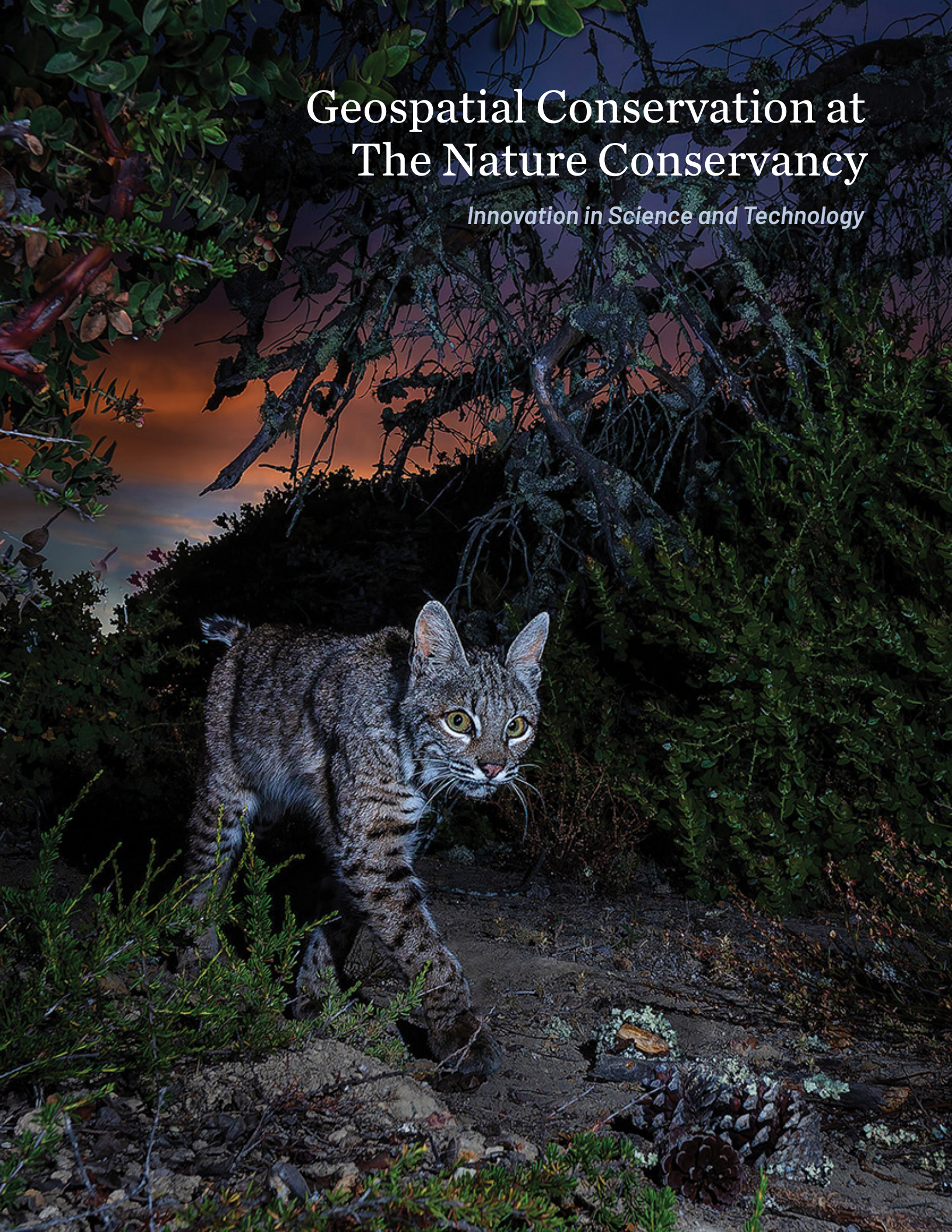


Geospatial Conservation at The Nature Conservancy

Innovation in Science and Technology



2025 Annual Report & Map Book

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About the Cover

This bobcat was captured on a camera trap at TNC's Dangermond Preserve in California. On the back cover is a mosaic of hundreds of camera trap images that represent just a fraction of the photos generated regularly by remote cameras on the preserve. Camera traps have been used for decades for research and monitoring of biodiversity. Remote cameras generate thousands of images that are now often reviewed and tagged with the help of AI. Recently, TNC developed a platform for managing camera trap data and integrating AI into wildlife monitoring. See story on p. 14.

PHOTO: © John Stuelpnagel; mosaic created with AndreaMosaic.

This page: A mountain lion caught on a camera trap at Dangermond Preserve. The preserve is large and intact enough to support a breeding population of this elusive apex predator.

PHOTO: © John Stuelpnagel

FOREWORD

A Window for Action

Teal Wyckoff
Associate Director, Geospatial Services,
The Nature Conservancy

Ryan Abernathey
Co-founder & CEO, Earthmover

The climate and biodiversity challenges of our time are no longer distant or abstract. They are unfolding across landscapes, oceans and communities right now, and they demand action at a scale and pace we now have the technologies to identify, analyze and act upon, should we choose to implement them fully. The decisions we make now will determine whether we can stabilize the climate, slow biodiversity loss and protect people from the most severe impacts of environmental change.

Meeting this moment requires more than ambition. It requires strong science, supported by modern foundations in technology, data and collaboration—a coming together that sets aside our sense of ownership over domains. Geospatial science plays a critical role in this work. Indeed, it is how we make sense of complex systems, determine *where* action will have the greatest impact for conservation and translate that evidence into decisions that can be acted on with confidence—together.

Conservation-oriented organizations have an opportunity to apply these capabilities in the service of ambitious goals. But no single institution can meet the scale of today's challenges alone. Progress depends on a broader scientific and conservation community, aligned by shared purpose and enabled by technologies designed for partnership at a planetary scale.

We are operating in an era defined by exponential growth in data volumes. Environmental, climate and social data are being generated continuously across every region of the world. Yet data alone does not create impact. Quality matters. Trusted, well-designed data products built with scientific rigor, transparency and replicability are essential if information is to be used confidently by scientists, practitioners and decision-makers. This report reflects a growing commitment across the field to invest not just in more data, but also in innovative technologies and better data in the systems that make it usable, credible and actionable.

The work highlighted in these pages illustrates a fundamental shift in how conservation science is practiced. Modern, future-ready technologies such as cloud computing, advanced analytics and artificial intelligence are enabling globally distributed teams to collaborate in real time, support sophisticated analytical and governance needs, and scale insight far beyond what was previously possible while concurrently future-proofing in a world of rapid technological change. These integrated systems help maintain scientific rigor while translating complex analyses

into insights that leaders can readily incorporate into policy, planning and investment.

Innovative technology also enables openness and partnership. Addressing climate change and biodiversity loss requires shared knowledge, tools and action across governments, Indigenous peoples, communities, nongovernmental organizations and the private sector. By leveraging technology to share data, methods and insights, we strengthen a global community working toward a common mission.

The tools and integrated technological platforms needed to meet our present challenges are at our fingertips. The window for action is open but narrowing. We must invest, act decisively and apply technological innovation with discipline, focusing on the places where science tells us we can make the greatest difference. Geospatial science provides the clarity and confidence to do exactly that.

Together, through science, technology and collaboration, we can deliver outcomes that matter, at the scale and speed this moment requires.

PHOTO: An early dry season controlled burn (which burns cooler than those conducted later in the dry season) in savanna woodlands at Fish River Station, Northern Territory, Australia. TNC is working to help the Indigenous Land Corporation purchase the property and place it in the hands of the Indigenous people who will sustainably manage it. See Map Spotlight on p. 26. © Ted Wood



An Innovation Framework for Conservation Science & Technology



Zach Ferdaña
Director, Conservation & Geospatial Systems

Niraj Swami
Senior Director, Conservation Technology, Strategy & Enablement

What got you here won't get you there. Getting there requires a beginner's mind and a sprinkle of innovation.

The Nature Conservancy (TNC) is built on a strong history of crafting innovative conservation strategies and finding new ways to put them into practice. With these strategies have come action plans, conservation gains, and measures of success. TNC's legacy includes some of the most successful conservation efforts on planet Earth. We celebrate these successes over our 75-year history.

We never shy away from the challenges we face in ensuring we conserve the lands and waters on which all life depends. Yet in this 5th industrial revolution when human creativity is advancing smart machines at breakneck pace, we need to keep a diligent eye towards sustainability and resilience. Ultimately, how we balance collaborative intelligence and technological convergence with sustainability and resilience will largely be determined by human innovation. Innovation is more important than ever as we strive to mitigate the speed of climatic changes and adapt to ecosystem shifts.

Our Conservation & Geospatial Systems team, working in close partnership with our Conservation Technology, Strategy & Enablement team, represents our science and technology wing within our IT organization at TNC. Our vision is to collaboratively design, build, support and scale technology solutions for conservation science. An essential component of this vision includes experimenting, learning from, and strategizing what's next, while working with external partners and technology leaders to shape emerging capabilities around TNC's mission. This vision reflects our intention to put our best ideas forward most efficiently in leveraging technology for conservation. To support this vision, we are advancing an innovation framework. The reference book *Accelerating Innovation*¹ is helping us build and implement an innovation framework to guide our best ideas and thereby increase our conservation footprint.

Innovation is a process of taking ideas from inception to impact. Being a team within IT whose principal responsibilities revolve around supporting our conservation science community of over 2,000 staff, we are largely operating within a Business As Usual (BAU) framework. Although innovation has limited room to evolve on a BAU roadmap, where we might expect no more than 10% improvements to our operations in any given year, we are finding ways to discover minimum viable successes (MVS). MVS can also be termed "little i," and we utilize this space to continually adapt the parts of our story that effectively leverage science and technology to meet our mission. However, innovation is also increasingly focused on business transformation. Achieving "big I" beyond 10% will require not only creativity and operational efficiency, but also mapping out our most novel ideas for maximum impact.

According to *Accelerating Innovation*, we first need to identify both high problem novelty (existing solutions applied to new problems) and high solution novelty (existing problems applied to frontier solutions). Mapping our ideas on a problem/solution matrix, we are beginning to see how we can accelerate our conservation impact with innovation. For instance, in the solution novelty space, TNC has long struggled with how to support our conservation science community in having adequate storage and compute resources for spatial analysis and discovery. Our spatial science methods are a hallmark of our work, but without these adequate resources, we cannot demonstrate the results to our leadership as decision support. We had an existing problem that needed a frontier solution. In the following pages of this report, we cite other high problem and solution novelty work in conservation science and technology.

Mapping your own innovation portfolio, whether you're building the science or enabling the tools that deliver it, you might also find that what got you here won't get you there.

¹ Budden, Phil and Murray, Fiona E.S. 2025. *Accelerating innovation: competitive advantage through ecosystem engagement*. Cambridge, Massachusetts: The MIT Press.

Empowering Innovative Workflows

Advancing Climate Science Through Cloud Computing and AI

Luke Parsons and Ava Goodarzi

The Nature Conservancy's 2030 goals are ambitious: help 100 million people adapt to climate change; accelerate carbon mitigation; and conserve critical lands, waters, and ecosystems. Achieving these goals requires answering fundamental questions that have long challenged conservationists. Which 100 million people face the greatest climate risks? Are the ecosystems we're working to protect themselves vulnerable to climate change? Will they remain resilient in a warming world? And will the places that need nature-based interventions now shift with future warming?

Answering these questions demands analysis at scales previously unimaginable, from individual communities to entire continents, across multiple climate variables, and spanning decades of historical and projected change. Being innovative requires us to think outside of traditional workflows, exploring new spaces in science and technology. Climate scientists on TNC's Global Science team are tackling these challenges head-on by integrating cutting-edge cloud computing infrastructure, artificial intelligence and high-performance computer science partnerships.

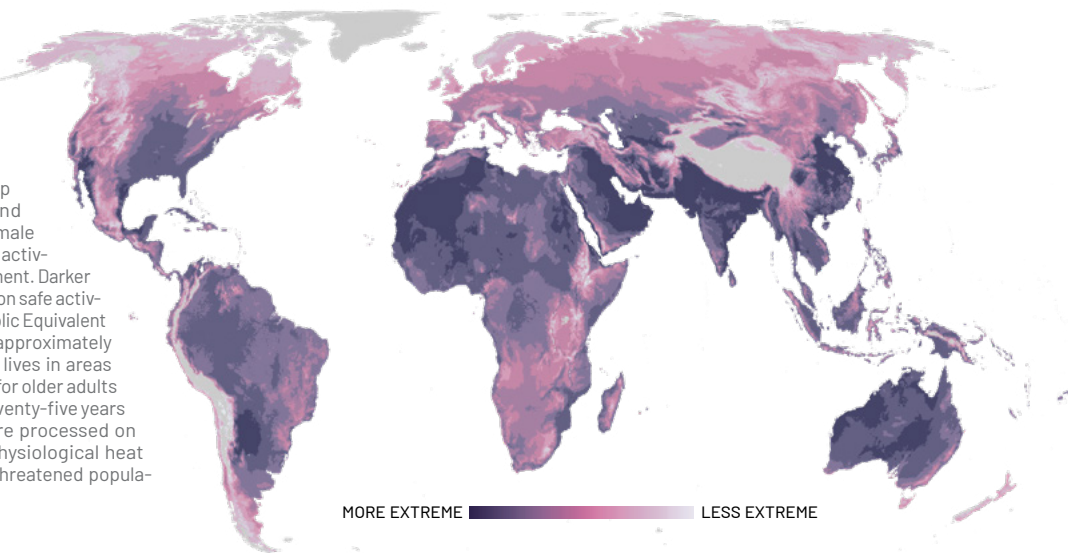
The data requirements for global climate risk assessments are massive. A single analysis might integrate terabytes of climate model output, satellite observations, population demographics and ecosystem data across multiple spatial and temporal scales. Traditional desktop computing simply cannot handle this volume or complexity.

To address this need, our workflow leverages three interconnected technological pillars. First, we use Amazon Web Services (AWS) cloud infrastructure to store and process massive climate datasets, including high-resolution ERA5 reanalysis data and CMIP6 climate projections, making these resources accessible to our entire team without the bottleneck of local data downloads. Second, we've integrated AI-assisted coding tools into our development process, accelerating script development, debugging and documentation, while maintaining scientific rigor. Third, through partnerships with the University of Utah's Center for High Performance Computing and similar university centers, we access the computational power needed for the most intensive analyses, processing hundreds of model scenarios simultaneously.

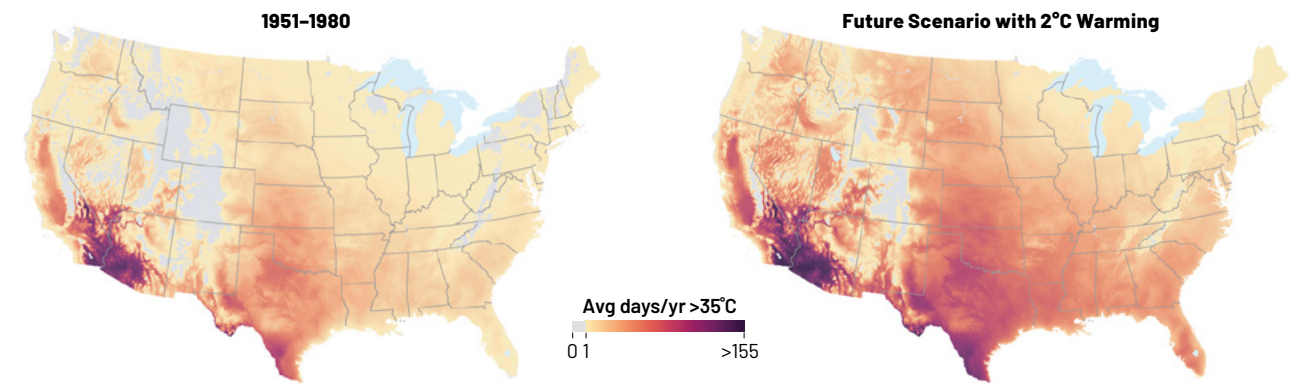
This integrated approach transforms what's possible. Analyses that took months on local machines now run in hours or days. Formerly time-consuming code debugging and modifications can now take minutes using AI. We can test multiple methodological approaches, incorporate uncertainty from dozens of climate models and rapidly iterate based on reviewer feedback or emerging conservation priorities. Perhaps most importantly, our cloud-native workflows enable more seamless collaboration between team members across TNC's global network and with external research partners.

We have no time to lose. This increased level of operational efficiency and data science capability is already leading to more effective decision support for our conservation leaders.

Global livability limitations for older female adults. This assessment uses hourly ERA5-Land reanalysis data (1995-2024) and a human heat balance model to map where ambient temperature and humidity already restrict older female adults (age 65+) to minimal physical activity, even in the shade with air movement. Darker colors indicate greater restrictions on safe activity levels, measured in METs (Metabolic Equivalent of Task). The analysis reveals that approximately 25% of the global population now lives in areas experiencing unlivable conditions for older adults in the hottest hours of the year. Seventy-five years of hourly global climate data were processed on CHPC infrastructure, applying physiological heat stress modeling to identify heat-threatened populations worldwide.

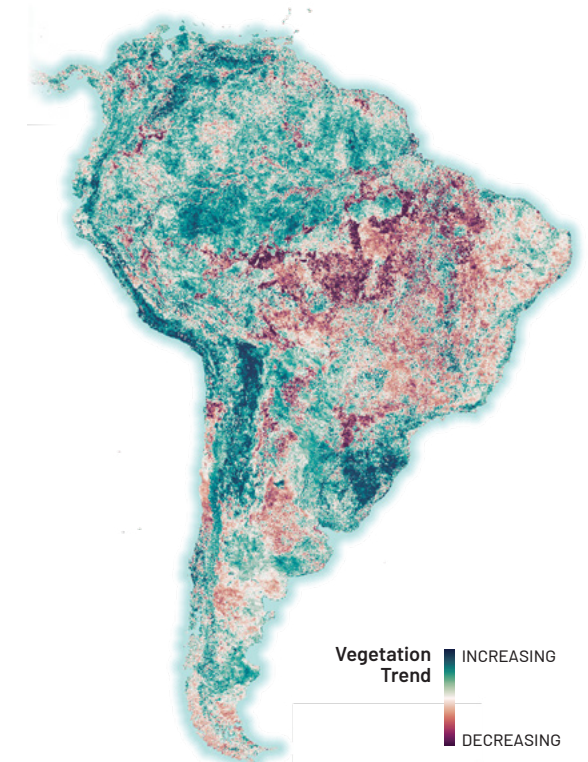
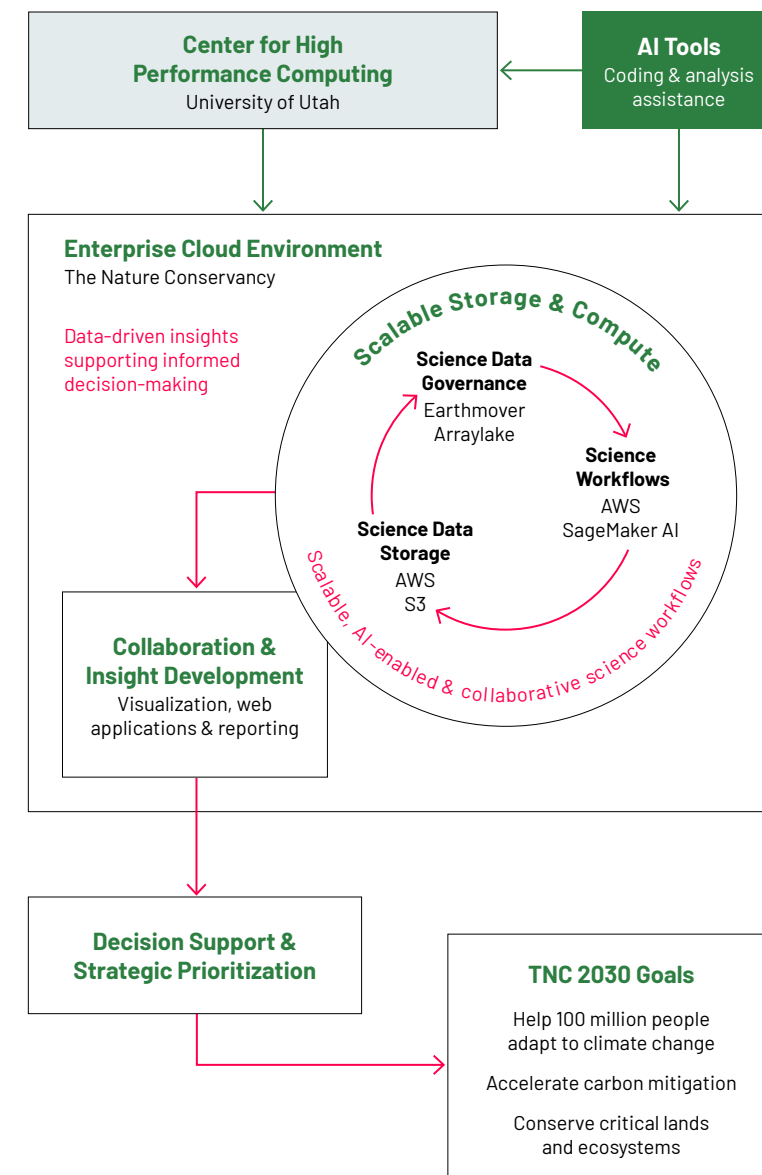


SOURCES: Global: Parsons, L. A., J. W. Baldwin, G. Guzman Echavarría, O. Jay, P. Kalmus, H. Staudmyer, J. K. Vanos, N. H. Wolff (2026), *Intensifying global heat threatens livability for younger and older adults*, in press at *Environmental Research: Health*, DOI: 10.1088/2752-5309/ae3c3a.; CONUS: Parsons, L. A., J. T. Erbaugh, F. Lo, R. McCrary, S. R. Raman, D. Shindell, et al. (2026), *Climate change and disparities in extreme heat exposure for socially vulnerable areas in the contiguous United States*, *Earth's Future*, 14, e2025EF006463, DOI: 10.1029/2025EF006463.



Average number of days per year exceeding 35°C (95°F) in past decades and in a modeled future scenario with 2°C warming. Above this threshold, electric fans can become unsafe for cooling. Past and future daily maximum air temperature exposures under different climate scenarios were evaluated to examine heat exposure disparities among socially vulnerable communities using high-resolution downscaled climate projections. This analysis identifies where targeted heat adaptation resources are most urgently needed to protect vulnerable populations. Over four terabytes of downscaled CMIP6 climate data combined with high-resolution population and vulnerability datasets were analyzed to assess heat exposure disparities at approximately 5km spatial resolution across the entire continental United States.

WORKFLOW SUMMARY



Analysis of ecosystem trends across South America using 25 years of satellite-derived Normalized Difference Vegetation Index data (2000 to 2025). Using cloud-native workflows, this analysis revealed critical hotspots of ecosystem degradation where vegetation productivity is declining over time, as well as resilient or recovering ecosystems that are maintaining or increasing their vigor despite environmental pressures. Innovative geospatial technologies powered by cloud computing infrastructure like AWS, supercomputing resources and artificial intelligence-enhanced analytics have fundamentally transformed our capacity to monitor and understand ecosystem resiliency across vast landscapes. This technological leap forward allows us to move from reactive conservation to proactive, data-driven strategies that can precisely target where interventions will have the greatest impact for both nature and people.

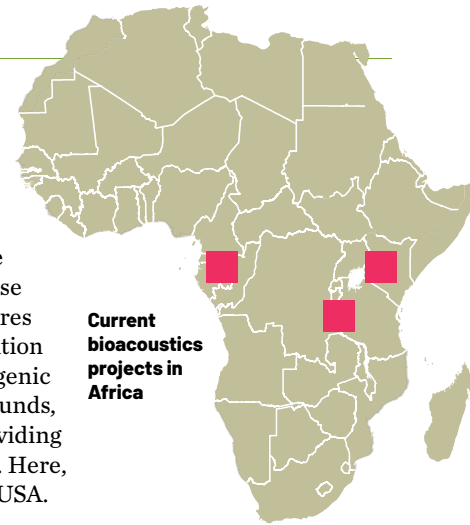
Note: Data were analyzed monthly. This example shows a single month.

Bioacoustics for Measuring and Monitoring Biodiversity

Tim Boucher, Anne Trainor, Max Lambert and Maia Murphy-Williams
 CONTRIBUTORS: Saint-Clair Ebaye, Emmanuel Mambela, Joshua Okumu, Alexander Piel and Bernice Sainepo

Introduction

Bioacoustics is the study of sound production, transmission and reception in animals. It examines how organisms across diverse species—from insects and frogs to whales and birds—use acoustic signals for communication, navigation and environmental sensing. The field emerged as a distinct discipline in the mid-20th century and integrates biology, physics, engineering and now AI for species identification. Researchers investigate how sounds are generated (through vocal cords, specialized muscles, or body vibrations), how they propagate through different environments like air or water, and how animals perceive and interpret these signals. Bioacoustics has broad applications. It reveals behavioral patterns and social structures in wildlife, helps with species identification and population monitoring, and supports conservation efforts by detecting endangered animals in their habitats. It's also revealing how anthropogenic noise pollution affects animal communication and ecosystems. Beyond studying animal sounds, the field continues to expand with advances in recording technology and data analysis, providing crucial insights into animal ecology, evolution and the acoustic dimensions of biodiversity. Here, we highlight four TNC bioacoustics projects—three in Africa and one in Washington state, USA.



Monitoring Chimpanzees in Tanzania

The Greater Mahale Ecosystem in western Tanzania holds a significant proportion of Tanzania's chimpanzee population, more than 75% of which is found outside formally protected areas such as the world-renowned Mahale Mountains National Park. Our bioacoustics work in Greater Mahale uses passive acoustic monitoring to determine if chimpanzees are moving through forest patches and ecological corridors. By placing acoustic recorders along ridges, riparian zones, village land forest reserves, community grazing areas and proposed forest reserves, we aim to detect vocalizing chimpanzees across large remote areas where direct observation is difficult. These devices record during peak calling periods—mainly sunrise to mid-morning—and their 500–1,000-meter detection range allows us

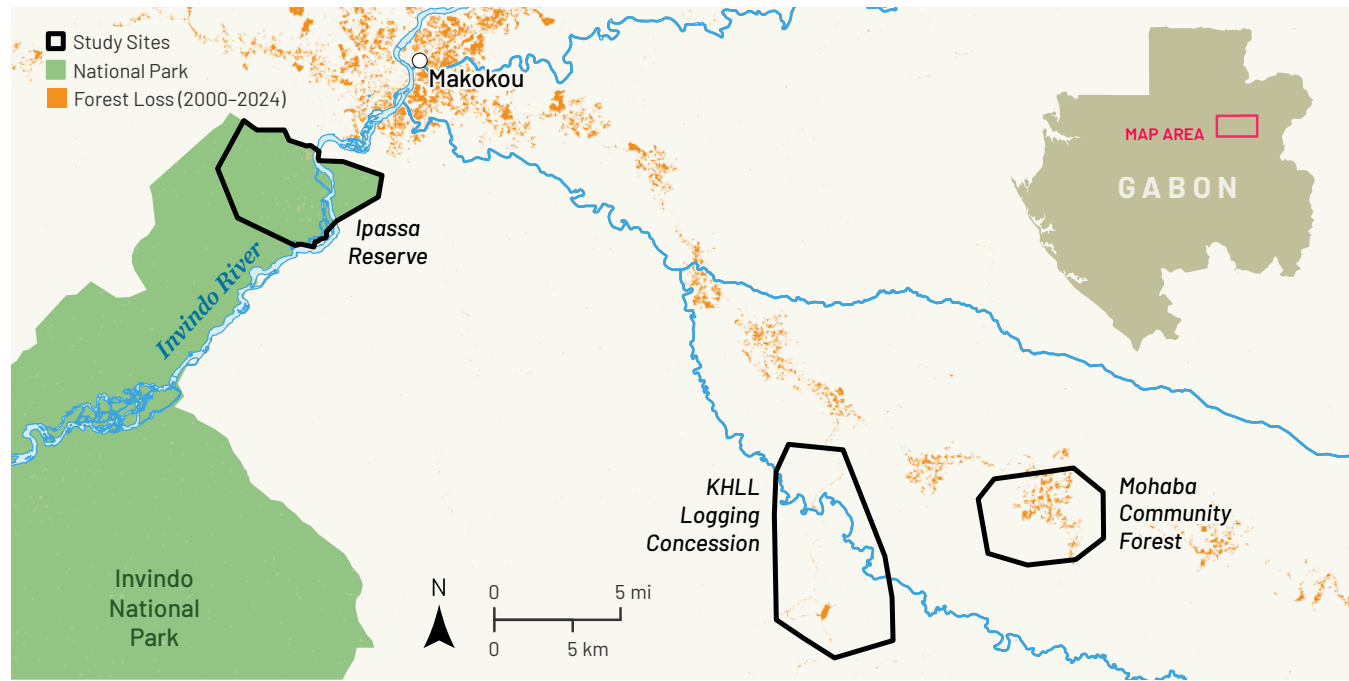
to identify when chimps use specific corridors as passageways between major forest reserves. This landscape-scale method complements camera traps and the SMART app for patrols, which capture silent movement, enabling us to distinguish active corridors from inactive ones. Initial deployments began in 2025, with monitors rotated seasonally to capture variations in use. These devices provide data on chimpanzee presence, movement and seasonal dependence on a corridor. Over multiple sampling periods, the combined acoustic, camera trap and patrol data offer the first systematic approach to identifying functional connectivity for chimpanzees in western Tanzania, strengthening conservation planning and guiding protection of critical habitat linkages in the Lake Tanganyika Basin.



PHOTOS: Chimpanzees in the forest at Mahale National Park on Lake Tanganyika in Tanzania

© Ami Vitale (this page)
 © Patrick Doran/TNC (previous page)

MAP: Modeling chimpanzee movement corridors in the Greater Mahale Ecosystem



MAP: Study sites and forest loss in Gabon

Gabon Biodiversity Assessment

We face an increasing need for nature-based solutions to climate change, particularly forest pathways, with their significant potential for reducing CO₂ emissions. We also need effective management of forests to realize multiple benefits, especially in low and middle-income countries in Africa, where deforestation is accelerating. In Gabon, TNC, in collaboration with the national park agency (ANPN), tropical ecology research institute (IRET) and the director general of wildlife and protected areas (DGFAP), conducted a biodiversity assessment to develop a reliable and scalable methodology for measuring biodiversity changes in tropical forests. We used passive acoustic monitoring, camera traps and a Biodiversity Intactness Index to measure and compare biodiversity in a community forest, a certified

logging concession and a protected primary forest. AI-powered platforms then helped us analyze both acoustic data (BirdNET) and camera trap data (ConservationAI). The results show that the Ipassa Nature Reserve had the highest biodiversity, followed by the logging concession and the community forest.

The study demonstrates a potentially scalable method for measuring changes in local biodiversity in a tropical forest. It highlights the advantages of combining acoustic monitoring and camera traps for a more comprehensive assessment of biodiversity, while emphasizing the importance of monitoring biodiversity for effective management.

Kenya Soil Acoustics

Soil acoustics—also referred to as *soil ecoacoustics*—is an emerging, non-invasive method for assessing below ground biodiversity and soil health by recording the sounds produced by soil organisms and physical processes. In healthy soils, biota such as earthworms, beetles, termites and plant roots generate various vibrations that can be captured using piezoelectric microphones or contact probes inserted into the soil. The recordings are analyzed using acoustic indices, and healthy soils tend to produce complex, noisy acoustic signatures, while degraded soils are quieter, reflecting reduced biotic activity.

Soil acoustics sampling in Kenya is being piloted as an innovative, non-invasive method to measure below ground biodiversity and soil health across semi arid rangelands. Sampling occurs at standardized points following the Land Degradation Surveillance Framework used by the Laikipia Conservancies Association, typically gathering four recordings per site. These acoustic signatures are later analyzed to quantify biological activity

and compare degraded, intact, and intervention-managed rangelands. Early results confirm that healthy soils tend to produce more diverse and complex acoustic signals, while degraded soils are quieter, consistent with lower biological activity. The approach offers rapid, repeatable sampling and reduces reliance on destructive or labor intensive soil biodiversity surveys.

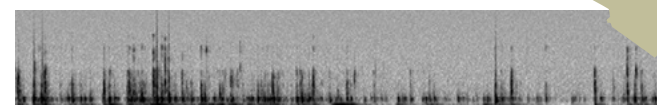


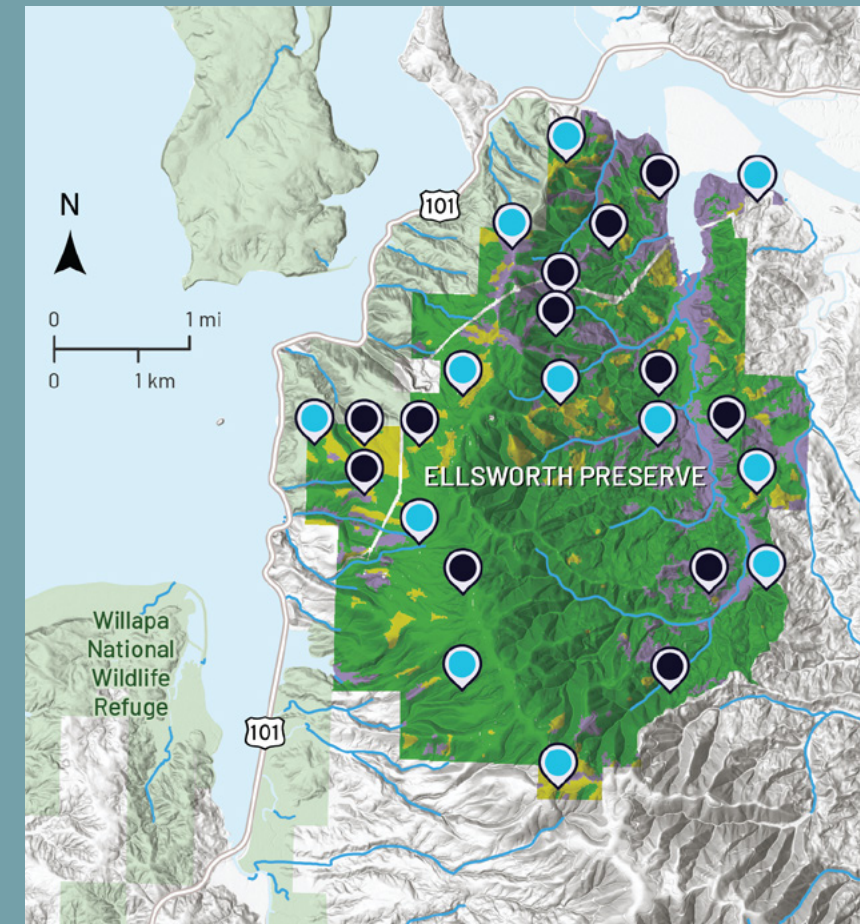
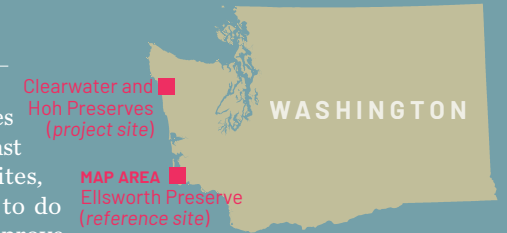
PHOTO: Soil probe used for acoustics monitoring. © Tim Boucher/TNC
GRAPHIC: Spectrogram of recorded audio

Olympics Biodiversity Project

In 2025, The Nature Conservancy in Washington initiated a study to better understand the mechanics and feasibility of a “biodiversity credit” system. Biodiversity credits are in the broader family of “nature credits,” which aim to generate revenue—either from private voluntary markets or regulatory means—by demonstrating an improvement to natural systems. Unlike carbon credits—which generate revenue by avoiding carbon emissions and sequestering carbon in forests, wetlands and other carbon sinks—biodiversity credits generate revenue by showing an increase in some measures of biodiversity. In recent years, TNC Washington has successfully established a carbon credit project on our coastal rainforest preserves. Credits generated from this project have yielded important revenue to advance forest restoration needs and allow TNC to invest in other climate mitigation programs. Given the success of our carbon program, we wanted to explore whether a biodiversity credit system could be layered on to a carbon crediting system, provide conservation-relevant benefits to biodiversity and generate a justifiable return on investment.

We used the Wallacea Trust’s Biodiversity Credit method to measure the co-benefit of biodiversity on our carbon-sequestering forest restoration project. For the pilot project, TNC’s Ellsworth Preserve serves as a reference site, where restoration has already occurred and where we expect higher biodiversity. Hoh and

Clearwater preserves on the Olympic Coast are the project sites, where we intend to do restoration to improve biodiversity towards what we observe in the reference site. TNC purchased Ellsworth over 20 years ago to protect remnant old-growth forest and restore old-growth forest characteristics. Hoh and Clearwater were more recently under industrial timber operations and are in earlier stages of restoration. In 2025, we deployed dozens of acoustic recorders and camera traps to measure bird and mammal diversity across our preserves. This equipment was randomly distributed across different habitat types that largely reflect proximity to riparian areas. Across all audio recorders from the three preserves, we detected over 3 million bird calls from 91 species across the six-week period. Interestingly, 54 species were detected only at Ellsworth Preserve. Across all camera traps, we captured more than 120,000 images. Of those, 3,925 detected 12 different mammal species, including multiple mountain lion detections at our Olympic preserves. Data analysis is ongoing; however, preliminary calculations indicate significantly higher biodiversity at our reference preserve (Ellsworth) compared to the project site (Hoh and Clearwater).



PHOTOS: Black bear investigating a camera trap (top)
© Olympics Biodiversity Project; Reviewing camera trap images in the field (bottom). © Hannah Letinich

MAP: Monitoring locations at Ellsworth Preserve

● Acoustic Monitor ● Camera + Acoustics ■ Habitat Stratification

Computer Vision in Industrial Fishing

Harnessing Edge AI to Transform Electronic Monitoring in Longline Fisheries

Vienna Saccomanno

Industrial fishing is essential to global food security, but 90% of global fisheries are either overfished or cannot sustain further pressure. In most industrial operations around the world, fishers are required to report their catch. But without independent monitoring, self-reporting is unverifiable, creating conditions for many licensed fishing vessels to conduct widespread illegal, unreported and unregulated (IUU) fishing activities.

TNC is working to combat IUU fishing by advancing electronic monitoring technologies that bring transparency to industrial fleets. Electronic monitoring (EM)—the use of onboard video cameras, GPS and sensors to monitor fishing activity—provides verified data that strengthen management and deter illegal practices.

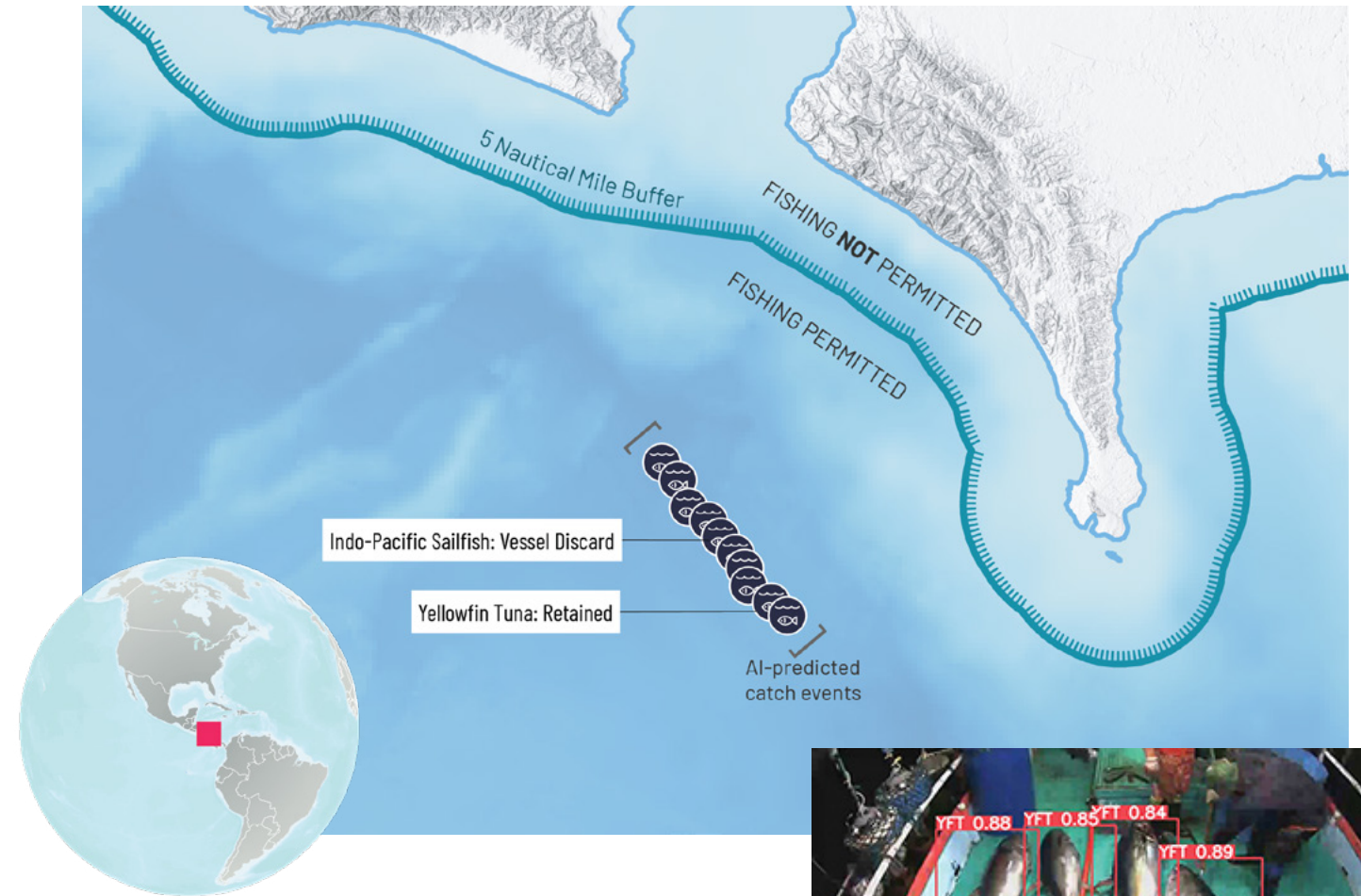
Despite the demonstrated value of and support for EM, industry-wide implementation is hindered by the volume of EM video footage collected on vessels and the subsequent costs and logistics of traditional video review by humans. To dismantle these major barriers to scaling EM, TNC and our partners completed a pilot in the Eastern Tropical Pacific Ocean that operationalized detection of potential IUU fishing activity using computer vision on the edge—an application of AI that makes processing data faster by analyzing EM footage aboard longline fishing vessels in near real time.

Our edge-computation approach takes historically siloed components of fisheries operations—e.g., EM footage, electronic logbooks, and GPS data—and makes them interoperable with an edge module to establish a new system that is greater than the sum of its parts. The AI-powered EM system consists of a modular pipeline deployed on an edge device that processes

live EM footage using a computer vision model that counts and classifies the species of fish that are caught. This configuration enables an edge-based comparison of the captain's electronic logbook catch report to the AI catch predictions, producing a fishing-risk profile based on alignment between these data sources. The risk profile also includes the geospatial location of AI-predicted catch events to assess whether fishing occurred in appropriate locations. Vessels are equipped with satellite internet terminals to send the AI predictions of fishing activity and associated risk profile for final human verification.

Embedding edge AI into the EM review process means that stakeholders receive near real-time verified information on the sustainability of a vessel's catch before products enter the global supply chain. Stakeholders can then drive continuous on-the-water improvements that lead to improved conservation outcomes. This innovative application of AI recently earned recognition from the Bezos Earth Fund as one of 15 global grantees of their AI for Climate and Nature Grand Challenge. Competing with over 1,200 applicants, TNC was awarded a \$2M implementation grant to scale this solution to industrial longline vessels in the Western Central Pacific Ocean.

In an era of accelerating environmental change and growing demand for sustainable seafood, this AI-powered system demonstrates meaningful advancement in fisheries monitoring and management. To help this solution scale, The Nature Conservancy has released the entire full-stack solution as open source to advance equitable access and empower global longline fisheries operations to harness AI-enabled electronic monitoring for smarter, more sustainable management practices. To learn more, visit [nature.org/edgeai](https://www.nature.org/edgeai).



MAP: Illustration of the geolocation where longline catch events were predicted by computer vision models aboard the TNC partner vessel. Geospatial catch events depicted here are from a single day of fishing and automatically summarized in the Daily Report sent off the edge module.

PHOTOS: (this page) Electronic monitoring photo from a fishing vessel that is tagged with an AI-predicted fish species; (opposite page) Overhead view of freshly caught tuna stacked on the deck of a docked fishing vessel. © Jonne Roriz

IMAGE: (below) Example of a daily summary report from a fishing vessel.



The Nature Conservancy
Developed in collaborations with tryo-labs

Daily Report

Summary
Aggregated Risk Score
Catch Sequence
GPS Locations of Catches
Additional Information

Summary

<p>Total Catches Retained Catches that were caught and retained</p> <p style="font-size: 1.5em; font-weight: bold; text-align: center;">13</p>	<p>Total Vessel Discards Catches that were caught and returned to the water</p> <p style="font-size: 1.5em; font-weight: bold; text-align: center;">1</p>	<p>Total Water Discards Catches that were discarded from the water</p> <p style="font-size: 1.5em; font-weight: bold; text-align: center;">0</p>	<p>Risk Score Weighted risk score of the day</p> <p style="font-size: 1.5em; font-weight: bold; text-align: center;">1.29</p>
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Animl

An Open-Source Platform for Managing Camera Trap Data

Eric Abramson, Nathaniel Rindlaub and Kelly Easterday

TNC California developed Animl for managing camera trap data and integrating artificial intelligence into wildlife monitoring. The system accepts data from multiple camera trap types, including both traditional SD-card cameras and those using cellular or wireless networks. By combining real-time data streams with cloud-based machine learning, Animl transforms months-long monitoring workflows into near-instant detection and response systems.

The platform uses a two-stage approach to image analysis. First, object detection models identify animals, people and vehicles in images. Then, open-source classification models classify species relevant to each project. This modular design allows conservation teams to deploy specialized classifiers tailored to their geography and target species, whether monitoring rats on

California islands, mammals in Kenyan savannas, or wildlife in Peruvian rainforests.

Animl dramatically accelerates the otherwise labor-intensive process of reviewing thousands of camera trap images. It filters out empty images, prioritizes images showing animals of concern and sends alerts when target species are detected. Users can review predictions through both web and mobile interfaces, validate labels and export data for further research. Because Animl is a cloud-based platform, users can invite other team members to join a collaborative analysis. When paired with an integrated wireless camera network, it eliminates the need for manual camera checks and SD-card retrieval, thus improving team capacity and helping conservation science move faster.

Santa Cruz Island



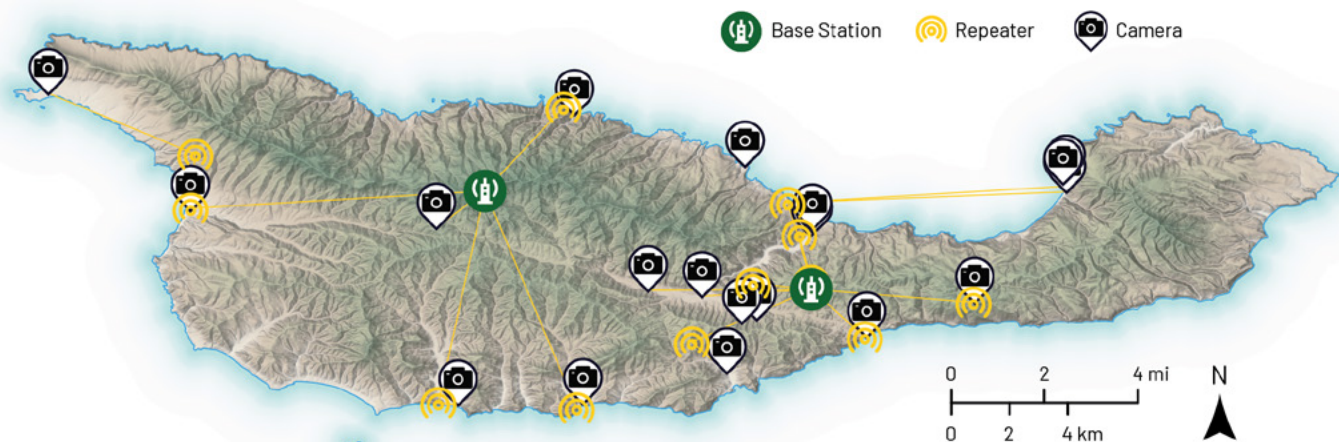
Santa Cruz Island is the largest of California's eight Channel Islands. At 96 square miles, it's the largest privately owned island in the contiguous U.S. and is over four times the size of Manhattan.

More than 1,000 species of plants and animals inhabit the island's high peaks, deep canyons, pastoral valleys and 77 miles of dramatic coastline. TNC deployed Animl as an early warning system for invasive rats. The island is remote and difficult to access, making traditional camera trap monitoring impractical. Previously, staff hiked treacherous terrain every three months to retrieve SD cards, creating dangerous lag times during which rats could establish and reproduce rapidly.

Now, solar-powered wireless cameras transmit images immediately to the cloud. These cameras are linked through a low-power, long-range mesh network designed to move images hop-by-hop

across rugged terrain until they reach a central base station with an internet uplink. This architecture allows cameras placed miles from any infrastructure to reliably push data off the island without human retrieval. This system was utilized to overcome Santa Cruz Island's steep topography, unpredictable weather and limited connectivity by letting each camera act as both a sensor and a relay node—ensuring images keep flowing even if one unit goes offline or is knocked over by wildlife.

Animl's machine-learning models analyze each image within minutes, sending alerts if rodents are detected so they could then be promptly removed. This system compressed our response time from months to minutes, protecting decades of conservation investment in this fragile island ecosystem. The network captures all terrestrial mammals on the island, providing valuable ecological data while maintaining vigilant, real-time biosecurity monitoring.



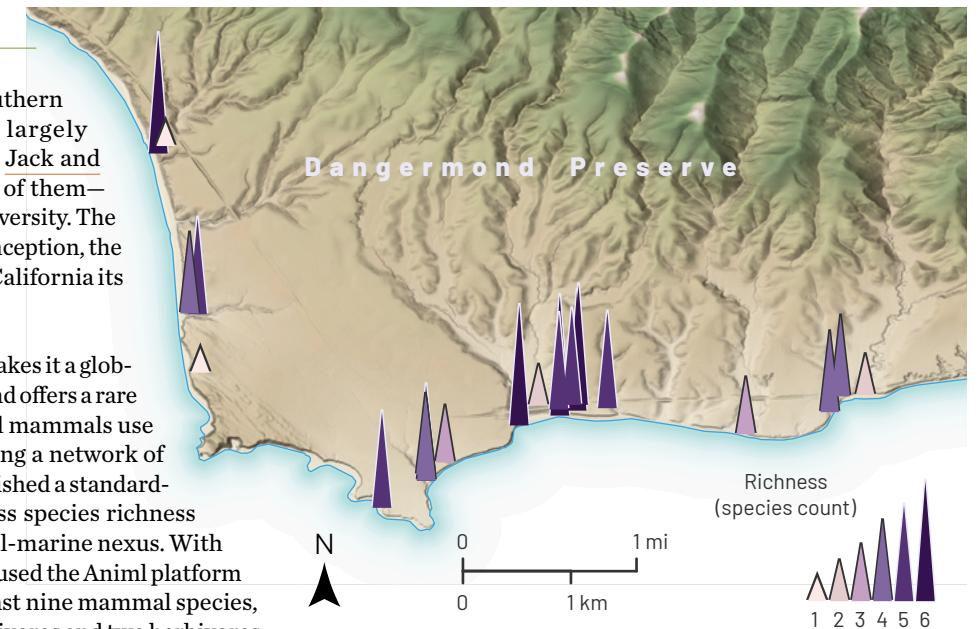
MAP: Our camera trap network extends across the remote and rugged landscape of Santa Cruz Island.

Dangermond Preserve

There aren't many places on the Southern California coast that remain largely untouched by development. TNC's Jack and Laura Dangermond Preserve is one of them—exceptional in size, location and biodiversity. The 24,364-acre preserve sits at Point Conception, the sharp corner of coastline that gives California its distinctive crook.

Dangermond's unusual geography makes it a globally important site for conservation and offers a rare opportunity to study how terrestrial mammals use California's wild coastline. Leveraging a network of motion-activated cameras, we established a standardized monitoring framework to assess species richness and occupancy across this terrestrial-marine nexus. With nearly 1.5 million images in hand, we used the Animl platform to classify and regularly detect at least nine mammal species, including three carnivores, four omnivores and two herbivores. Coyote, mule deer and wild pigs were the most widespread, occurring at over 90% of sites, while species such as gray fox and striped skunk appeared infrequently.

Coastal cameras consistently recorded high species richness, with several locations along the southern preserve boundary emerging as biodiversity hotspots and transit corridors. These findings underscore the preserve's role as a stronghold for adaptable species and highlight seasonal shifts in wildlife activity that can inform management decisions. For example, carnivore occupancy—especially mountain lions—increased markedly in winter, while deer and wild pigs were more active in fall, suggesting predictable patterns tied to breeding and foraging cycles. This project lays the foundation for long-term monitoring and adaptive management, ensuring that conservation strategies are grounded in robust, landscape-scale data.



MAP: Observed species richness from a study of 24 camera trap locations. A total of nine mammal species were detected across all locations.



PHOTOS: (from left) Coyote on the beach at Dangermond Preserve; Camera trap and repeater on Santa Cruz Island © Nathaniel Rindlaub/TNC; Skunk and fox caught on a camera trap on Santa Cruz Island; Skunk doing a handstand for the camera trap on Santa Cruz Island. © TNC



A New Flight Path for Conservation

How Precision Drone Technology is Transforming Management at a Texas Preserve

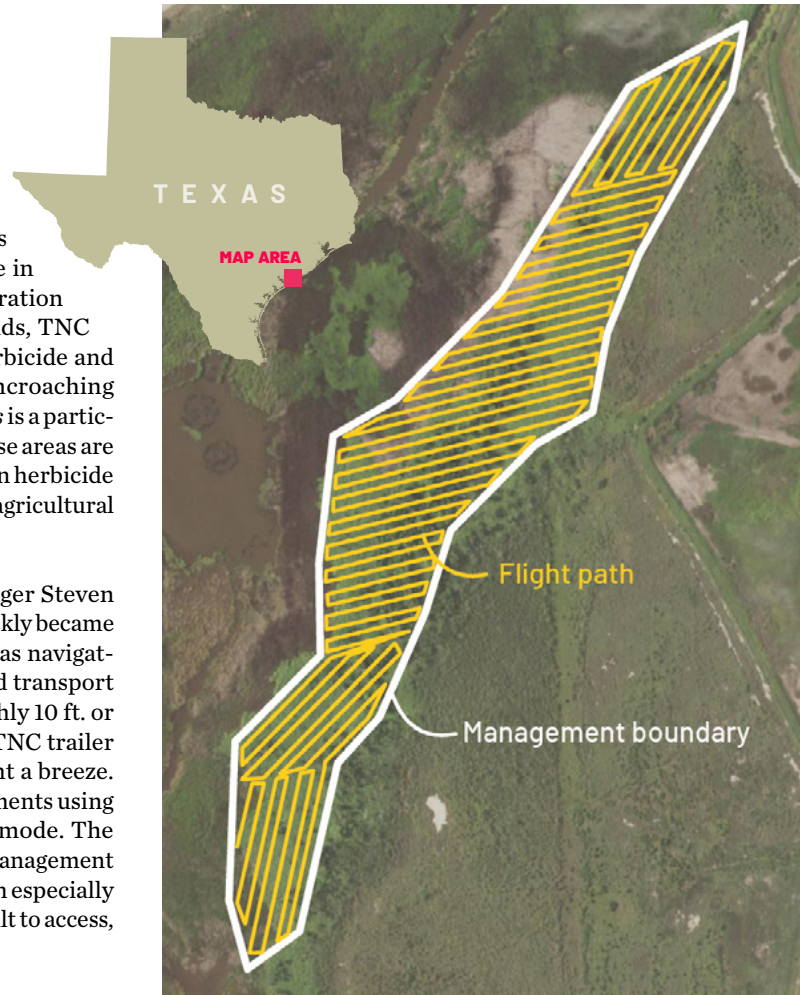
Jacqueline Ferrato

Clive Runnells Family Mad Island Marsh Preserve in coastal Texas is not quite an island but more than just marsh. This TNC preserve contains some of the best examples of native coastal prairie in Texas and serves as a native seed source for restoration projects at other sites. As at many other grasslands, TNC manages Mad Island with prescribed fire, plus herbicide and mechanical treatments for invasive plants and encroaching brush. For example, aggressive growth of *Phragmites* is a particular concern here, and treatment is a challenge. These areas are inaccessible via foot or vehicle, so TNC staff relied on herbicide treatments applied via helicopter. Enter a precision agricultural drone: the DJI Agras T40.

Our learning curve was steep, but Preserve Manager Steven Goertz obtained the necessary certifications and quickly became proficient in drone set up and break down, as well as navigating its proprietary software. To address storage and transport challenges given the large size of the aircraft (roughly 10 ft. or 3m in diameter when unfolded), we customized a TNC trailer to make frequent use and cleanup of the equipment a breeze. The drone allows us to apply herbicide as spot treatments using preprogrammed mission flights or manual flight mode. The operator can target problem areas across an entire management unit in a matter of minutes. This technology has been especially advantageous in areas that would otherwise be difficult to access, or where other machinery is likely to get stuck.

We also deploy a smaller drone to collect multispectral imagery, which allows for planning flights using various vegetation indices, such as Normalized Difference Vegetation Index. This method can be useful where target species have a distinct enough spectral signature against the surrounding vegetation or landscape, particularly during certain times of the year or after prescribed fires. The ag drone also can broadcast seed using different payload attachments. Dispersing native seed following disturbance can help boost native community establishment, and a common practice following prescribed fire has been throwing out native seed on foot and by hand. With the ag drone, dispersion rates and speeds can be customized depending on the amount of available seed.

Technological advancements like this in conservation and land management may come along only once in a career. This drone technology transforms the way we evaluate problems when the solution can be applied so efficiently and effectively.

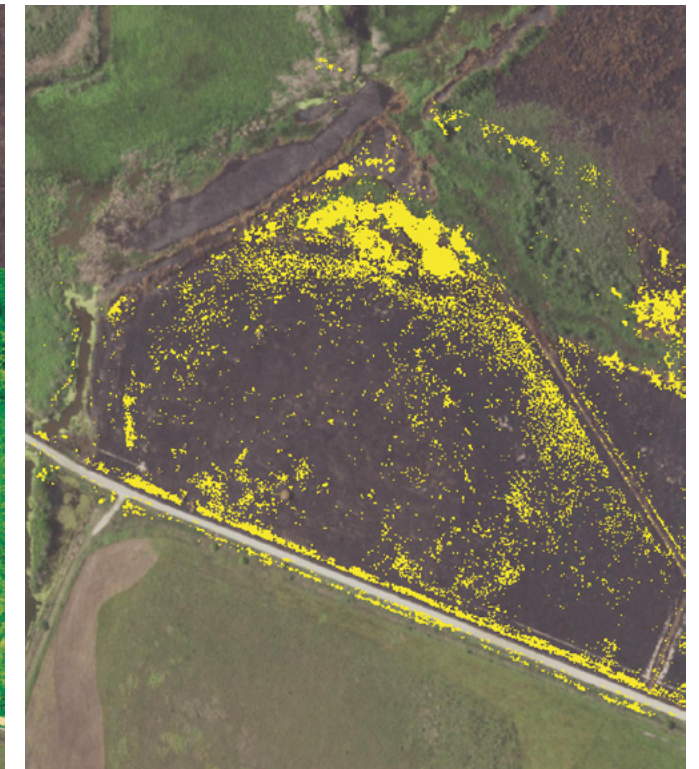


MAP: Drone flight path seen in a post-mission analysis

“The drone is a complete game changer for prairie and wetland management. We’re able to accomplish tasks that we simply could not have done otherwise, achieving results in 6-8 months that otherwise would’ve taken 8-10 years!”

STEVEN GOERTZ
Preserve Manager

PHOTOS: Adding herbicide (left) and native seed (right) to the drone.
© Jacqueline Ferrato/TNC



MAPS: Drone-captured NDVI data for a management area at Mad Island Marsh Preserve (left), and treatment prescription based on NDVI (right)



Where Nature Holds the Line

Measuring Protection Along a Living Coast



PHOTO: Little Marsh Island is seen in the middle left of this aerial photo, with the town of Wachapreague on the right. © Peter Frank Edwards

Zak Poulton

Along Virginia's Atlantic coast, the town of Wachapreague sits behind a chain of marshes and barrier islands that absorb wave energy before it reaches homes and a working waterfront. But as storms intensify and sea levels rise, the marsh itself has begun to erode—putting the town's last natural line of defense at risk.

To slow erosion, The Nature Conservancy, the town and local volunteers constructed experimental oyster reefs along nearby Little Marsh Island. The idea was simple: weaken the waves so the marsh behind them can persist.

Researchers later confirmed that the reefs reduced wave energy before reaching the marsh. But one question remained: Did the shoreline change? To find out, conservationists turned to the sky.

Traditional shoreline monitoring relies on handheld GPS measurements that can vary with tides, vegetation or the observer's position. Drone surveys, by contrast, capture the entire landscape at once. Each flight produces a detailed three-dimensional model, allowing us to measure shoreline position, slope and elevation consistently year after year.

Baseline drone surveys in 2019 documented steep, retreating marsh banks. More recent surveys tell a different story in areas protected by reef structures. Slopes have become more gradual, sediment has accumulated between the reefs and the marsh edge, and the shoreline has reorganized into a more stable form. Where waves are weakened, the marsh edge has stopped collapsing along the banks.

These findings show that oyster reefs do more than reduce wave energy—they influence sediment movement and help reshape the shoreline itself. Because drone surveys are repeatable, the site now serves as a long-term record of resiliency. This project has transformed restoration from a one-time installation into an ongoing evaluation of coastal protection.

What began as a local effort to protect one small coastal town will continue to serve as a learning site for students of all ages. It also offers a practical framework for measuring nature-based solutions wherever communities rely on natural defenses to live with water rather than fight it.

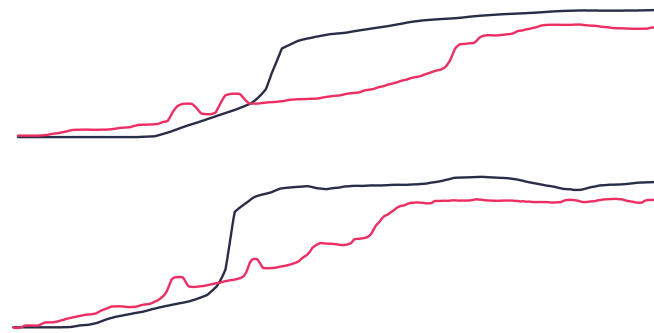
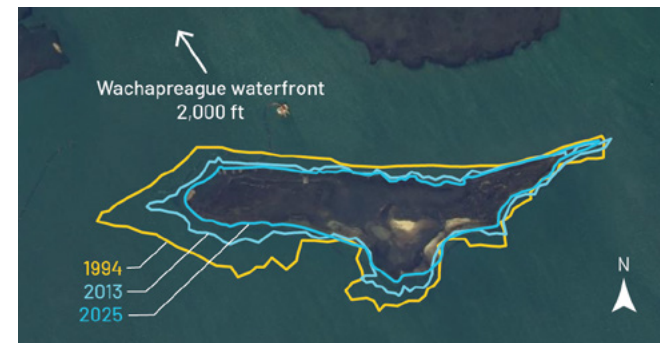
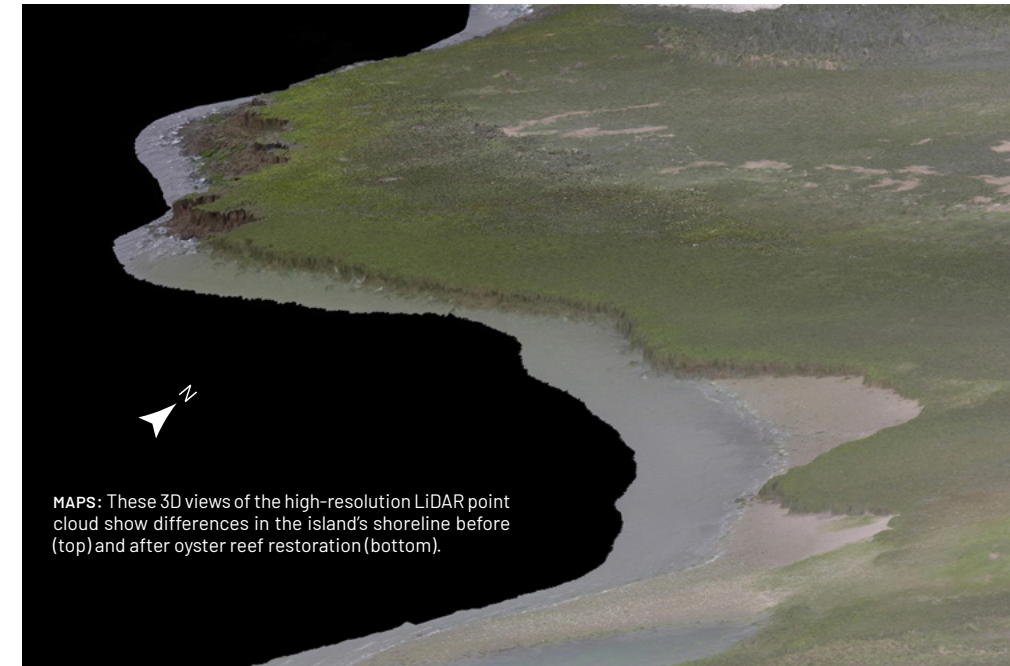


IMAGE: Selected profiles from 2019 (pre-restoration) and 2025 (post-restoration) show a steep erosion scarp that is now a more gradually sloping shoreline behind the restored oyster reefs.



MAP: Little Marsh Island buffers wave energy before it reaches the Wachapreague waterfront but has eroded significantly in the last several decades.

IMAGERY: © Commonwealth of Virginia, 2025



MAPS: These 3D views of the high-resolution LiDAR point cloud show differences in the island's shoreline before (top) and after oyster reef restoration (bottom).

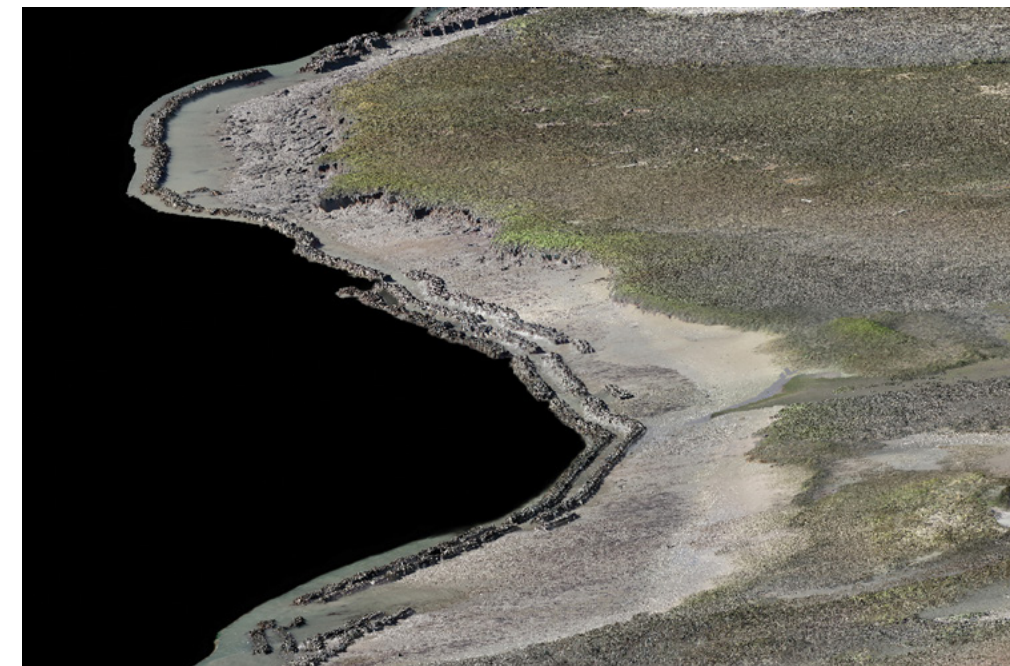


PHOTO: Volunteers placing oyster reef substrate. © Brittany Collins/TNC

FINDING OPPORTUNITY IN A CHANGING LANDSCAPE

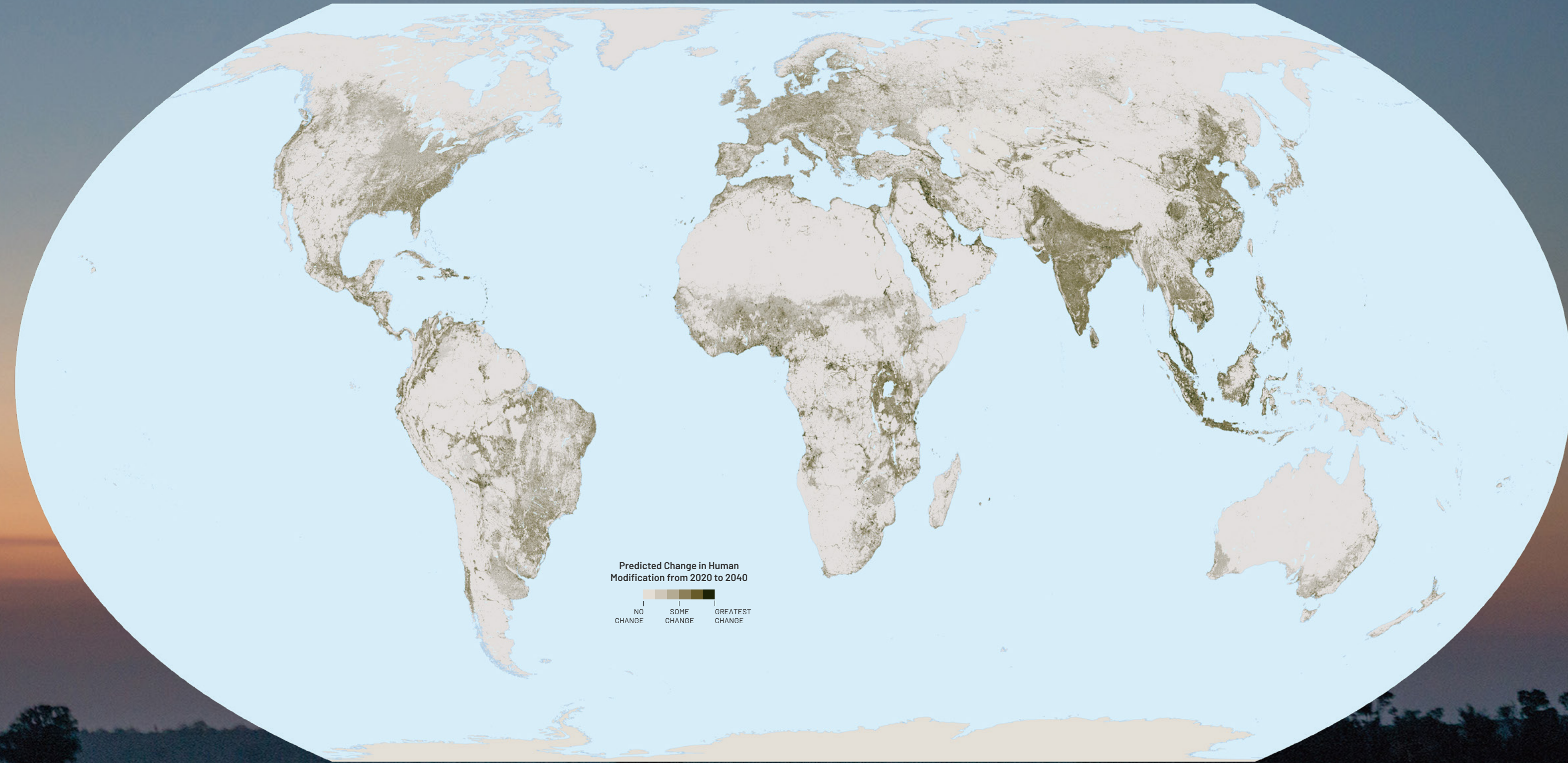
Katie Walker
CONTRIBUTORS: James Oakleaf, Glenn Moncrieff, Maria Voigt, Christina Kennedy

Globally, we are facing both climate and biodiversity crises driven by human activities. TNC's 2030 Goals—alongside international agreements like the Kunming-Montreal Global Biodiversity Framework—set targets and commitments to stop and reverse these trajectories and move toward a more sustainable future. To accomplish these goals, TNC needs to understand how threats to biodiversity are evolving through space and time and apply that knowledge to conservation planning and participatory decision-making.

For years, TNC has mapped the extent and intensity of human activities that threaten biodiversity across landscapes with the Human Modification (HM) framework—allowing us to track present conditions and change over time. Now, we are looking ahead to predict that change before it happens. New global forecasts using AI models to analyze large volumes of data are being used to project where human pressures are likely to expand, compound or level off in the future. Based on trajectories of past human modification, enriched with socioeconomic and geophysical data, these *HM Forecasts to 2040* incorporate rigorous uncertainty quantification to produce worst-case, best-case and middle-of-the-road projections. In doing so, we can provide planners and decision-makers with a more realistic picture of threats and opportunities to potentially avoid and mitigate undesirable impacts.

To date, TNC's work considering future scenarios has focused on land use transitions and extrapolating historic trends into the future. The new work featured here advances the science of forecasting in two major ways. First, these forecasts examine more nuanced trajectories of human activity than what categorical land use change scenarios offer, by considering a wider catalog of input data alongside a greater diversity of pressures. Second, we are improving how we make predictions by utilizing innovative AI modeling and incorporating measures of uncertainty. Through application of convolutional long short-term memory networks—a type of AI model designed to recognize patterns through space and time—these methods step away from pixel-based linear assumptions and move toward recognizing more complex spatial and temporal trends, such as leapfrog development, edge expansion and other non-linear patterns. By rigorously quantifying uncertainty in our forecasts, we can project not only the most likely future, but also the worst plausible outcomes. Uncertainty tells us how much room we still have to shape the future through the choices we make today. With these improvements, we are enabling decisions to be made in anticipation of change rather than in response to observed loss.

The global *Human Modification Forecasts to 2040* data can be found on Zenodo [<https://zenodo.org/records/19700998>] under CC-BY-4.0 license. A detailed publication on methods is forthcoming.



MAP: *Human Modification Forecasts to 2040* play a critical role in helping us see how the world could change, where there may be opportunity for action, and what conservation interventions could achieve. When looking at these forecasts, we see that we could lose an additional 2.3 million square kilometers of natural lands before 2040 (where natural lands are defined as HM < 0.1). Threat intensification is anticipated to occur in many already moderately modified ecosystems, for example, in the Indian subcontinent and East African rangelands. In contrast, the rate of natural land loss is predicted to stabilize or decline in parts of Central Asia and Eastern Europe, particularly in the best-case forecasts. Deforestation is expected to continue at the existing frontiers in the Amazon basin, Congo basin, and Southeast Asia. In the worst-case forecasts, this deforestation spreads beyond the existing frontier into more remote parts of these regions. Over much of the world, however, the future remains uncertain, giving us opportunity to shape the path ahead.

PHOTO: A sunset view of Mariana Menoli's soybean farm in Santarém, in the state of Pará, Brazil. Menoli's parents were among the first in their state to partner with TNC. The organization helped suppliers develop a system for buying soybeans from farms that comply with deforestation laws. Today, her family still works with TNC on strategies for better field management. © Robert Clark

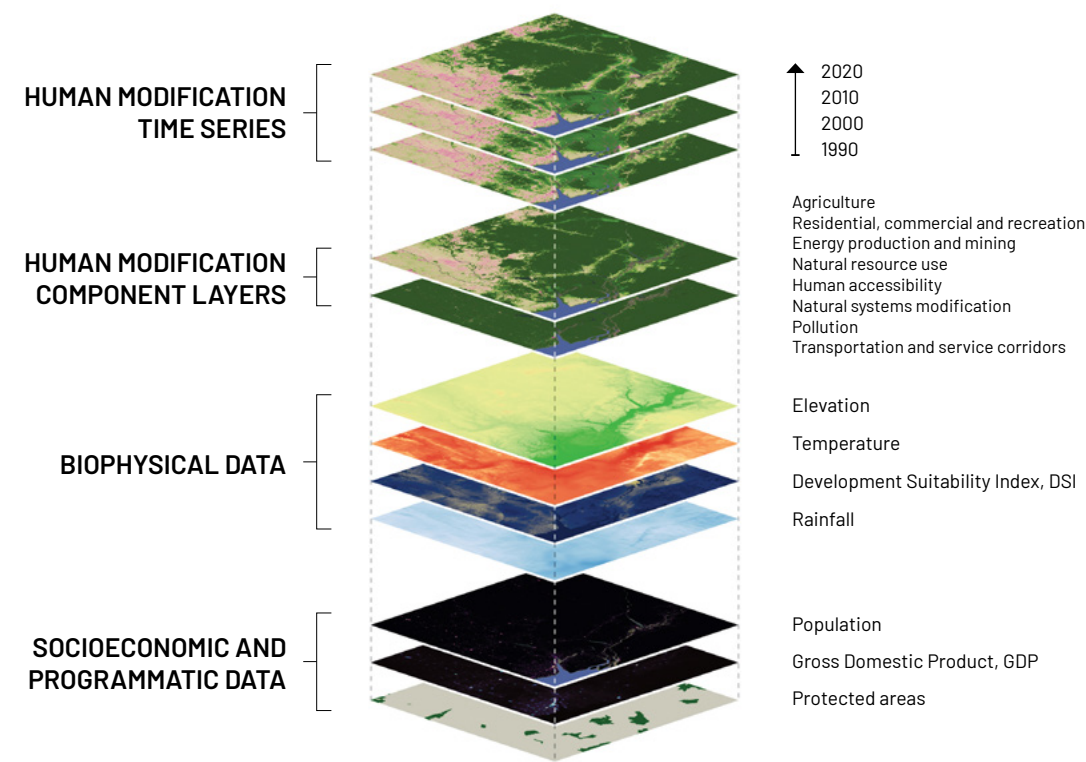
Global to Local: Pará in Focus

These forecasts can be used both globally and regionally to inform place-based conservation strategies. Here, we zoom in to the state of Pará in Brazil, home to over 8 million people and rich biodiversity. Pará contains 20% of the Amazon rainforest, making it an important region for both climate and biodiversity concerns, especially as it continues to face extreme levels of deforestation—accounting for nearly 40% of the combined deforestation across all of Brazil. TNC partners with Pará's government, Indigenous communities and other stakeholders to plan and implement conservation and management strategies to mitigate loss and safeguard these ecosystems for future generations.

Signals of Change: From Patterns to Predictions

To help train the AI model, a catalog of input data was curated. The foundation for the forecasts is a time series of Human Modification ranging from 1990–2020, mapping the individual and cumulative impact from a variety of human activities that are known to put pressure on biodiversity. The data—valued with a continuous range from 0 (no detectable modification) to 1 (complete modification)—can be used to understand patterns of fragmentation, degradation and conversion of natural lands (HM < 0.1). In Pará, just over 171,000 square kilometers

of natural lands were lost between 1990 and 2020—about the same land area as Uruguay, or the state of Florida in the United States. When combined with socioeconomic data (e.g., gross domestic product, population) and geophysical constraints (e.g., topography, climate), we can better characterize the spatiotemporal patterns and drivers of change. By combining the consistent time series with the covariate layers, we can explore not just where, but why changes are happening to meaningfully adapt the forecasts for localized relevancy and overall accuracy.

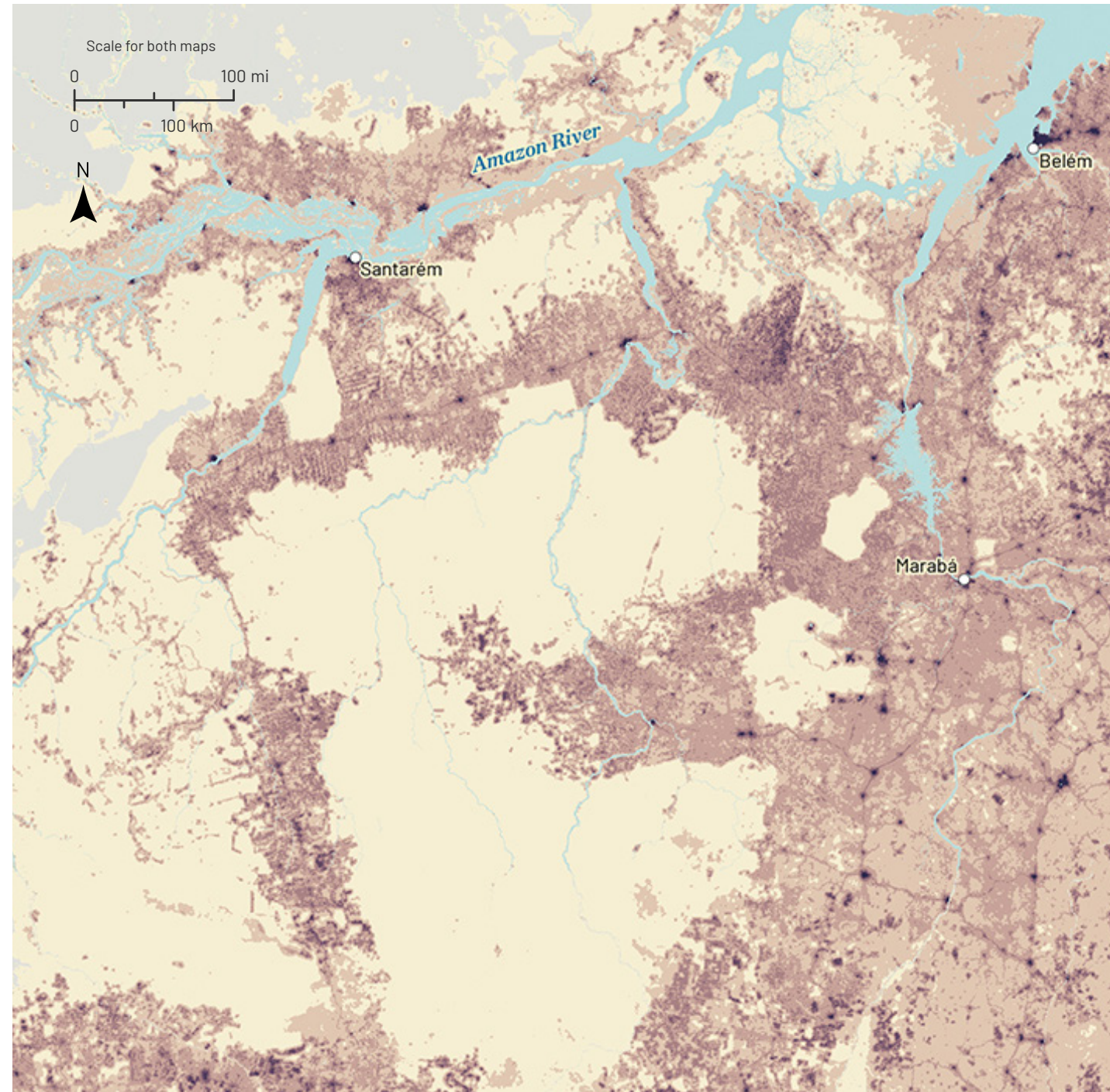
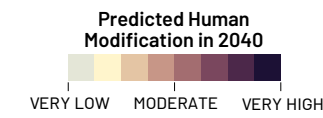


Looking Ahead to 2040: Anticipating Threats, Targeting Solutions

The *HM Forecasts to 2040* can support decision-making as it relates to questions like: What regions of the world are facing the largest and most rapid change? Where are opportunities to mitigate human pressures on biodiversity? Where can we employ conservation strategies to protect large intact landscapes before they are lost?

In Pará, the forecasts show that approximately 75,000 square kilometers of additional natural lands (HM < 0.1) could be lost before 2040—roughly the land area of Panama, or the state of South Carolina in

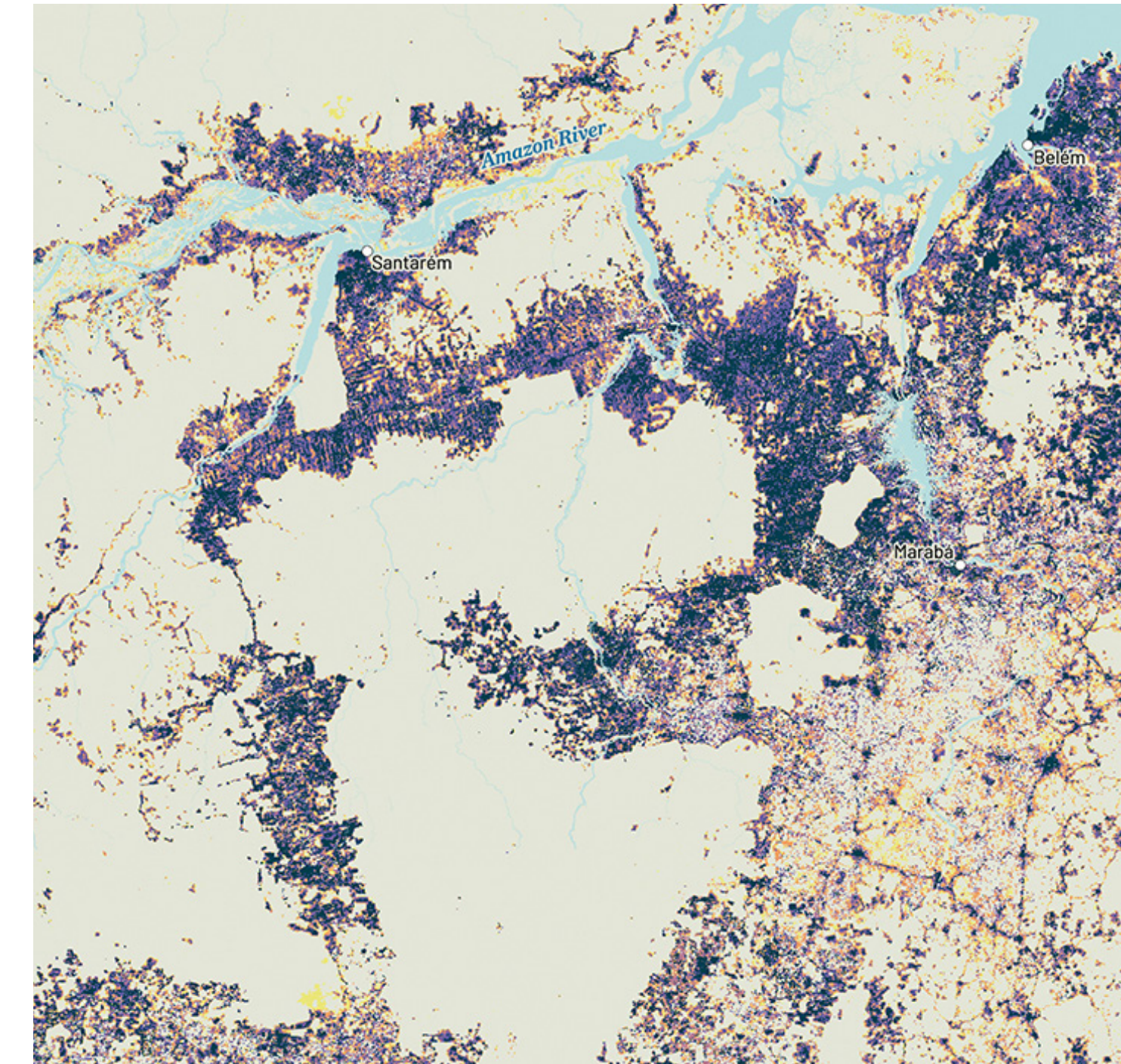
the United States. From the HM historic time series, we know that agriculture and natural resource use (e.g. logging) are significant drivers of change in the region—supporting the importance of programs such as the *Pará Sustainable Cattle Program*, which promotes animal-level cattle traceability to avoid ranching on illegally deforested lands, and the *Amazônia Agora* plan targeting net-zero deforestation by 2030.



Science to Strategy: Timely Conservation for Biodiversity

When the *HM Forecasts to 2040* are intersected with biodiversity data, we can generate a metric for urgency to target conservation strategies and better pinpoint not only where to implement actions but also by when. The *Estimated Time to Act* framework identifies when a cumulative percentage of species within a community are expected to experience levels of human pressure beyond what they were exposed to in 2015—indicating a time when the community could be beyond its niche limits. Some communities have already been critically exposed to human modification and will require intensive restoration and management to recover; some are at the tipping point of exposure, and urgent action could prevent further biodiversity loss; other communities are not projected to experience

increased exposure before 2040, and protection strategies could provide a safeguard against future threats. In the worst projected outcome for Pará, 23% of the land area (approximately 23,000 square kilometers—the land area of Belize, or the state of New Hampshire in the United States) is at urgent risk before 2040—shown here in purple. These species risk projections provide insights for where timely and appropriate conservation interventions could be targeted to minimize biodiversity loss and meet commitments such as TNC's 2030 Goals and the Global Biodiversity Framework.



Map Spotlight

Indigenous Fire Management Benefits Biodiversity and Reduces Climate Emissions

Hong Jiang

For millennia, northern Australia's Aboriginal people used controlled burning to manage plant and animal resources and to maintain the health of their cultural and natural assets. When European settlers arrived, many Indigenous Australians were forced off their lands, disrupting traditional fire management practices. Without regular intentional burns during the cooler months, dry grasses build up and provide fuel for lightning-sparked wildfires later in the year. These fires burn significantly larger areas at hotter temperatures, releasing more carbon dioxide and other greenhouse gases.

In 2012, TNC helped establish one of the first savanna fire management projects and, since then, has continued to help Australia's Indigenous communities successfully plan, prepare for and register savanna fire management projects. This management reduces greenhouse gas emissions and keeps more carbon stored in woody vegetation through reintroducing controlled burning during the early dry season and preventing large-scale, late-season wildfires. Projects registered under savanna fire management methods can claim this reduction in overall greenhouse gas emissions as Australian Carbon Credit Units, which they can then sell to fund additional land management.

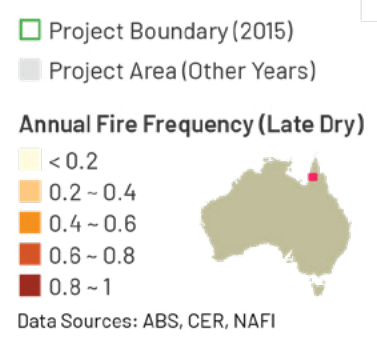
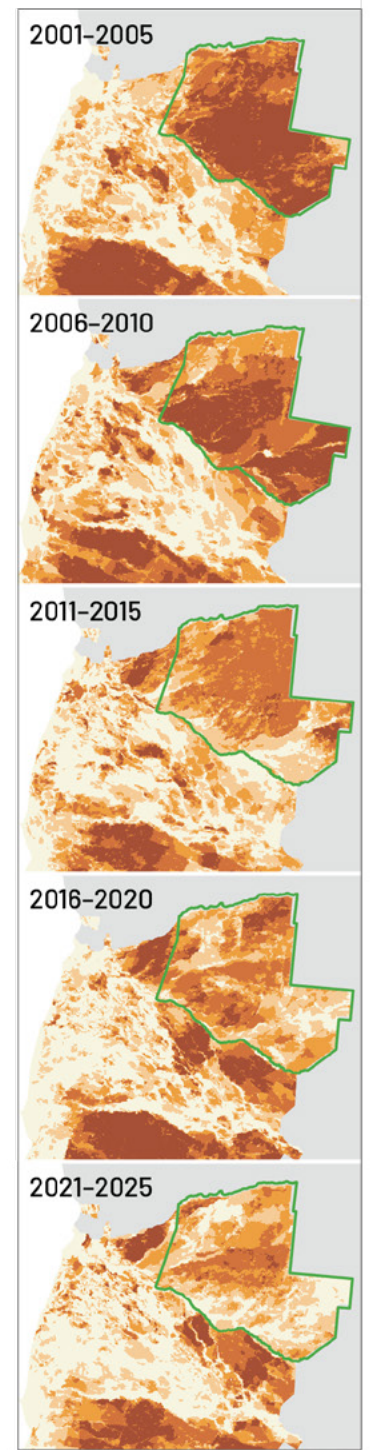
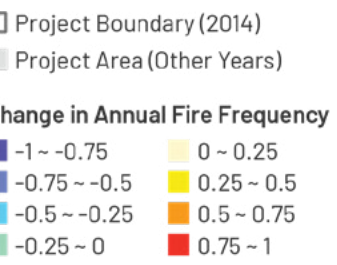
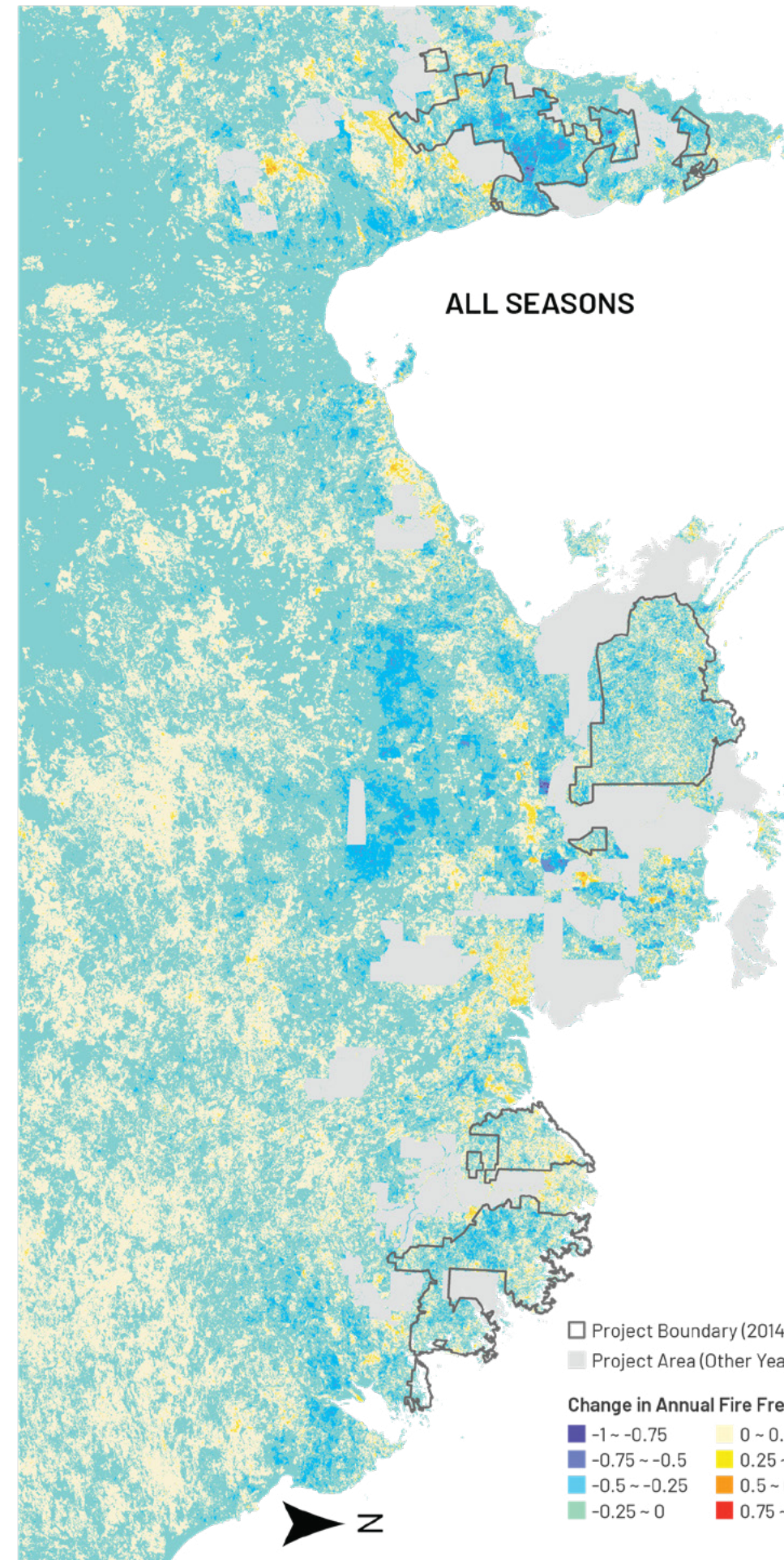
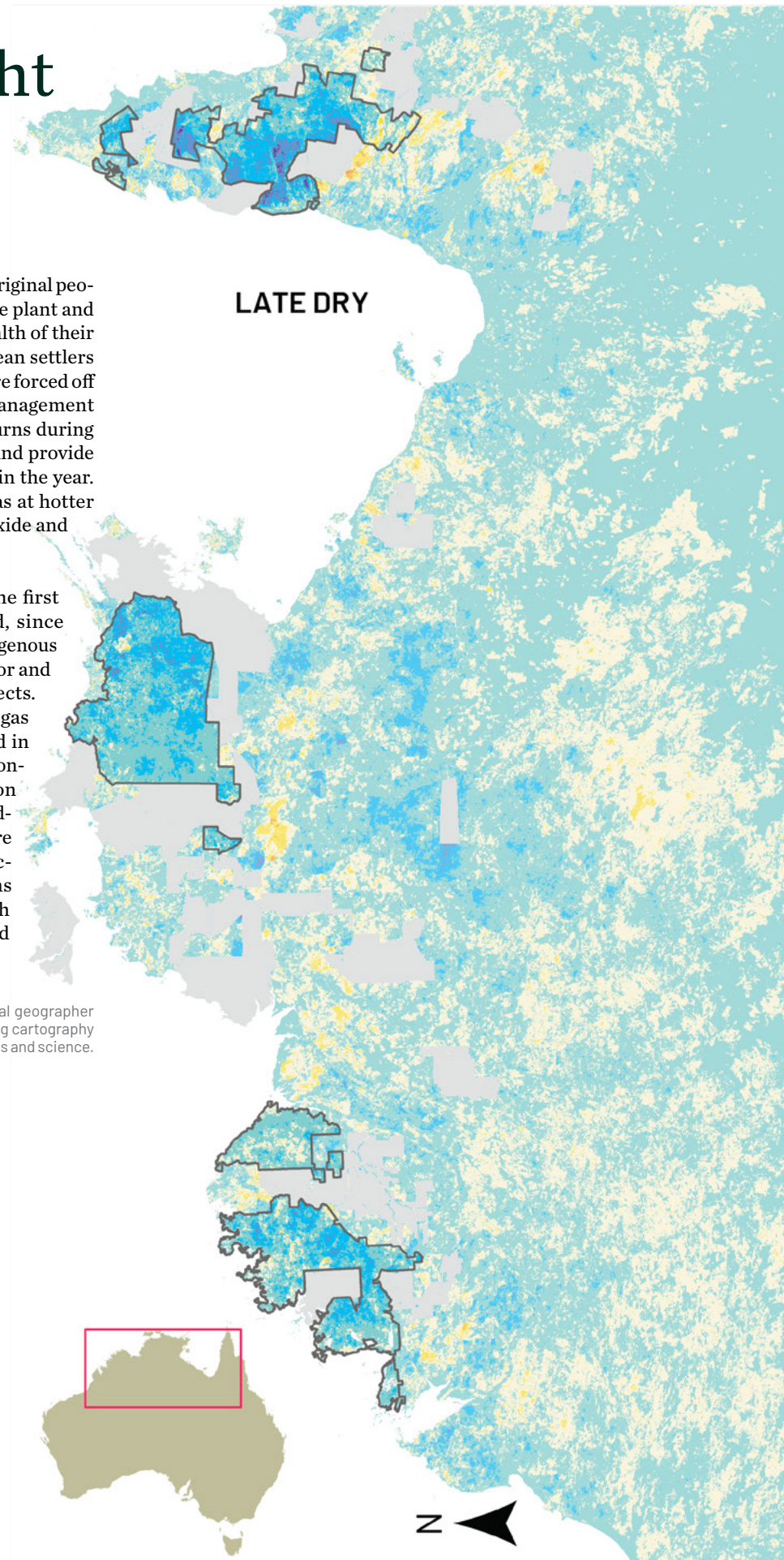
Hong Jiang is a fluvial geomorphologist and physical geographer who works as the GIS officer with TNC Australia, using cartography and spatial modelling to support conservation projects and science.

MAP: (this page) This map shows changes in annual fire frequency in the late dry season from the period between 2000 and 2014 to the period between 2015 and 2025, before and after projects registered in 2014.

MAP: (opposite page) This map shows changes in annual fire frequency in all seasons from the period between 2000 and 2014 to the period between 2015 and 2025, before and after projects registered in 2014.

Note: this map is mirrored to compare with late dry season annual fire frequency changes.

MAP: (far right) This map series showcases changes in annual fire frequency in late dry season over time at five-year intervals, within a project registered in 2015 and its surroundings.



Annual Geospatial Survey & Trends

The Nature Conservancy conducted the 2025 (seventh annual) survey 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, survey 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.

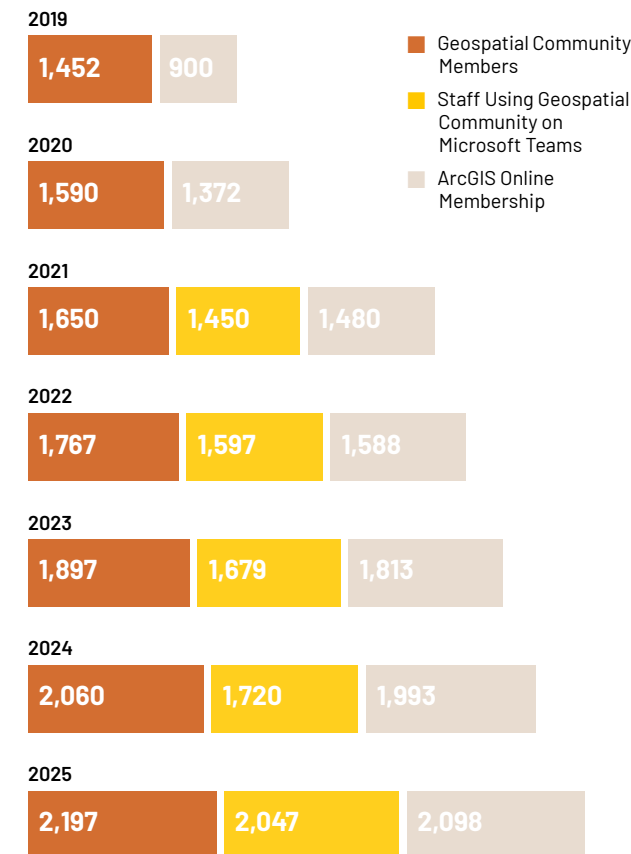
2,143 Staff invited to participate in the survey

365 Respondents [96% completed the entire survey]

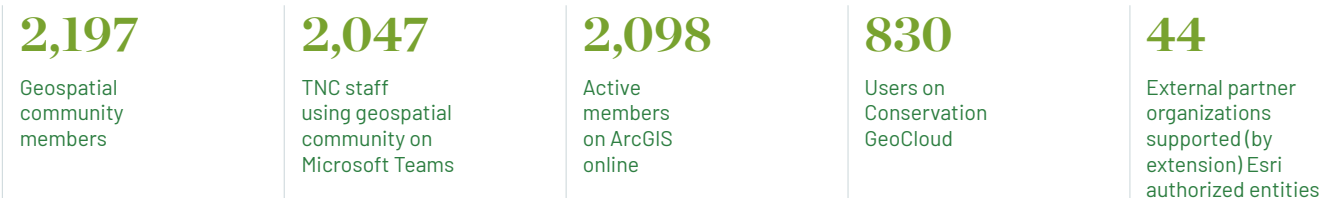
Note: As with all surveys, these results are only as accurate as the response rate. Therefore, results do not necessarily reflect the status of the entire TNC geospatial community.

Geospatial Community Growth

In the past seven years, our geospatial community has grown significantly, in line with overall staff growth of 50% during this period. Today, 37% of TNC staff use geospatial technology in their work. Note that numbers are not cumulative, and there is significant overlap among the categories.

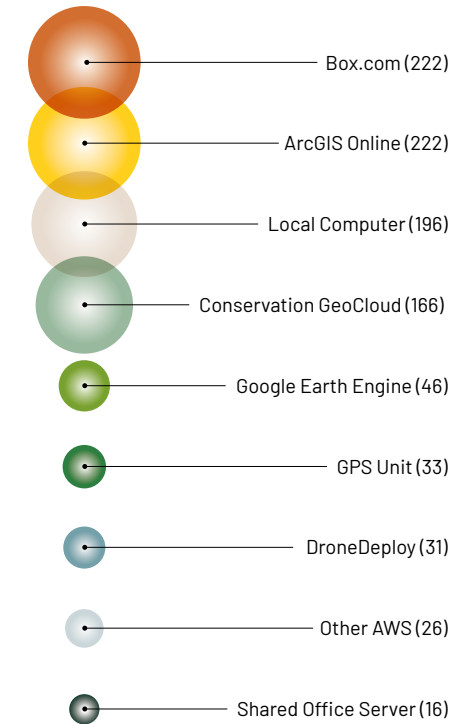


Defining TNC's Geospatial Community



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.



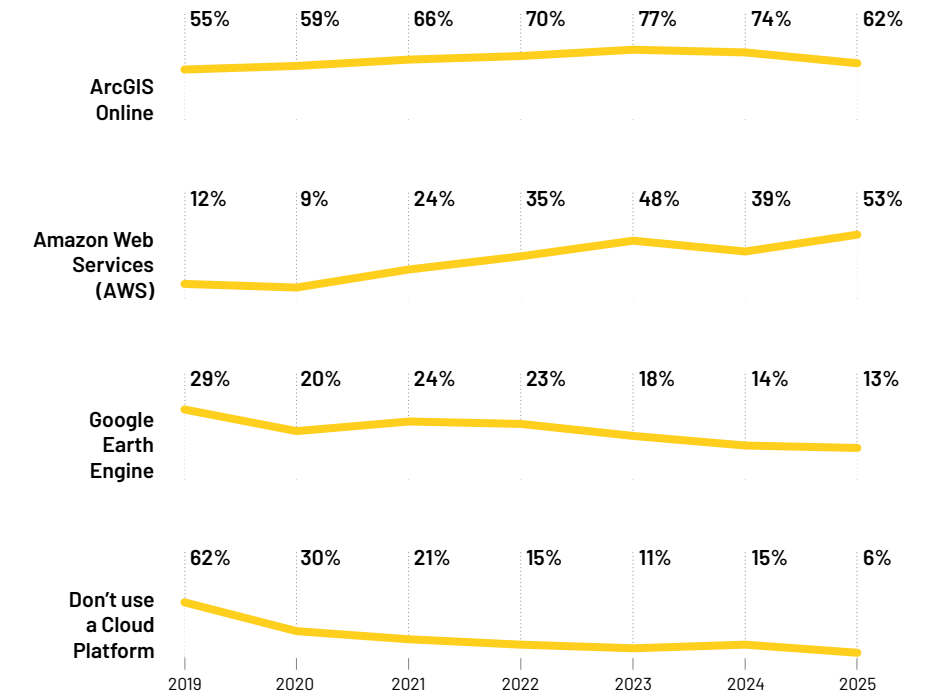
Priorities of the Geospatial Community

We asked respondents to identify strategic objectives the Geospatial Systems team should focus on to make the biggest impact on the community's work.

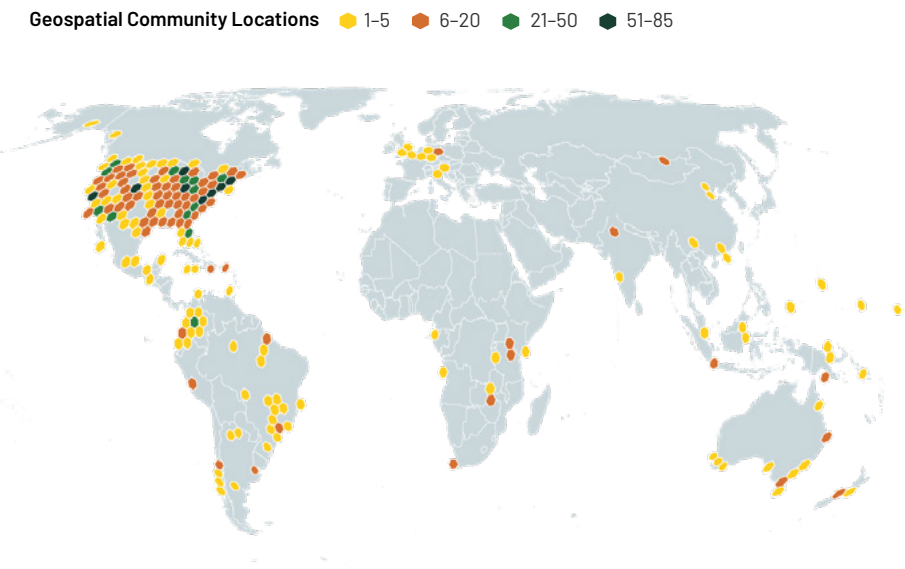
- Design and implement a conservation science data storage, sharing and governance catalog platform
- Improve the Conservation GeoCloud based on user needs & feedback
- Expand the Conservation GeoCloud to new audiences with an emphasis on global equity
- Pilot innovative conservation science technologies and translate successful explorations into production-level solutions
- Simplify and accelerate geospatial IT support
- Enable mapping of conservation progress and impacts to visualize TNC's 2030 Goals
- Strengthen TNC's geospatial storytelling and internal web GIS community engagement
- Implement a cloud-based science compute and storage environment with AI and machine learning (AI/ML) and other capabilities
- Explore the role of open-source technologies in our cloud-based compute, analytics and hosting landscape

Cloud Platform Usage

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



This map shows the physical work locations of our geospatial community: Note that many staff work across broad geographies that may reach far beyond their work location.



Looking Ahead

A Future-Ready Knowledge Management Ecosystem

John Poulsen
Global Director of Science Capacity
Deputy Director of One Conservancy Science

TNC's distinctive strength comes from combining global reach with rigorous, place based science and deep partnerships. Together, these strengths allow us to generate evidence that scales beyond individual projects and geographies. To meet the accelerating challenges of biodiversity loss and climate change, we must function as a *learning organization* that can rapidly adapt as new data and insights emerge. By capturing, connecting and mobilizing our knowledge, we can advance not only our own conservation impact, but conservation practice everywhere.

As a large, distributed organization, our knowledge is often fragmented across programs, geographies and systems. This can limit how effectively we use information, leading to duplication, inefficient use of limited time and resources and unnecessary risk to sensitive data. As our data volumes and analytical capabilities continue to grow, these limitations will increasingly constrain our ability to act quickly, consistently and at scale.

As we strive to achieve our 2030 goals and beyond, a future ready, integrated ecosystem of data and knowledge can make TNC's knowledge accessible and reusable across the organization. This will empower our staff to readily access, synthesize and learn from information when it matters most. Part of this ecosystem must incorporate seamless integration with analytics and AI tools, allowing knowledge to be rapidly summarized, interpreted and applied. This must be coupled with clear governance to protect sensitive information while enabling appropriate access and collaboration.

Within this ecosystem, AI will be applied responsibly to extend human expertise, with strong oversight grounded in sound judgment and scientific rigor. We will use AI as long as it can enhance knowledge about our planet while also aligning with our values and enabling more time for mission-critical, relationship-driven work. Guided by our commitment to minimize negative environmental and social impacts,

TNC aims to leverage the generation of knowledge such that it can accelerate our conservation impact and help safeguard people and nature in a rapidly changing world.

Strengthening how we manage knowledge across TNC is not just an IT upgrade. It has the potential to enable better science, smarter decisions, and greater impact at scale.



PHOTO: An egret stands on a bag of oysters. © Erika Nortemann/TNC

Acknowledgments

This seventh edition *Geospatial Conservation Annual Report & Map Book* has been a collective effort between TNC staff in Information Technology and Global Science, as well as staff in Africa, Australia and the United States, specifically in California, Texas, Virginia, Washington and elsewhere across the organization. A big thanks goes to Jan Slaats and Becca San Fratello for conducting and synthesizing our annual survey, and Jay Sullivan for his always outstanding support for print publication. Danielle DeGarmo (contractor) did the incredible layout and design work, and a special thanks goes to Danny White for his editing review. We appreciate the contributions of Niraj Swami in IT and John Poulsen in Global Science to the Introduction and Looking Ahead sections, respectively. We are also grateful to Ryan Abernathey of Earthmover for his collaboration on the foreword to this edition.

Thanks to Luke Parsons and Ava Goodarzi for their help in highlighting innovative science workflows. We appreciate the contributions of Tim Boucher, Anne Trainor, Saint-Clair Ebaye, Emmanuel Mambela, Joshua Okumu, Alexander Piel, Bernice Sainepo, Max Lambert and Maia Murphy-Williams in highlighting how TNC is using bioacoustics monitoring. Thanks to Vienna Saccomanno for helping to showcase how we're using AI in fisheries conservation and to drone pilots Jacqueline Ferrato and Zak Poulton for highlighting their work. We're grateful to Eric Abramson, Nathaniel Rindlaub and Kelly Easterday for their contribution to our story on camera traps for conservation science. We greatly appreciate John Stuelpnagel for providing the amazing photos on the front cover and inside the cover, and thanks to Moses Katkowski for coordinating our many photo requests.

Thanks to Katie Walker, Glenn Moncrieff, Maria Voigt, Christina Kennedy and James Oakleaf for their tireless work on highlighting the Human Modification forecasts. Thanks also goes to Hong Jiang in Australia for being this year's featured cartographer in our Map Spotlight. In One Conservancy spirit, these folks and many others have made essential contributions to this edition. We also extend appreciation to TNC's global leadership in IT and Global Science for championing the work of TNC's geospatial & conservation science community. 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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IMAGE: Drone technology is integrated into the science program at TNC's Volgenau Virginia Coast Reserve. This drone-captured LiDAR point cloud (a three-dimensional elevation model) gives a detailed picture of the shoreline's response to oyster reef restoration at a marsh island near the town of Wachapreague. See story on p. 18.



