ecoregional Assessments**
   Intensive spatial assessments conducted by TNC and partners to identify key biodiversity areas for every terrestrial, freshwater and marine ecoregion.
2. **Ecological Units**
   A method to characterize and map the diverse properties of land and water at a scale equivalent to a natural habitat.
3. **Coastal Resilience**
   A program developed to identify where tidal marshes, oyster reefs and other habitats reduce risk to coastal communities from sea level rise and storm surge.
4. **Resilient Sites**
   Places where microclimatic buffering protects the resident plants and animals from the direct effects of climate change.
5. **Connectivity and Climate Flow**
   Key areas for movement, dispersal and migration in response to a changing climate.
6. **Resilient and Connected Network (RCN)**
   **A network of lands that, if conserved and restored, could sustain the full spectrum of terrestrial biodiversity as climate changes.**
7. **Freshwater RCN**
   A network of rivers, lakes and wetlands that, if conserved and restored, could sustain the full spectrum of aquatic biodiversity.

# THE PATH TO RESILIENCE

Developing the science of resilience took over a decade and followed a meandering path. Challenges in plotting biodiversity elements led to breakthroughs in mapping land characteristics that, in turn, inspired new techniques for modeling microclimates. These advances then gave way to mapping wall-to-wall climatic gradients to simulate adaptive range shifts. Along the way, we had a lot of help. By the time we had completed both the terrestrial and freshwater resilient and connected networks, we had engaged around 350 scientists on our steering committees representing 22 NGOs, 17 state agencies, 17 universities, eight Natural Heritage programs, six federal agencies and TNC staff from all 50 states. These scientists reviewed and tested the results and pointed out the trail when it grew faint.

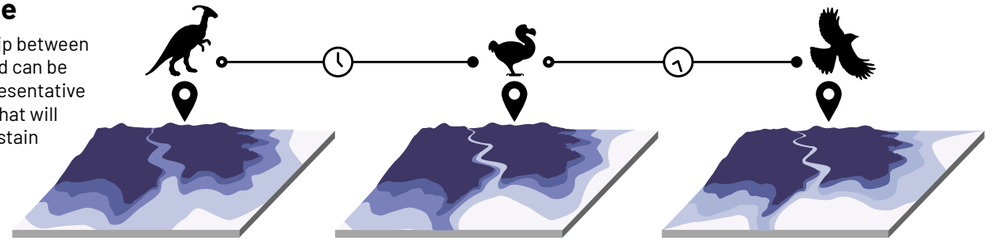
# THE PRINCIPLES OF RESILIENCE

## Thriving Biodiversity

To reverse the biodiversity crisis, we need to conserve, restore and create high-quality source areas where nature can thrive for generations.

## Conserving Nature's Stage

The close relationship between the biota and the land can be used to identify representative geophysical stages that will endure and, thus, sustain diversity.

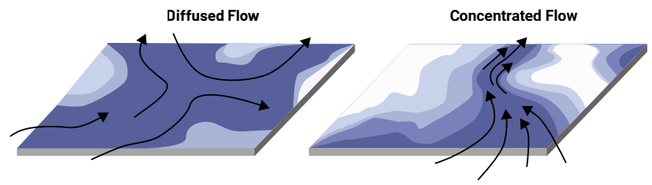


## Managing Microclimates

Sites offering a range of local temperatures and moisture combinations allow species to persist even as the regional climate becomes less suitable.

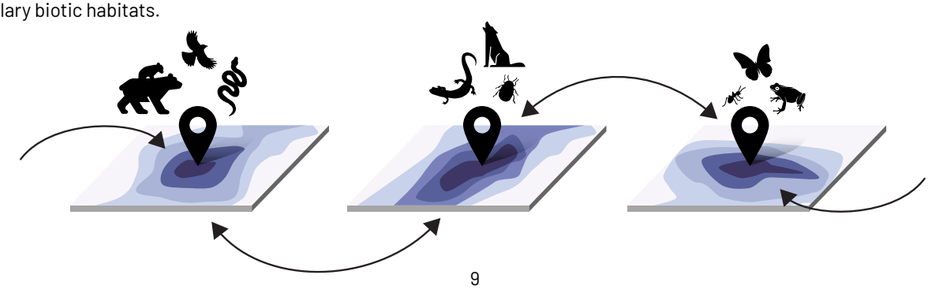
## Enhancing Connectivity

In response to a changing climate, nature must move. Facilitating movement requires a permeable landscape with key corridors conserved along climatic gradients.

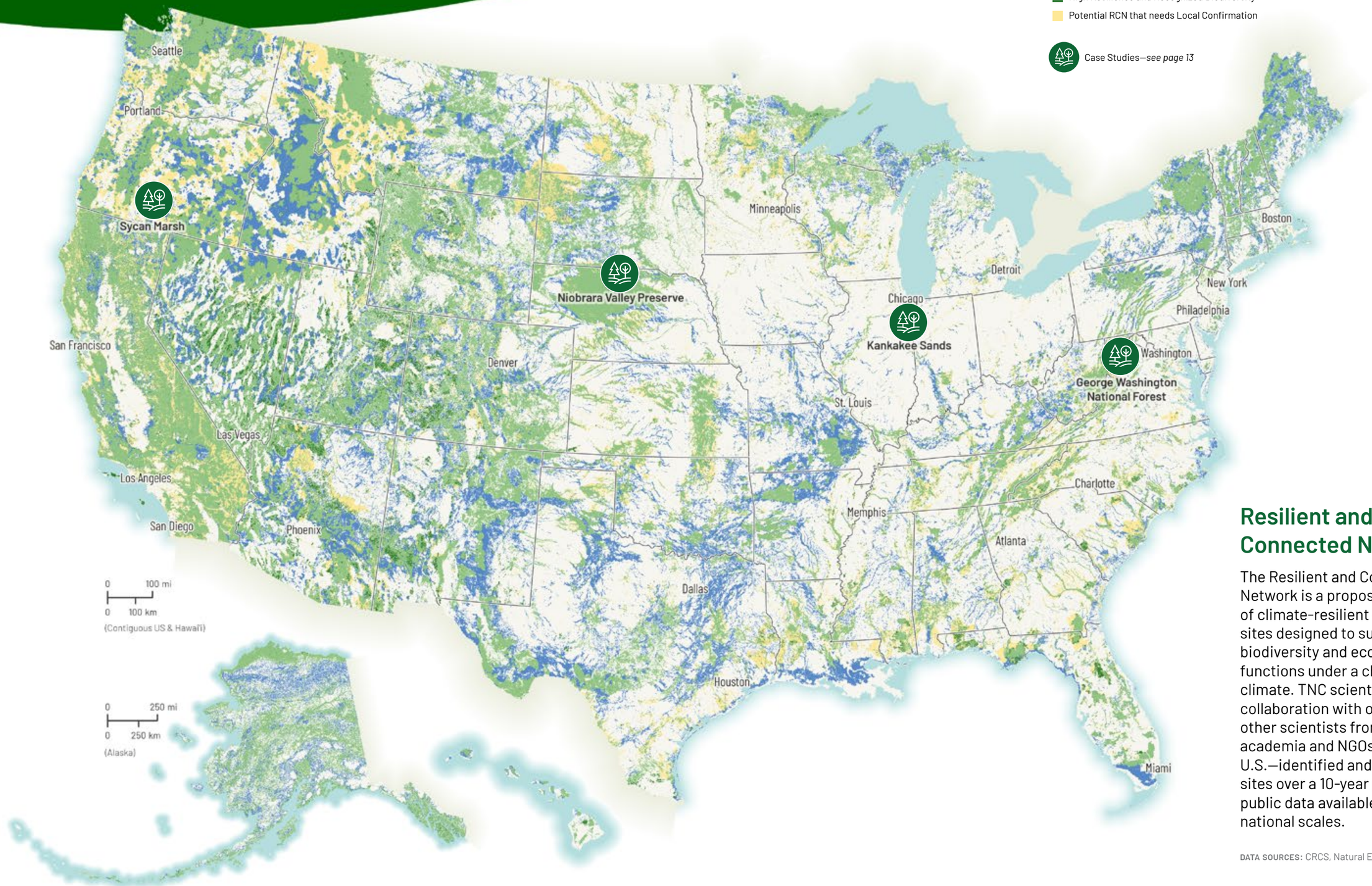



## Building Conservation Networks

To sustain the full diversity of nature, we need to conserve well-connected networks of representative resilient sites supporting exemplary biotic habitats.



# Land



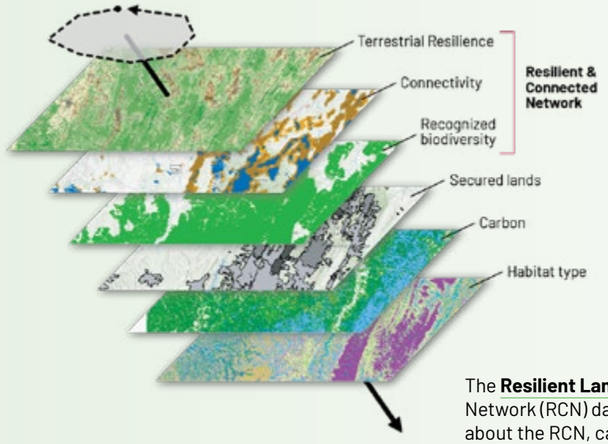

## Resilient and Connected Network

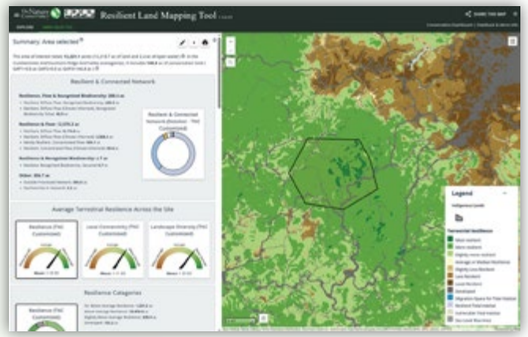
The Resilient and Connected Network is a proposed portfolio of climate-resilient conservation sites designed to sustain biodiversity and ecological functions under a changing climate. TNC scientists—in collaboration with over 150 other scientists from agencies, academia and NGOs across the U.S.—identified and mapped these sites over a 10-year period using public data available at state and national scales.

DATA SOURCES: CRCS, Natural Earth, Esri

Online tools allow users to easily access and interact with the spatial data and results of our analyses to support conservation and restoration decision-making. More importantly, these web tools create a transparent link between the information online and its data sources, building trust across our user community. The Nature Conservancy has a long history of building tools that are at the center not only of our own conservation decisions, but also those of many partners across the globe.

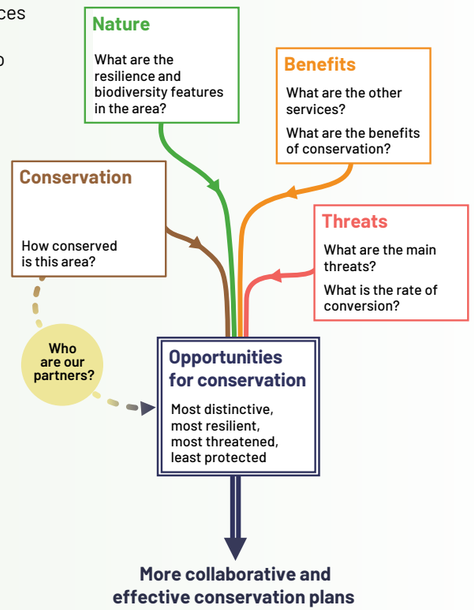
# Tools




The **Resilient Land Mapping Tool** is the gateway to the Resilient and Connected Network (RCN) data. It allows users to select a custom area and get information about the RCN, carbon stock estimates, habitat type and secured lands. More than 10,000 users a year employ it to make conservation decisions across the U.S.

The new **Conservation Dashboard** leverages our shared spatial data resources to highlight opportunities for action. It summarizes natural benefits and conservation statistics for the conterminous U.S. at scales from counties to states to regions. This tool is mobile friendly, so people can check all these numbers on the go.

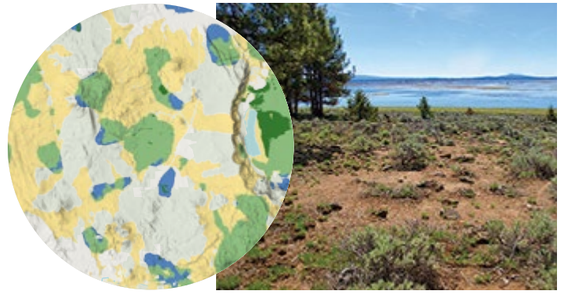



# Case Studies

## Protection

***Niobrara Valley Preserve, Nebraska***

TNC's Niobrara Valley Preserve was established before the resilience data was created, but the analysis reinforced the value and long-term resilience of this area. It represents 56,000 acres of resilient and connected land at a biological crossroads of the Great Plains. To date, 581 plant, 213 bird, 86 lichen, 70 butterfly, 44 mammal, 25 fish, 17 reptile and 8 amphibian species have been recorded at the preserve.



## Improved Management

***Sycan Marsh and Surrounding Forest, Oregon***

Nestled within thousands of acres of dry forests, Sycan Marsh is located within the ancestral homelands of the Klamath, Modoc and Yahooskin—collectively, The Klamath Tribes. Appearing as a large patch of resilient land in a vulnerable landscape, the marsh is home to thousands of birds. And for TNC Oregon and Indigenous partners, it's an epicenter of forest, fire ecology and fire management research.

## Restoration

***Kankakee Sands, Illinois***

The resilience of this black oak savanna site reflects many years of restoration efforts by TNC Illinois. Research revealed that only 0.02% of this habitat remained by 1985. Restoring this landscape benefits not only black oaks, which thrive in sandy soils, but also myriad other species that thrive in dry sand and prairies, including bird-foot violets, which are a main food plant for rare regal fritillary caterpillars.

## Designation

***Zoning for Connectivity and Resilience in the George Washington National Forest, West Virginia***

Thanks to the TNC West Virginia team, the final draft forest plan incorporates CRCS resilience data. Forest Service staff designated the Shenandoah Mountain along Great North Mountain corridor with protective management prescriptions that could ensure the viability of native biodiversity over the long term.

**PHOTOS, FROM TOP:** © Chris Helzer; © Richard Kolbell; © Fauna Creative; © Kent Mason

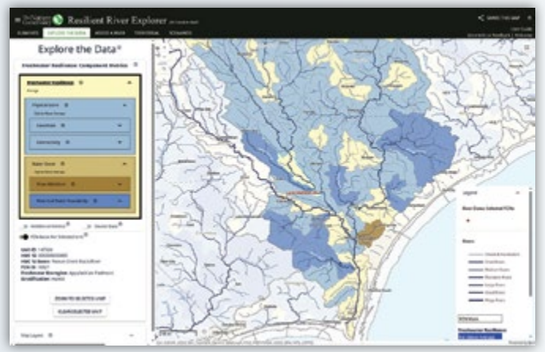
# Freshwater


## Resilient and Connected Network

Over the last century, the ecological integrity of most streams and lakes has declined, and now climate change is further impacting freshwater environments. In response, TNC engaged 60 freshwater conservationists over three years to assess river networks across the conterminous United States for their resilience to climate change. Integrating the results with maps of freshwater systems recognized for their biodiversity value, we identified a representative Freshwater Resilient and Connected Network that, if conserved and restored, could sustain freshwater diversity under a changing climate. The results will provide conservationists with information needed to restore and sustain freshwater systems.

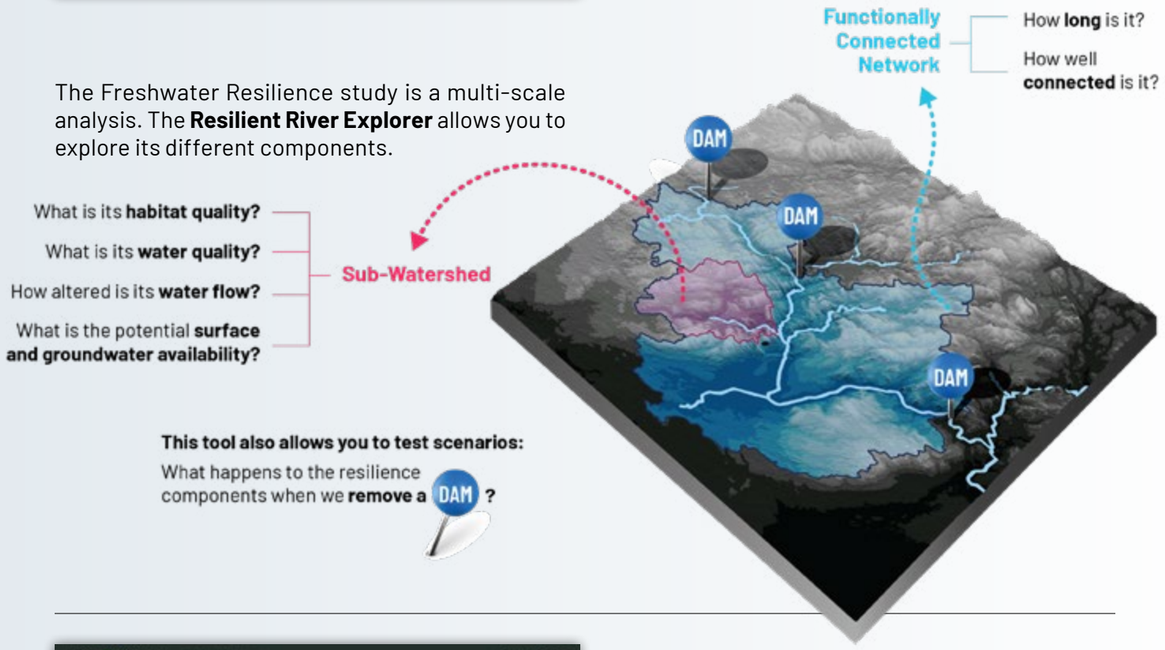
DATA SOURCES: CRCS, Natural Earth, Esri

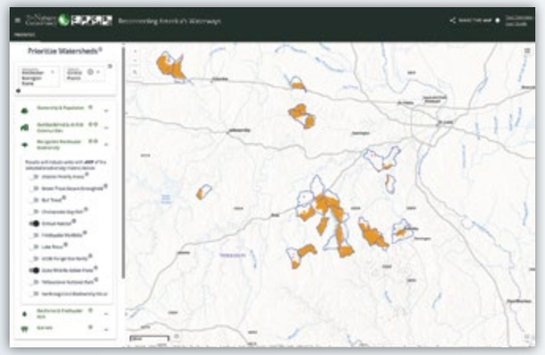
# Tools




The **Resilient River Explorer** provides access to freshwater resilience results for every small watershed in the conterminous U.S. This tool allows users to learn about the elements of freshwater resilience, explore resilience scores and contributing factors, choose a river to assess, view associated terrestrial resilience data and test restoration scenarios.

The Freshwater Resilience study is a multi-scale analysis. The **Resilient River Explorer** allows you to explore its different components.




The **Reconnecting America's Waterways** web tool enables users to query a suite of ecological and socioeconomic data to identify watersheds across the conterminous U.S. where restoring freshwater connectivity (dam removal, culvert replacement, etc.) could benefit nature and people.

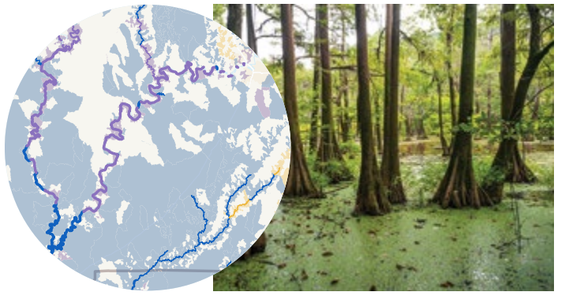


# Case Studies

## Restore Condition

***Restoring the Wabash River, Indiana & Illinois***

The Wabash River features the longest stretch of free-flowing river east of the Mississippi River. Essential for drinking water and home to 120 rare, threatened or endangered species, its water quality has degraded due to high sediment and nutrient loading from intensive land use. TNC Indiana collaborates with private landowners, state and federal agencies, and farmers to ensure this potentially resilient river supports the communities that depend on it.

## Reconnect

***Reconnecting the Alabama River, Alabama***

Reconnecting the Alabama River through the construction of natural fish bypass channels would enable species like the Alabama sturgeon to migrate freely through one of the world's most important river systems. TNC Alabama and a coalition of agency partners are mapping restoration options to create a better future for this resilient river and the thousands of species it supports.

## Protect *Follensby Pond—Establishing a Freshwater Research Preserve, New York*

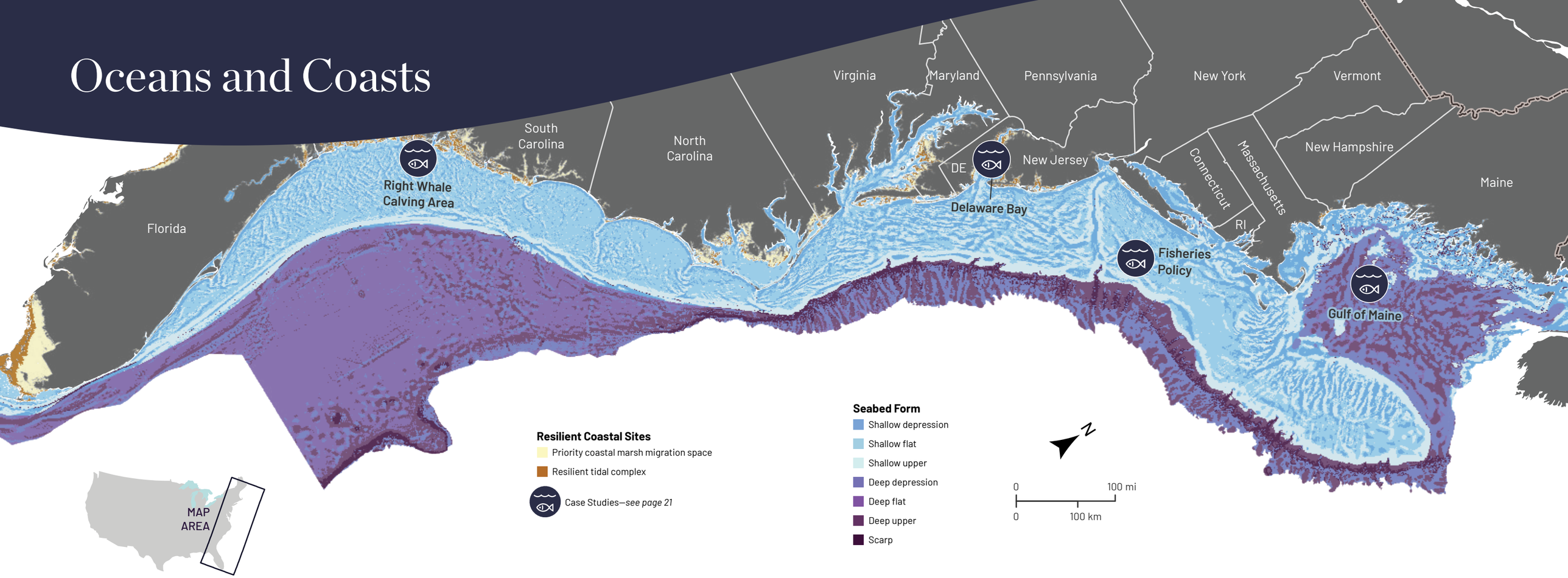
Follensby Pond is a marvel, with its cold, deep, highly oxygenated waters, abundant populations of coldwater fish species and healthy surrounding forest. In a historic agreement, TNC New York and the New York State Department of Environmental Conservation are protecting the 14,600-acre property, which includes the thousand-acre resilient lake and its watershed, for future generations. The agreement establishes a first-of-its-kind freshwater research preserve and recognizes the long-term relationships Indigenous Peoples have with the region.


## Restore Flow

***Colorado River Basin—Partnering to Find Solutions, Arizona, California, Colorado, Nevada, New Mexico, Utah and Wyoming***

Drought and rising temperatures have accelerated evaporation from reservoirs and snowpack to the point that rivers run dry earlier in the season and parched soils soak up precipitation before it reaches the river channel. Working closely with federal and state agencies for more than 20 years, TNC is building relationships with farmers, ranchers, municipalities, states, Tribal Nations and other partners to reduce pressure on existing water supplies and increase the river's potential resilience.

# Oceans and Coasts




## Ecoregional Assessments and Resilient Coastal Sites

In the land-saltwater interface where tidal marshes form, we studied shoreline elevation and topography to identify where marshes may be able to migrate inland in response to rising sea levels. We further studied the shape, size and condition of each "migration space" to estimate the likelihood of such migration. We used the likelihood of migration, reestablishment and persistence as an estimate of each marsh's climate resilience. This work builds off our Coastal Resilience program where we first engaged with local communities on the threat of sea level rise and storm surge.

A breakthrough in mapping marine biodiversity occurred when we began to understand how topography and sediment underlie the distribution of seafloor habitats and aggregate to form recognizable seabed forms like shoals, banks and canyons. Seabed features, in turn, interact with currents to create areas of persistent nutrient upwellings or calm depositional environments that underlie the feeding and migratory patterns of many species. Realizing that certain iconic marine areas, such as Cashes Ledge, were sunken mountain ranges led us to apply our techniques for mapping ecological land units to the marine environment, creating ecological marine units (or EMUs, as we fondly call them).

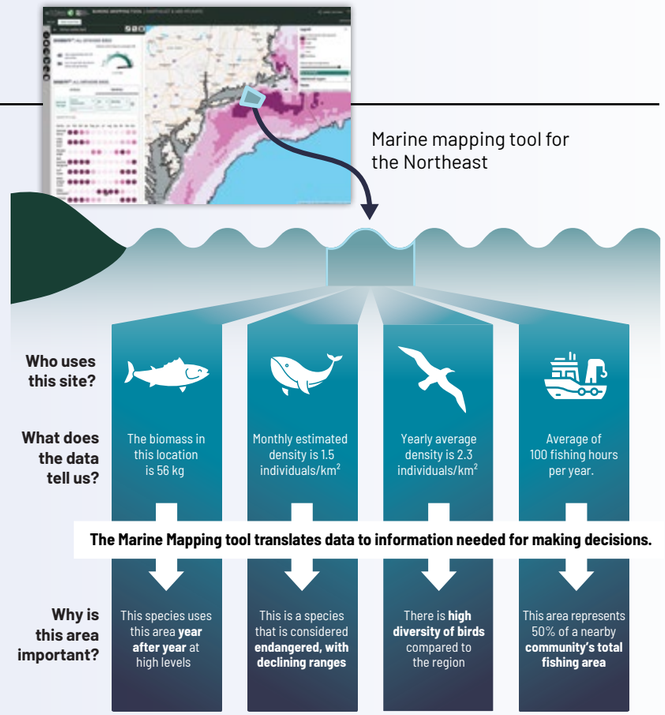
These enduring geophysical and oceanographic features provide the conditions and support for many species to thrive. In fact, it is well documented that many species return to similar locations year after year, as these reliable sites provide a stage for many species to breed, hide from predators and find food.

So, while ocean and coastal systems may look a bit different, with patterns that change more rapidly than on land, the same core principles of resilience still apply. Diverse systems remain important, as they provide flexibility to adjust to fluctuations. Understanding connectivity between sites and building networks is still critical to be able to sustain processes, provide representation and redundancy of habitats, and facilitate the adaptive movement of species among and between sites. We are looking forward to mapping this new resilient and connected network so that we can collectively conserve and restore many vital places across our oceans and coasts.

# Tools

The **Marine Mapping Tool** takes users into the ocean and underwater to explore how fish, marine mammals, invertebrates, sea-birds and people use specific places. Users can draw or import an area of interest and generate details showing which species are present, how their use changes seasonally, and how their abundance and persistence compare with other places in the ecoregion. Drawing on hundreds of peer-reviewed data-sets and models, this ground-breaking tool makes formerly specialized and technical data available to and interpretable by any interested user. It also starts connecting the dots between species, features and habitats so that we can better understand and tell a more complete story about marine species and the habitats on which they depend.

The Marine Mapping tool is available for the Northeast and Southeast regions along the Atlantic seaboard.




For every tidal marsh along the coast from Maine to Texas, users of the **Resilient Coastal Sites** web tool can inspect the "migration space" available to the marsh for adapting to sea level rise; assess the size, shape, and condition of the migration space; and estimate the marsh's resilience—i.e., the likelihood that the marsh will migrate, reestablish and persist into the future. The accompanying Story Maps allow users to explore barriers to migration in addition to the benefits of various conservation strategies for enabling marsh migration.

**Coastal Resilience** is a program and decision support platform that examines nature-based solutions for coastal climate adaptation. The program works with local and regional municipalities to explore how coastal habitats reduce risk while providing critical ecosystem services. This work stretches across the United States and the Caribbean.

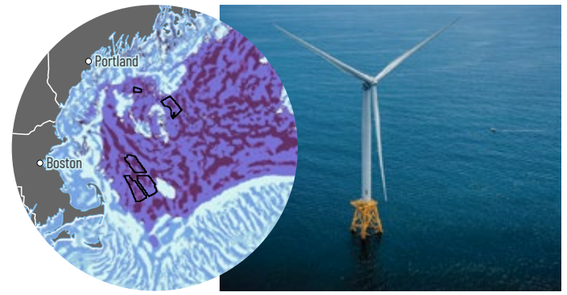


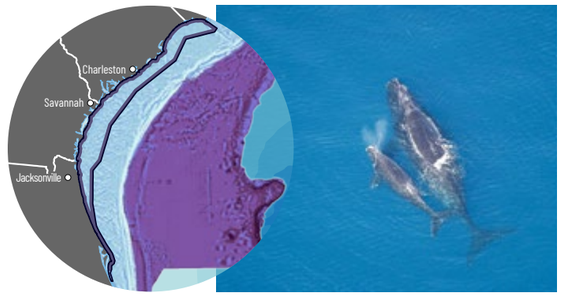
# Case Studies

## Siting

***Determining the Best Suitability for Offshore Wind in the Gulf of Maine***

Ensuring appropriate siting of Wind Energy Areas offshore requires large amounts of data to understand potential overlaps with critical habitats and species in the area. TNC supported the Bureau of Ocean Energy Management (BOEM) and NOAA by providing the best science and data for modeling of high suitability areas for wind across the region. BOEM analysts used TNC datasets and the Marine Mapping Tool as part of their review, and, as a result, areas important for the life cycle of species and for critical habitats such as deep-sea corals were removed from consideration for offshore wind development.




## Designation

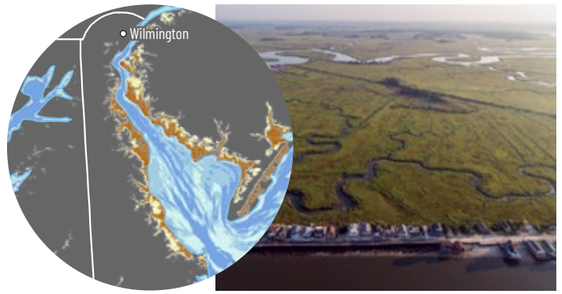
***Right Whale Calving Area in the South Atlantic Bight***

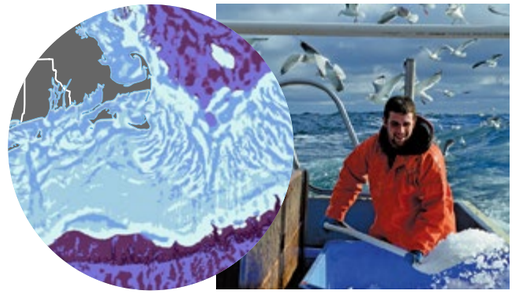
Since 2017, the small remaining population of North Atlantic right whales has been experiencing high mortality, in part from entanglements and ship collisions. Essential to their recovery is the shallow calving area off the South Atlantic coast. TNC's South Atlantic Bight Marine Assessment identified this site as critical to sustain a high concentration of whales during part of the year. TNC staff across the Southeast region also used the assessment to support NOAA's designation of the area as Critical Habitat.

## Restoration and Management

***Sea Level Rise and Marsh Migration in Delaware Bayshore***

The 2017 Resilient Coastal Sites analysis estimated the resiliency to sea level rise of more than 10,000 coastal sites from Maine to Virginia. Foremost among them are marshes along the shores of Delaware Bay. TNC Delaware's goal is for at least 50% of all resilient coastal wetlands and maritime forests to be able to shift into new habitats by 2035. Moreover, their Coastal Resiliency Roadmap will help at-risk communities identify funding sources to help them adapt to sea-level rise.



## Fisheries Policy

***Supporting Fisheries Management in the Northeast and Mid-Atlantic Regions***

In 2015, NOAA reconsidered fisheries measures and designations across the Northeast as part of an Omnibus Essential Fish Habitat Amendment. TNC staff played an active role in that process, not only as part of key fisheries council advisory committees and panels, but also providing the best science and data to support updated designations. Staff also used data from the Northwest Atlantic Marine Ecoregional Assessment to support our proposals and suggestions to federal regulators.

# Selected Resilience Projects

Tackling climate change is one of TNC's critical global priorities, and climate resilience is a key consideration in many of our conservation projects around the world. Anchored by our cutting-edge resilience science developed in the U.S. and now replicated in Brazil, we're applying the principles of resilience across our global portfolio of conservation work. Highlighted here is a small sampling of conservation projects around the world where resilience is a crucial consideration. From identifying a climate-resilient conservation network in China to forest carbon projects in the Solomon Islands and Papua New Guinea to river restoration projects in the U.S., we'll continue to advance our science toward a more resilient, sustainable world.

Countries and oceans where TNC works

In **Europe**, TNC is developing policies and tools to focus both TNC's and EU countries' strategies and funding towards priority places for aquatic ecosystems for biodiversity. Countries need this to create mandated Nature Restoration Regulation plans for restoring and protecting healthy ecosystems and clean abundant water. This builds on methods developed for the Freshwater Resilient and Connected Network tool in the U.S.

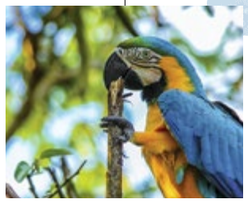
Ecological representation, or conservation of the full variety of biodiversity and ecosystems, is critical to climate resilience. **Mongolia** contains the world's largest intact temperate grassland and, supported in part by TNC's science-based conservation planning, one of the world's most ecologically representative protected area networks for terrestrial biodiversity. Sustainable financing initiative Eternal Mongolia will deliver lasting conservation of this exceptional landscape.

**Resilience science is integrated across all of our work in the U.S.**
*See pages 13, 17 and 21 for selected case studies*

We conducted the first statewide, comprehensive assessment of the vulnerability of **California's** coastal habitats, imperiled species and conservation lands to sea level rise. This study is informing future conservation strategies to manage for resilience and mitigate potential losses of vulnerable habitats.

**Brazil**
*See foldout section, page 24*

CoralCarib aims to use advanced strategies to improve marine biodiversity in priority coral reef ecosystems in **Cuba, Jamaica, Haiti** and the **Dominican Republic**. Project activities are designed to protect, restore and sustainably use coral reefs with high potential to survive future climate impacts, using a pioneering new modeling approach to identify and prioritize coral climate refugia sites.



In the **Colombia Amazon (Caqueta River basin)**, TNC is developing climate adaptation strategies and initiating their implementation through pilot projects. The components of the project are focused on first, analysis of climate change hazards, vulnerability and risks; second, analysis of social, ecological, economic and political context; third, identification of nature and Indigenous traditional knowledge-based solutions; and lastly, designing an adaptation strategy plan.

As the world's second-largest rainforest, the **Congo Basin** serves as a critical carbon sink while regulating regional and global climates through water cycling and atmospheric cooling. While TNC's work in the Congo Basin is in its early stages, this expansive forest landscape represents a connected network of habitats that supports extraordinary biodiversity, stabilizes ecosystems and provides natural buffers to the impacts of climate change.

In the Cubango-Okavango River Basin in **Angola**, our efforts to protect and restore this vital watershed are essential for maintaining the Okavango Delta's ecological health, resilience to climate variability and role as a biodiversity hotspot.

In **Sichuan Province, China**, we've conducted a pilot study to integrate the effects of climate change into our conservation planning approach and identify a climate resilient conservation network.

TNC is supporting what could become **Solomon Islands'** largest carbon project by safeguarding 14,500 hectares of mangrove and lowland forest in Isabel province.

TNC is investigating the potential of developing a protected area project across 400,000 hectares of savannah woodland and wetlands in western **Papua New Guinea**. Carbon financing is being considered as a sustainable alternative to industrial logging for the local communities.

TNC is leading **Australia's** largest shellfish reef restoration initiative, having restored 21 reefs across the Australian southern seascape. We are committed to bringing shellfish reefs back from the brink of extinction and aim to restore 60 shellfish reefs by 2030, comprising 30 percent of this lost habitat for the country. Sparked by an initial partnership with the Australian government, we are now well on our way to bringing an entire ecosystem back from the brink of extinction.

# Mapping Climate Resilience in Brazil

Milena Rosenfield

While The Nature Conservancy initially developed terrestrial climate resilience mapping for the United States, identifying places that can sustain biodiversity in the face of climate change is essential for planning conservation and restoration actions globally. TNC Brazil's science team, in collaboration with several Brazilian research institutions, has conducted the first mapping of terrestrial climate resilient sites in Latin America, applying and refining the same methodology developed in the U.S.

Brazil is a tropical and megadiverse country with diverse topographic features and ecosystem types. The analysis revealed landscapes with high microclimatic variability that are connected by natural habitats, allowing plants and animals to move in response to climate change. These results will allow scientists to identify not only the most resilient regions, but also areas where management interventions could improve resilience.

The study has direct applications to conservation, such as prioritizing natural areas for protection or degraded sites for restoration, identifying potential biodiversity corridors, and indicating regions directed for sustainable use of natural resources. It also has applications for country-level adaptation plans, as guidance for the creation of protected areas and as a tool for assessing the vulnerability of protected areas to climate change.

By using global databases coupled with national and transnational databases, as well as available tutorials online, we can replicate this analysis in different regions and contexts. The results have the potential to contribute to technical and scientific discussions on the impact of climate change on biodiversity and can be used to support public policies for conservation, restoration and sustainable use of natural resources at multiple spatial scales. The resilience analysis and associated data can be useful for planning at watershed, state, national or regional scales.

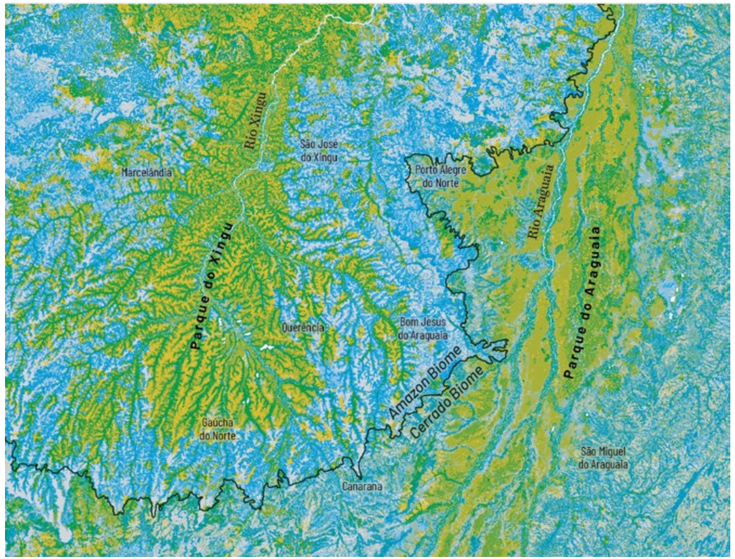

PHOTOS (FROM TOP): Amazon Forest © Gabriel Gabino Moreira/ TNC Photo Contest 2019; Treefrog (*Dendropsophus minutus*) in the Cerrado biome in Brazil © Rafael Batista de Mendonça/TNC Photo Contest 2021; Pau-Brasil National Park in Bahia, Brazil in the Atlantic Forest © Adriano Gambarini

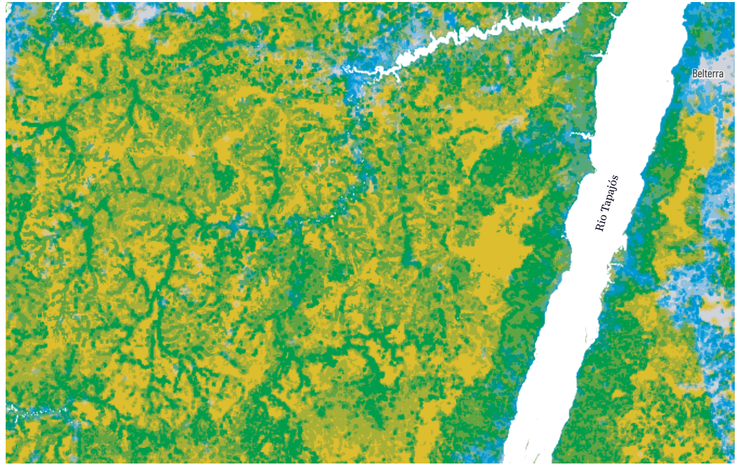
DATA SOURCES: TNC, Natural Earth, Instituto Brasileiro de Geografia e Estatistica

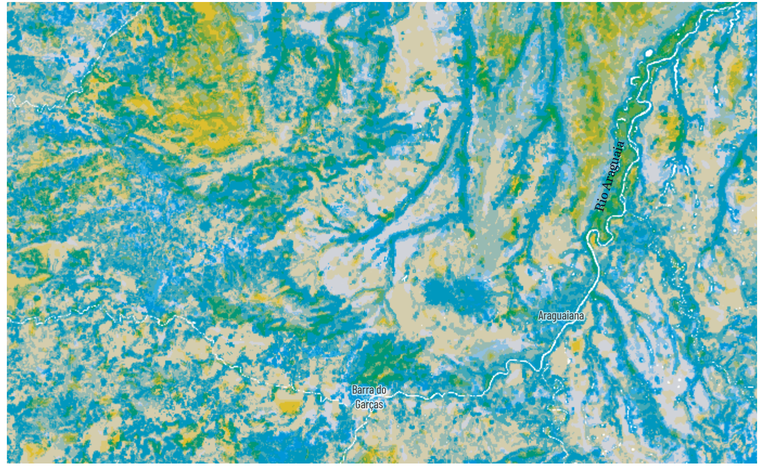
## Interpreting climate resilience categories

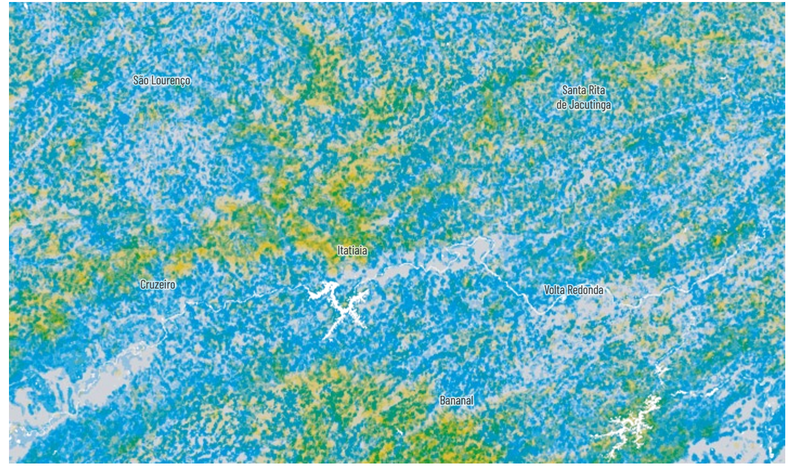
Landscape resilience was determined as the combination of landscape heterogeneity and local connectedness, generating a total of 16 combinations (classes), that were grouped in four quadrants. The classes and quadrants created in this framework allow for the identification of different areas of interest, for example areas that are priorities for conservation versus restoration, or those that may serve as ecological corridors.


MAP: This area shows the transition between the Amazon and Cerrado biomes. This region is characterized by having many Indigenous lands and conservation areas, and these stand out as having **high resilience** and **high local connectedness**. There are also many areas with **high landscape heterogeneity** across the landscape, which have the potential for increasing their resilience through management actions.





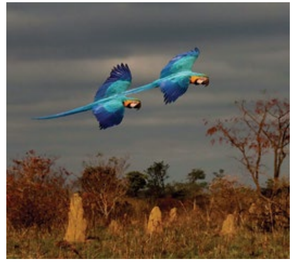

**The Nature Conservancy works primarily in three of Brazil's biomes. The maps on this page show close-up examples of the resilience data in selected places where TNC is working.**

# Amazon

The Amazon region, due to its size and conservation status, stands out for having the highest percentage of areas with high resilience in Brazil. Over 40% of this region has mid to high landscape resilience, the highest value compared to the country's other biomes. Within this biome, the areas of greatest landscape resilience are concentrated in the northwest and west. Overall, almost 36% of the biome has high local connectedness, but low landscape heterogeneity, representing mostly conserved natural habitats in less heterogeneous lands. The Amazon has extensive native vegetation still conserved and remains very important for biodiversity conservation in the face of climate change.

On the map, the combination of both greater landscape heterogeneity and greater local connectedness translates to **higher landscape resilience**. These areas have the greatest potential for future conservation. They indicate places that provide better conditions and more diverse habitats for organisms and species, thus favoring their persistence in a changing climate.

Sites with **high local connectedness** but low landscape heterogeneity, although not highly resilient, have low resistance to the movement of species and more conserved natural vegetation. They remain important for conservation now, as they allow the movement and flow of individuals across the landscape and could serve as potential ecological corridors to facilitate adaptation to climate change or displacement to more resilient areas.

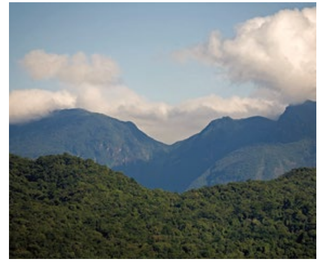


# Cerrado

In contrast to the Amazon region, higher values of landscape resilience in the Cerrado represent only around 17% of the biome's area. The Cerrado's areas of greatest landscape resilience are concentrated in the north and east of the biome, in the northwest, and in the far west. Conversely, lower resilience areas account for 37% of the biome. Only the Atlantic Forest has more lower resilience areas among Brazil's biomes.

Where both landscape heterogeneity and local connectedness are low, these areas offer **lower landscape resilience** and low potential for increasing resilience. However, these sites could be important for alternative land uses—ideally sustainable ones—to provide ecosystem services with lesser impacts on biodiversity. Also of note in the Cerrado region are areas with **high landscape heterogeneity** but low local connectedness (32% of the biome), which are areas that currently have low natural vegetation and where restoration could increase landscape resilience.

PHOTOS: (AMAZON) Chauá parrot in the Amazon rainforest © Lucas Castro/TNC Photo Contest 2019; The Rio Curipi meets the Rio Uaçá on its way to the Atlantic Ocean, in the Oiapoque indigenous region of the Brazilian Amazon © Haroldo Palo Jr.; (CERRADO) Native Cerrado grasslands and forest cover in Chapada dos Guimaraes National Park, Mato Grosso State, Brazil © Marci Eggers/TNC; Macaws in flight in Emas National Park in the Brazilian Cerrado © Christian Spencer/TNC Photo Contest 2022; (ATLANTIC FOREST) The Atlantic Forest in the state of Rio de Janeiro, Brazil © Adriano Gambarini; Dense foliage, forest scenery and cloud topped mountains in the hills east of Curitiba, Parana state, Brazil © Scott Warren



# Atlantic Forest

In the Atlantic Forest, higher values of landscape resilience represent only 6% of the biome's area, which is the lowest percentage across all biomes in Brazil. This biome is densely populated, with large, important urban areas and a long history of overexploitation of natural resources. Areas with the greatest landscape resilience are concentrated in the south and southeast of the region, coinciding with regions of moderate to high elevation and steeper slopes. This biome, however, has potential for increasing landscape resilience in areas with high landscape heterogeneity but low local connectedness (48% of the area). Such improvement, though, would require better land cover management and restoration interventions.

Sites with **high landscape heterogeneity** but low local connectedness, although not highly resilient, do have high potential for improving their resilience. This result would require restoring native vegetation to improve local connectedness between natural habitats. Improving ecological corridors between vegetation remnants and/or restored areas could benefit the flow of biodiversity and overall landscape resilience.

Scale for all maps
0 10 mi
0 10 km

# Annual Geospatial Survey & Trends

The Nature Conservancy conducted a sixth annual survey in fall 2024 to assess the status and needs of our geospatial community across GIS, remote sensing and data science disciplines. We asked respondents about their use of cloud platforms, storage and compute needs, training, software usage, and their specific geospatial areas of expertise and technology support. Since 2019, these responses have enabled us to track trends and build an effective enterprise geospatial system that supports practitioners and elevates the excellence of our geospatial work.

*Note: As with all surveys, these results are only as accurate as the response rate. Therefore, results do not necessarily reflect the status of the entire TNC geospatial community.*

**2,085**
STAFF INVITED TO PARTICIPATE IN THE SURVEY

→

**291**
RESPONDENTS [95% COMPLETED THE ENTIRE SURVEY]

## Defining TNC's Geospatial Community

**2,139** GEOSPATIAL COMMUNITY MEMBERS

**1,983** STAFF USING GEOSPATIAL COMMUNITY MICROSOFT TEAMS

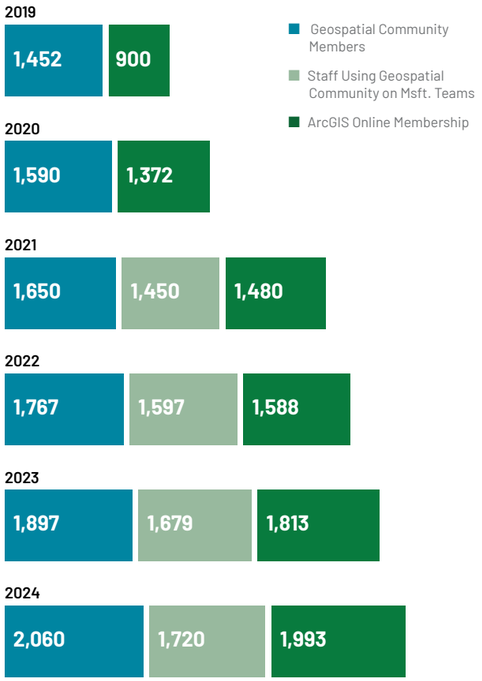
**2,025** ACTIVE MEMBERS ON ARCGIS ONLINE

**737** USERS ON CONSERVATION GEOCLOUD

**44** EXTERNAL PARTNER ORGANIZATIONS SUPPORTED (BY EXTENSION) ESRI AUTHORIZED ENTITIES

## Geospatial Community Growth

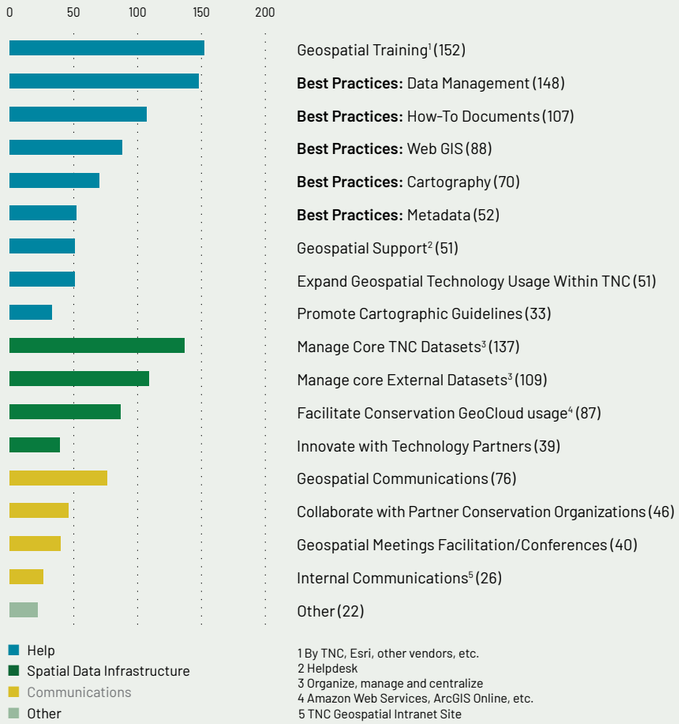
In the last six years, our geospatial community has grown significantly. Today, over 35% of TNC staff use geospatial technology in their work.






## Priorities of Geospatial Community

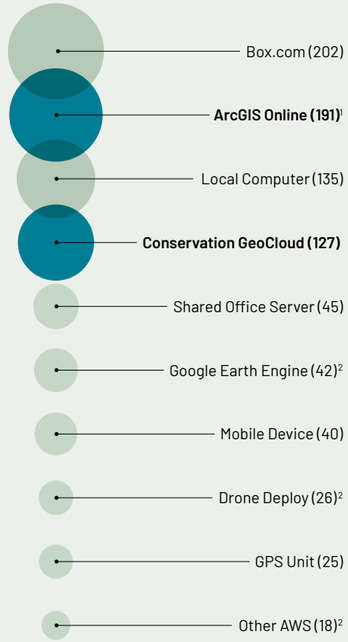
We asked respondents to identify the top priorities that the Geospatial Systems Team should focus on in the next year to make the biggest impact on the community's work.




1 By TNC, Esri, other vendors, etc.
2 Helpdesk
3 Organize, manage and centralize
4 Amazon Web Services, ArcGIS Online, etc.
5 TNC Geospatial Intranet Site

## Storing Spatial Data

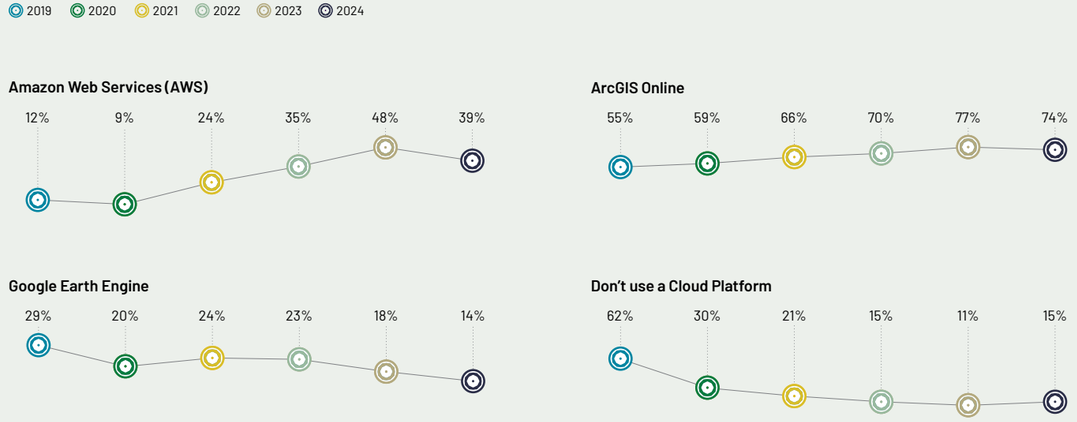
Most respondents now use TNC's Conservation GeoCloud to store their spatial data. Box.com and local computers are also widely used to store spatial data.




1 Also a part of the Conservation GeoCloud
2 Other Cloud Systems

## Cloud Platform Usage

Over the past six surveys, we have seen increased usage of cloud platforms, principally ArcGIS Online and Amazon Web Services.



# Map Spotlight

## IMPROVING RIVER CONNECTIVITY, ONE HEADGATE AT A TIME

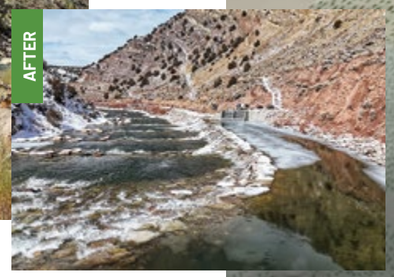
**Lucy Haggard**
Colorado

In northwest Colorado, the Town of Maybell hosts one of the largest irrigation diversions from the Lower Yampa River, a key waterway of the Colorado River Basin. The 18-mile Maybell Ditch, established in 1896, provides water for 21 agricultural producers through a network of lateral ditches that wind through the community. While the ditch worked well for decades, declining river flows and aging infrastructure warranted a modernized headgate and diversion. In 2017, using a combination of private, state and federal funding, the Maybell Irrigation District and TNC Colorado embarked on a collaboration that has culminated in replacing the rusty, broken headgate, as well as restoring the river at the diversion. The updated diversion facilitates more efficient water use, allows upstream travel for numerous endangered or threatened fish species, and improves recreational boater access.

Lucy Haggard is a conservation geographer with TNC Colorado who works on cartographically driven maps and visualizations to support science and projects around Colorado and beyond.


The original diversion (above) had massive boulders in the channel, placed to divert water from the river into the ditch. This design created dangerous conditions for boaters and inhibited fish passage, particularly during low flows. As part of the new diversion, a constructed stair-step riffle creates a more gradual riverbed (right), improving navigability for recreational boaters.






For over 126 years, operation of the original headgate (far left) required an arduous three-mile hike down a remote canyon to open or close the device. The new headgate (near left), completed in 2024, enables remote operation via cell phone, making the whole system more responsive to changing river flows and agricultural producer needs.

PHOTOS: © Jennifer Wellman, © JHL Constructors, © Diana Lane, © Toby Hayman; DATA SOURCES: TNC, CDOT, NHD, NLCD, BIA, Esri

Maybell

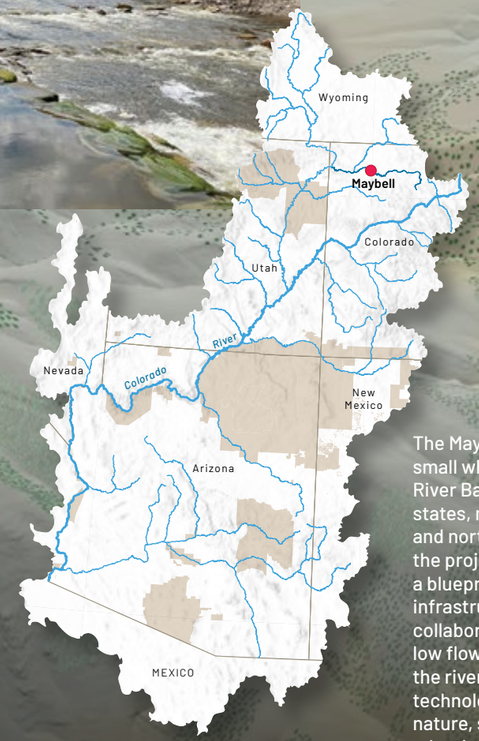
*Agricultural fields irrigated from the Maybell Ditch include **cultivated crops**, as well as **hay and pasture**.*

YAMPA RIVER

40

73 miles to Steamboat Springs →

MAYBELL DITCH




The Maybell Diversion Project may seem relatively small when compared with the massive Colorado River Basin (inset map), which spans seven U.S. states, numerous Tribal lands (beige on map), and northern Mexico. Despite its remote location, the project and its overwhelming success offer a blueprint for much-needed rural irrigation infrastructure improvements and deep community collaboration across the basin. As drought and low flows continue to disrupt the hydrology of the river, modernizing irrigation systems through technological upgrades will be key to sustaining nature, supporting people's livelihoods and adapting to a hotter, drier future.

Diversion location

EPILOGUE

# The Great Transformation

## FROM THE AGE OF PROGRESS TO THE AGE OF RESILIENCE ON PLANET AQUA

**Jeremy Rifkin**

The excerpts below are adapted from *Planet Aqua: Rethinking Our Home in the Universe*

What would happen if we suddenly realized that the planet we live on appeared eerily alien, as if we'd been teleported to some other distant world? That frightening prospect is now. Our planetary hydrosphere, which animates all life on Earth, is rebelling in the wake of a global warming climate, unleashing blockbuster winter snows, torrential spring floods, devastating summer droughts, heatwaves and wildfires and deadly autumn hurricanes, wreaking havoc on ecosystems, infrastructure, and society.

We have misjudged the very nature of our existence and to what we owe our lifeline. We have long believed that we live on a land planet when in reality we live on a water planet. It's the hydrosphere, after all, that moves the lithosphere, atmosphere, and biosphere, making life possible and human society viable.

We are embarking on a new adventure that's taking us from the dying Age of Progress to an emerging Age of Resilience and a reset of the human story. The transformation is simple and profound: rethinking the waters that animate the ecosystems as a "life source" rather than a "resource" and learning how to adapt to the hydrosphere rather than adapting the hydrosphere to us. This is the dynamic that will allow us to replenish and conserve ecosystems and reflourish life.

The challenge before us is enormous. We will need to reassess every aspect of the way we live: how we engage nature, pursue science, govern society, conceptualize economic life, educate our children, and even orient ourselves in time and space on an animated planet. These and countless other choices that we make over the next several generations will determine whether life on Planet Aqua will be re-endowed. The next stage in the human saga is to let the waters prime our journey.

The mission focuses on a number of critical themes including stewarding our planetary biomes as shared commons, granting legal rights and personhood to ecosystems, addressing the dire threat of groundwater depletion, repurposing the water-energy-food nexus, deploying regenerative agricultural practices, adopting an eco-centric approach to science and technology,and developing new approaches to pedagogy, curricula, clinical learning, and incubator projects at the university and secondary school level.

These vast changes in the way we've come to think of our planet in the cosmic theater reboot the human story, taking us into a new life-affirming future. We live on a water planet and every aspect of our existence flows from this incontrovertible truth. Rebranding our home in the universe as Planet Aqua, and introducing this second naming of our planet into government constitutions, bylaws, codes, regulations, and standards, is the first giant step toward a realignment with the waters that animate our very existence. This epiphanic moment marks the beginning of a new transcendent journey to rekindle the pulse of life on our water abode. There is only a single agenda before us: making peace with a rewilding hydrosphere and finding new ways to flourish along with our fellow creatures. All else is a distraction.

PHOTO: Guarda Beach in Palhoça-Santa Catarina, Brazil © Rafael Imhof/TNC Photo Contest 2022


## Acknowledgments

This sixth edition Geospatial Conservation Annual Report & Map Book has been a collective effort between TNC staff in Information Technology and the Center for Resilient Conservation Science (CRCS), as well as staff in Colorado, Brazil and elsewhere across the organization. A big thanks goes to Jan Slaats and Becca San Fratello for conducting and synthesizing our annual survey, Alicea Halsted for her work on the digital companion to this report, and Jay Sullivan for his always outstanding support for print publication. Danielle DeGarmo (contractor) did the incredible layout and design work, Christopher Johnson (contractor) designed the stunning cover, and a special thanks goes to Danny White for his editing review.

Mark Anderson and his dedicated and passionate team of professionals at CRCS contributed much of the content in this edition. Thanks to Melissa Clark for her steadfast support throughout the creation of this report, as well as to Erik Martin, Arlene Olivero, Analie Barnett and Mary Khoury for their contributions. Special thanks to Marta Ribera for her help in synthesizing the cutting-edge science of the CRCS team and for her outstanding design skills as well.

Thanks to Milena Rosenfield and the Brazil science team for their help featuring their resilience mapping. Thanks also goes to Lucy Haggard in Colorado for being this year's featured cartographer in our Map Spotlight. In One Conservancy spirit, these folks and others have made essential contributions to this edition. We also extend appreciation to TNC's global leadership in IT, Global Science, and the North America Region, Jan Glendening in particular, for championing the work of TNC's geospatial conservation community. Most notably, we are honored to have had the opportunity to work with Jeremy Rifkin, world-renowned author, whose works on resilience are excerpted in this report. Finally, we are appreciative of our enduring partnerships with Esri, Amazon Web Services and Microsoft in continuing to support this incredible conservation work. We are most grateful for your support!

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