Mapping the Ecological Toll of Hurricane Helene and Recovery Efforts in Western North Carolina

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INTRODUCTION

When Hurricane Helene struck western North Carolina in September 2024, the damage to homes, roads, and communities was devastating. Recovery will take years and is expected to cost more than $59 billion. But people weren't the only ones affected—so were rare and sensitive species and habitats, from the anglers' favorite brook trout to the endangered Weller's salamander.

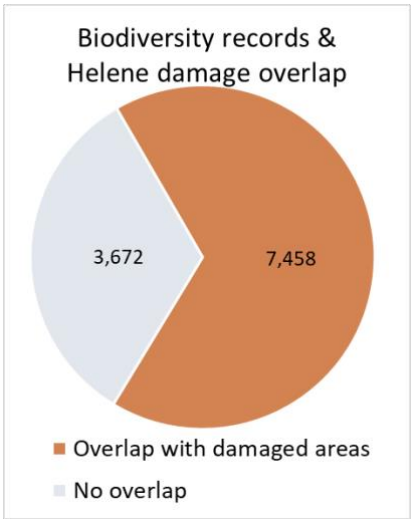
WHERE TO BEGIN IN ADDRESSING THE DAMAGES?

To help guide response efforts, North Carolina's Natural Heritage Program partnered with Duke University's Nicholas Institute for Energy, Environment & Sustainability to identify where species and habitats were likely to have been damaged by the storm.

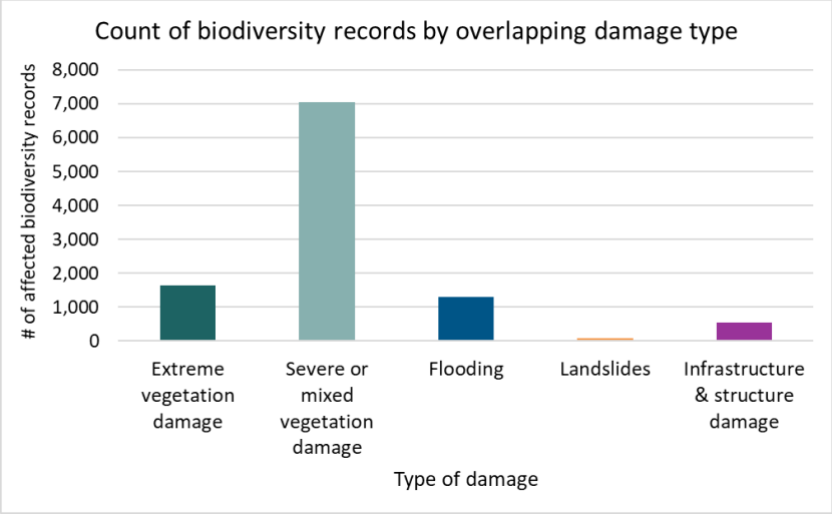
The Duke research team mapped the overlap between storm damage and more than 11,000 biodiversity records—locations where rare species or unique natural communities have been observed and documented—in western North Carolina. Researchers included four types of damage: vegetation loss (measured via satellite), flooding, landslides, and infrastructure damage.

More than 67% of the biodiversity records overlapped with at least one form of hurricane damage, and many records coincided with multiple types.

Figure 1. Biodiversity records that overlapped with (a) areas damaged by Hurricane Helene and (b) what kind of damage likely threatened each affected record



(a)



(b)

WHAT RISKS DOES HURRICANE DAMAGE POSE TO WILDLIFE?

Vegetation damage ranged from widespread areas of tree blowdowns and broken trunks creating large canopy gaps (classified as *extreme vegetation damage* in Figure 1b) partial canopy loss (*severe or mixed vegetation damage*). Vegetation damage can reduce the habitat for wildlife species that rely on trees and understory vegetation for nesting, foraging, and cover. For some plants that thrive in cool, shaded coves, the habitat may now be too sunny and open, while other plants may thrive in the new canopy gaps. Vegetation damage can also elevate habitats' wildfire risk, which can further alter ecosystems. And large-scale tree loss may also shift forest composition, as different plant species, particularly nonnative invasive plants, take advantage of increased sunlight and compete for new canopy gaps.

Fewer biodiversity records overlapped with areas affected by **flooding or landslides**, but these types of damage can have significant impacts where they did occur. Floodwaters scour streambanks, deposit debris, and wash away aquatic vegetation, which can degrade habitat for fish, amphibians, and invertebrates. Landslides, while more localized, can bury sensitive vegetation and destabilize slopes, leading to long-term erosion and adding excess sediment to streams.

WHAT ABOUT RISKS FROM RECOVERY AND REBUILDING EFFORTS?

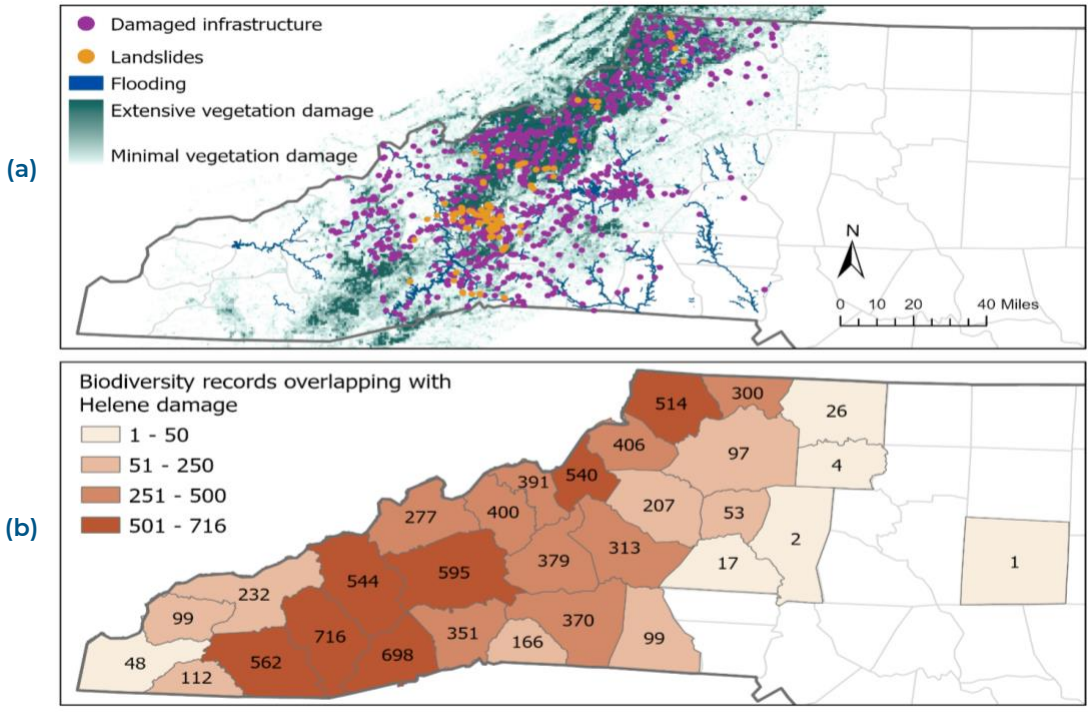
Perhaps the largest impact to biodiversity from Helene may be the human response to **damaged infrastructure**, as heavy-equipment crews work to repair damaged bridges, culverts, and roads and remove woody debris from rivers. This impact is very hard to capture, as available data from the North Carolina Department of Transportation was not comprehensive. For example, there is no readily available data on where woody debris needs to be removed from stream channels, which is likely to be a significant source of direct damage to riverbank communities and harm sensitive aquatic communities downstream through increased sedimentation. Even with these limitations, researchers found more than 500 biodiversity records potentially impacted by infrastructure repairs.

Identifying where infrastructure repair needs intersect with sensitive species and habitats allows planners to proactively reduce additional damage, so short-term recovery efforts do not worsen ecological harm.

WHERE DID LIKELY HURRICANE DAMAGE OCCUR?

Hurricane damage coincided with biodiversity records in 30 North Carolina counties, 18 of which contained at least 200 biodiversity records within damage areas. Jackson, Transylvania, and Buncombe counties were the most affected.

Figure 2. Maps showing (a) where different types of damage from Hurricane Helene occurred across North Carolina and (b) the number of biodiversity records overlapping with hurricane damage in each county



WHAT SPECIES WERE AFFECTED?

Many biodiversity records potentially affected by hurricane damage were plants (36% of all affected records), followed by natural communities (32%), and animals (27%).

Of the animal records affected, the most common groups were invertebrates (34% of all affected animal records), freshwater fish (25%), mammals (19%), and birds (15%). Some sensitive reptile and amphibian records were not included in the analysis due to data sharing restrictions, so these statistics likely underestimate hurricane impacts to those species.

In total, 721 different species and natural community types had occurrence records overlapping with areas damaged by Hurricane Helene.

Within hurricane-damaged areas, 20% of all biodiversity records represent species listed as endangered or threatened by North Carolina, and 7% were species listed as federally endangered or threatened. These proportions are about the same as the threatened and endangered species in the full biodiversity records dataset, which focuses on rare species and unique habitats.

Commonly affected species include recreationally important fish like the brook trout (*Salvelinus fontinalis*), the only trout native to western North Carolina. The brook trout is already under pressure from competition with nonnative rainbow and brown trout as well as habitat loss due to warming mountain streams.

Federally endangered species such as Virginia spirea (*Spirea virginiana*) and rock gnome lichen (*Gynmoderma lineare*), which grow along streams and rivers, were also likely affected. Some potentially impacted species, like Rose's heartleaf (*Hexastylis rosei*), are only found in North Carolina, making them especially vulnerable to habitat loss from Hurricane Helene. Others, like the tricolored bat (*Perimyotis subflavis*), are experiencing ongoing population declines due to external factors like white nose syndrome. These species each had at least 55 records overlapping with hurricane-damaged areas.

Figure 3. From left to right: Virginia spirea, brook trout, and tricolored bat.

Images courtesy US Fish and Wildlife Service, Wikimedia Commons (Marrabbio2), and Dave Thomas.

WHAT ARE NC AGENCIES DOING WITH THIS INFORMATION?

With such widespread damage both geographically and across a wide range of species, it's critical for North Carolina agencies to focus their limited resources where they can have the greatest impact. This analysis helps identify the species and locations most likely to have been severely affected, allowing agencies to prioritize on-the-ground assessments and recovery efforts where they are most needed.

So far this field season, Natural Heritage Program field staff have been busy visiting plant and natural community populations flagged using this analysis. So far, they have seen some plants, such as a population of Eastern shooting star (*Primula meadia*) completely taken out by a landslide, but others, such as Virginia spirea (*Spiraea virginiana*) still clinging to a soured riverbank. It will take some time to get a full picture of which species have been most impacted.

These field assessments will guide further actions to limit additional damage and support the recovery of affected species and habitats. This could include updated guidance for contractors involved in cleanup and reconstruction, temporary habitat protection measures to prevent further disturbance during recovery, and restoration projects targeting species and ecosystems hit hardest by the storm. For example, the North Carolina Wildlife Resources Commission has already developed best-practice guidance for contractors to minimize ecological harm during cleanup and infrastructure repairs.

By taking a targeted, data-driven approach, state agencies aim to ensure that the most vulnerable species and habitats receive timely attention to prevent lasting ecological losses from Hurricane Helene.

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Header image courtesy NC Department of Transportation.

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