

# How do you save a wolf that's not really a wolf?

Genetic study may complicate conservation of an iconic North American animal

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Eastern wolf (*Canis lupus*) in winter at Omega Park in Montebello, Canada. ROLAND SEITRE/MINDEN PICTURES

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When is a wolf a wolf? For more than 30 years, the question has dogged scientists, conservationists, and policymakers attempting to restore and protect the large wild canids that once roamed North America. Now, a study of the complete genomes of 28 canids reveals that despite differences in body size and behavior, North American gray wolves and coyotes are far more closely related than previously believed, and only recently split into two lineages. Furthermore, the endangered red and eastern wolves are not unique lineages with distinct evolutionary histories, but relatively recent hybrids of gray wolves and coyotes, the scientists report [online today in \*Science Advances\*](#).

That could be a problem for the wolves. The red wolf is currently protected under the U.S. Endangered Species Act (ESA), and some conservationists would like to see the eastern wolf listed as well. (It is protected in Canada.) But as hybrids, they may not qualify for protection under U.S. law. The study "helps with more data but hurts by giving less protection to [the] two wolf types," says Doug Smith, the leader of Yellowstone National Park's wolf restoration project in Mammoth, Wyoming.



The research team argues that red and eastern wolves should still be protected, and urges reconsideration of our black-and-white species concept. "People think that species should be genetically pure, that there should be tidy categories for 'wolf' and 'coyote.' That's not what we found," says Bridgett vonHoldt, an evolutionary biologist at Princeton University and the study's lead author. "The study shows that mixed ancestry is common, even in animals [in the western United States] we've traditionally identified as 'pure,'" adds Linda Rutledge, a postdoc in VonHoldt's lab who was not involved in the study and doesn't accept all its findings. "It shows how outdated the endangered species policy is with respect to hybrids."

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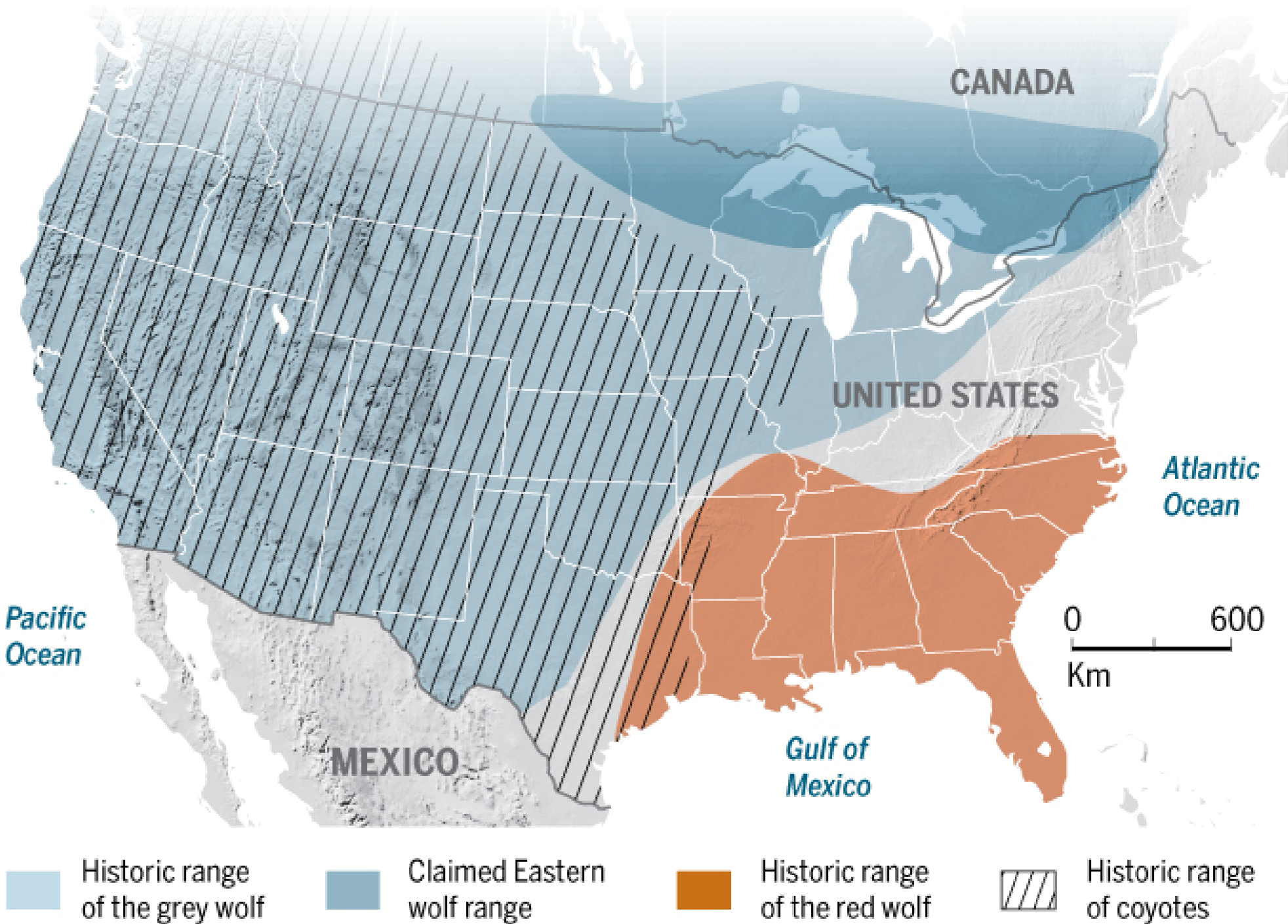
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Gray wolves (*Canis lupus*) and the smaller, narrow-snouted coyotes (*C. latrans*) have long been accepted as North America's two large canid species. But some scientists recognize two additional wolf species—the red (*C. rufus*), found in the southeastern United States, and the eastern wolf (*C. lycaon*), which ranges from the Great Lakes into eastern Canada (see map, below).

A continent of canids

Opinions vary on wolf ranges and identities, but most researchers agree that the gray wolf once roamed across much of North America (including into Mexico, not shown) and that the coyote ranged across the west. A new genetic study finds that the red wolf and the eastern wolf (one from Quebec in Canada, bottom) arose later by mixing with coyotes as they expanded eastward.



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The United States Fish and Wildlife Service (FWS) counts both as species. It put the red wolf on the endangered list in 1973 and started a captive breeding program for it in 1980, but reintroducing the animals has proven difficult, because they readily mate with coyotes. The agency has not put the eastern wolf on the endangered list, although it is restricted to a small portion of its

former range. (In a controversial move in 2012, FWS used the existence and range of the eastern wolf as a technicality that could invalidate the gray wolf's protections, because if the eastern wolf is a real species, then the gray's range in the original ESA filing was incorrect.)

Other researchers have suspected, however, that both "species" are, in fact, wolf-coyote hybrids that arose after the grays were hunted almost to extinction. To help sort out the North American wolves' muddled history, VonHoldt's team sequenced the whole genomes—nearly 3 billion bases each—of 28 large canids; they included wolves from Asia, Mexico, Canada, and the United States, plus coyotes, domesticated dogs, and a golden jackal. Comparing the genomes let them "look back in time at the canids' deep evolutionary history," VonHoldt explains, "and to find each species's closest relative, and when they diverged."

Using a molecular clock based on differences in the genomes to calculate when coyotes and gray wolves split, the team got a surprise: These canids separated from the Eurasian wolf and into two distinct lineages between 6000 and 117,000 years ago. Other researchers had previously dated this event to 1 million years ago using the fossil record. The recent date for the wolf-coyote split "is phenomenal," VonHoldt says. "They are very close relatives." Even western wolves that do not breed with coyotes still share some coyote genes.

[[{"video\_fid" : 104204}]]

But the team found even more coyote genes, of more recent origin, in red wolves and eastern wolves, including those from Algonquin Provincial Park in Canada where pure eastern wolves were thought to exist. The paper estimates that Algonquin wolves have about 32% coyote ancestry, and Quebec wolves more than 50%. The team concludes that neither the red nor the eastern wolf is a species. Instead, they suggest that both are hybrid populations that arose after Europeans arrived in North America, when gray wolves that managed to survive hunting and habitat loss mixed with expanding populations of coyotes. "There's nothing in their genome that's not gray wolf or coyote," says co-author Robert Wayne, an evolutionary biologist at the University of California, Los Angeles.

Rutledge and others, including conservation geneticist Paul Wilson, who studies the eastern wolf at Trent University in Peterborough, Canada, argue that researchers need to sequence more samples of *C. lycaon* before dumping that taxon. But others who have long questioned the status of eastern and red wolves welcome the work. "Wolf biologists and others have been waiting for this sort of definitive analysis for years," says Susan Haig, a wildlife ecologist at the United States Geological Survey in Corvallis, Oregon.

The loss of species status for the red and eastern wolves doesn't mean they should lose protection, Wayne and others say. Hybridization is "a natural and commonly occurring evolutionary event," Wayne says, noting that the ESA has successfully been used to protect hybrid species such as the Florida puma and western spotted owl. He thinks eastern and red wolves should be protected because they likely still carry genes from wolves that once inhabited these regions, and because they are evolving into animals better adapted to today's human-dominated landscapes. The team also argues that the agency's arguments for delisting the gray wolf are no longer valid.

It's possible that eastern and red wolves—if regarded as grays—would still be protected, but FWS declined to comment on the details of the paper.

Other scientists say the messy natural biology revealed by the study clashes with society's need for clear legal definitions. "It's beautiful work and topflight science," says Mike Phillips, a restoration ecologist with the Turner Endangered Species Fund in Bozeman, Montana. "But from a practical standpoint, to do what they're asking [and consider the ecological benefits of hybrids], you'd have to amend the ESA."

He and others lament the possibility that red wolves might lose ESA protection because of the findings. That, they say, would be a sad irony for canids that likely evolved because of human disturbance in the first place.

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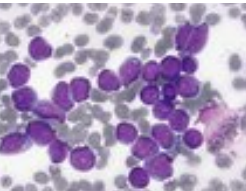
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