Nature Divided, Scientists United:
U.S.-Mexico Border Wall Threatens Biodiversity and Binational Conservation

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Fences and walls erected along international boundaries in the name of national security have unintended but significant consequences for biodiversity (Trouwborst et al. 2016). In North America, along the 3,200 kilometer U.S.-Mexico border, fence and wall construction over the past decade and efforts by the Trump administration to complete a continuous border "wall" threaten some of the continent's most biologically diverse regions. Already-built sections of the wall are reducing the area, quality, and connectivity of plant and animal habitats, and are compromising more than a century of binational investment in conservation. Political and media attention, however, often understate or misrepresent the harm done to biodiversity.

We call on fellow scientists to join us in expressing unified concern over the border wall's negative impacts on wildlife and habitat and binational collaboration in conservation and scientific research. Below we describe three ways in which border infrastructure and security operations (hereafter 'the border wall') threaten biodiversity, and we outline actions to minimize these threats.

1) The border wall bypasses environmental laws. In 2005, the U.S. Congress passed the Real ID Act which gives the Department of Homeland Security (DHS) authority to waive any laws that slow the wall's construction, including the Endangered Species Act (ESA) and National Environmental Policy Act (NEPA). With these laws sidelined, wall construction proceeds without the necessary depth of environmental impact analysis, development of less-damaging alternative strategies, post-construction environmental monitoring, mitigation, public input, and pursuit of legal remedies. Since 2005 DHS has issued seven waivers in all four U.S. border states, including three by the Trump administration in 2017 for construction in California and New Mexico.

2) The border wall harms wildlife populations by eliminating, degrading, and fragmenting habitats. The U.S.-Mexico borderlands traverse six ecoregions (Figure 1) containing vegetation types that include desert scrub, temperate forests and woodlands, semidesert and Plains grasslands, subtropical scrublands, freshwater wetlands, and salt marshes. These environments span portions of a broad Nearctic-Neotropical transition zone and support extraordinary biological diversity. Our analysis shows that the border bisects the geographic ranges of 1,506 native terrestrial and freshwater animal (n=1,077) and plant (n=429) species, including 62 species listed as Critically Endangered, Endangered, or Vulnerable by the International Union for Conservation of Nature (IUCN) Red List (Appendix S1, Table S1). Five borderlands conservation hotspots identified by Defenders of Wildlife represent top-priority areas of high biological diversity and binational investment in conservation that are threatened by border wall construction (Figure 1; Peters and Clark 2018).

Like any large-scale development, construction of the wall and associated infrastructure, such as roads, lights, and operating bases, eliminates or degrades natural vegetation, kills animals directly or through habitat loss, fragments habitats (thereby subdividing populations into smaller, more vulnerable units), reduces habitat connectivity, erodes soils, changes fire regimes, and alters

hydrological processes (for example by causing floods). As of 2017, DHS had constructed 1,050 kilometers of 'primary' pedestrian and vehicle barriers serviced by 8,000 kilometers of roads, and many thousands of kilometers of undesignated routes created by off-road patrol vehicles. Human activity, light, and noise associated with the wall further displace wildlife, making additional habitat unavailable.

The border wall threatens some populations by degrading landscape connectivity. Physical barriers prevent or discourage animals from accessing food, water, mates, and other critical resources by disrupting annual or seasonal migration and dispersal routes. For example, continuous walls could constrain endangered Peninsular bighorn sheep (*Ovis canadensis nelson*) from moving between California and Mexico to access water and birthing sites. It will be likely impossible for endangered animals like Mexican gray wolf (*Canis lupus baileyi*) and Sonoran pronghorn (*Antilocapra americana sonoriensis*) to disperse across the border to reestablish recently extirpated populations or bolster small existing populations. As climate change and increasingly warm, dry conditions redistribute resources and shift habitats in the borderlands, the wall may prevent some populations from tracking these changes. Fragmented populations may suffer from reduced genetic diversity and face greater extinction risks.

A continuous border wall could disconnect more than 34% of U.S. non-flying native terrestrial and freshwater animal species (n=346) from the 50% or more of their range that lies south of the border (Figure 2; Appendix S1). If cut off by a border wall, 17% of the 346 species we analyzed, including jaguar (*Panthera onca*) and ocelot (*Leopardus pardalis*), would have residual U.S. populations covering 20,000 km^2 or less (Table S1). This would elevate their risk of extirpation within the U.S. according to IUCN Red List criteria (Table S1; Appendix S1).

Border barriers could also hinder some low-flying species, like the ESA-listed Endangered Quino checkerspot butterfly (*Euphydryas editha quino*) and the ESA-candidate ferruginous pygmy-owl (*Glaucidium brasilianum* (Flesch et al. 2010). Over long periods, degradation of landscape connectivity can also drive genetic discontinuities in plants and animals. Although the influence of barriers on populations depends on both a species' movement ability and the quantity, quality, and spatial arrangement of habitats, for many species the biological impacts of a 'wall' are comparable to those of a 'fence'. What matters is whether the barrier is passable, and from a jaguar's point of view, an uncrossable fence has the same effect as a wall.

3) *The border wall devalues conservation investment and scientific research.* The U.S. and Mexican governments, tribes, non-governmental organizations, and private landowners have set aside many millions of acres of protected land and invested millions of dollars in conservation, often binationally coordinated (Peters and Clark 2018). Within 80 kilometers of the border, 4.5 million hectares of U.S. and Mexican protected areas are managed for biodiversity conservation (comparable to IUCN Protected Areas Categories I-IV) in addition to 2.6 million hectares managed for sustainable multi-use (IUCN Categories V-VI; Appendix S2). In total, 18% of the borderlands contain protected lands. This includes four clusters of protected lands that sandwich a total of 400 border kilometers to create contiguous binational habitat corridors through the Sonoran Desert, Sky Islands, Big Bend, and Lower Rio Grande (Figure 1). Numerous binational collaborations have also targeted specific species, like the binational aerial census of endangered Sonoran pronghorn. The wall places such investments at risk by undermining their objectives and diverting funds away from conservation projects and towards barrier construction.

The wall and associated security operations also obstruct scientific research. U.S. and Mexican scientists have shared distressing stories of being intimidated, harassed, and delayed by border security officers. Binational meetings and other collaborative activities become inconvenient and

constrained by the hours required to pass border security checkpoints. These factors diminish the amount of much-needed scientific work conducted in the borderlands. This is especially concerning given that waiving of environmental laws means independent research may provide the best source of scientific insight into the wall's impacts on biodiversity.

Scientists' Call for Action. As informed stewards of biodiversity, we urgently advise the following:

1) The U.S. Congress should ensure that DHS follows the sound scientific and legal frameworks of U.S. environmental laws, including the ESA and NEPA. Any future appropriations for border barrier construction and operations should require adherence to all environmental laws and preclude their waiver. In areas where DHS has already issued waivers, we call on DHS to carry out analysis, mitigation, and opportunities for public participation as prescribed by all relevant environmental laws.

2) For any barrier construction or security operations, DHS should complete rigorous pre-planning and pre-implementation surveys to identify species, habitats, and ecological resources at risk, and work closely with pertinent Mexican and U.S. government agencies, tribes, private landowners, the scientific community, and other stakeholders to gather such information.

3) DHS should mitigate as completely as possible any environmental harm resulting from projects. Mitigation should include forgoing physical barriers in places with high ecological sensitivity, such as cross-border corridors or critical habitat for endangered species. Wherever possible, border barriers should be designed for maximum wildlife permeability, including the use of vehicle barriers instead of pedestrian barriers. When harm to biological resources is inevitable, DHS should implement mitigation measures to ensure no net environmental loss, for example by purchasing or restoring replacement habitats.

4) DHS should facilitate scientific research in the borderlands to complement and assist environmental evaluation and mitigation efforts. This should include training Border Patrol agents to be sensitive to the presence of researchers and briefing Border Patrol agents when independent scientists will be working near the border.

We urge the U.S. government to recognize and give high priority to conserving the ecological, economic, political, and cultural value of the U.S.-Mexico borderlands. National security can and must be pursued with an approach that preserves our natural heritage.

Supplemental material

Supplementary data are available at BIOSCI online including supplemental file 1 (Appendix S1 on species analyses and Appendix S2 on protected area analysis) and file 2 (Table S1 on border species).

References

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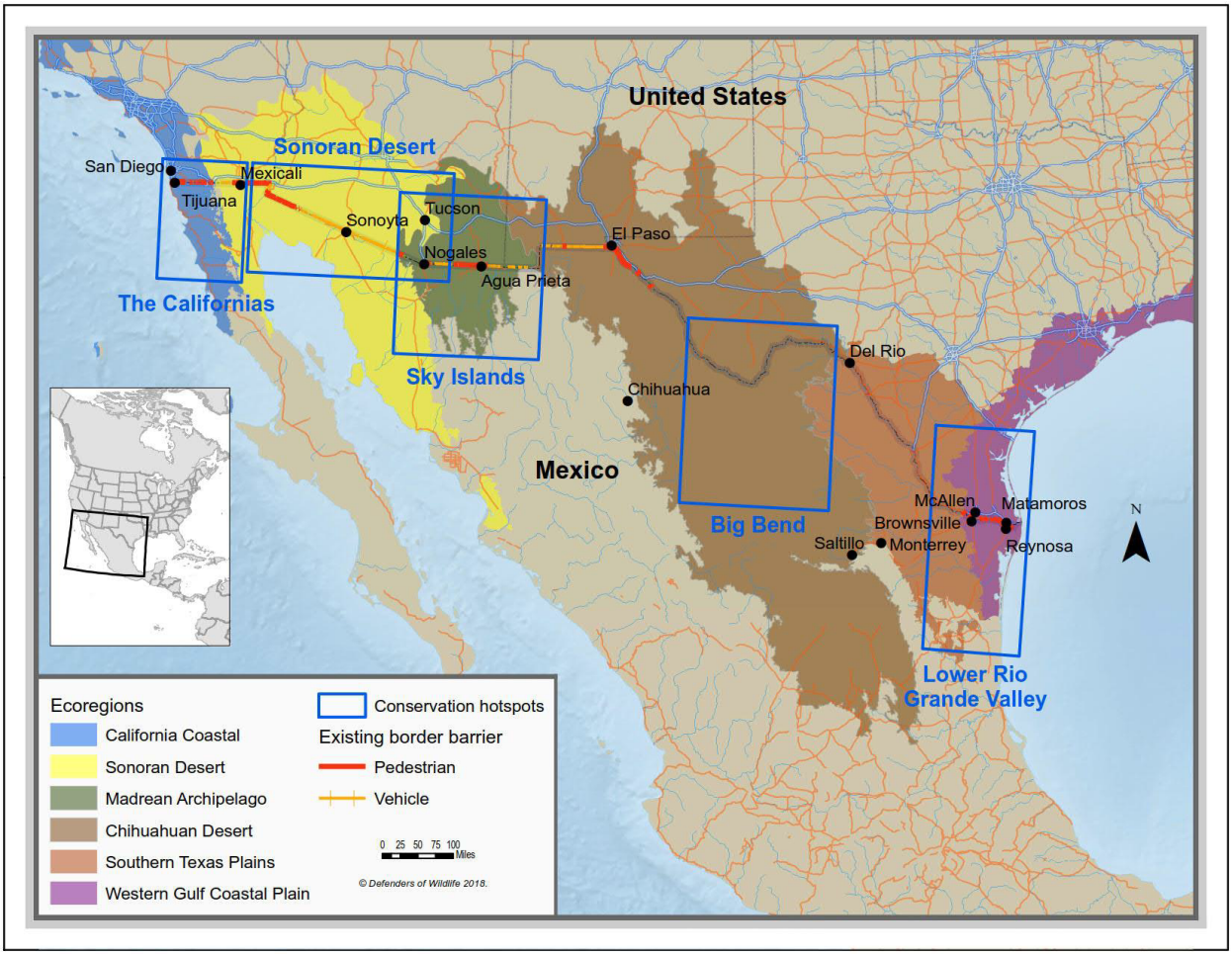

Figure 1. The five Borderlands Conservation Hotspots identified by Defenders of Wildlife, which highlight areas of high biological diversity and significant investment in conservation land and projects. See Peters and Clark 2018 for more information.

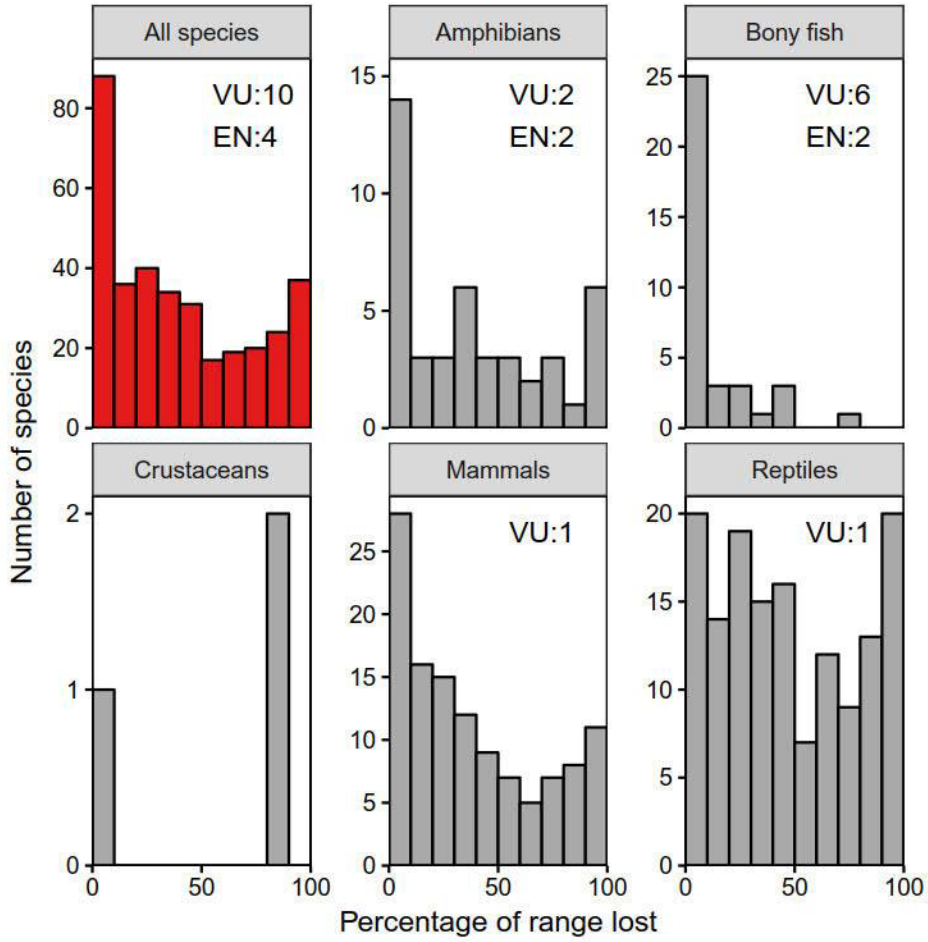

*Figure 2. Percentage of species ranges that may become inaccessible to U.S. species after construction of a U.S.-Mexico border wall. The number of species ranked in the IUCN Red List as Endangered ('EN') or Vulnerable ('VU') are shown by taxonomic group. Species include non-flying native terrestrial and freshwater animal species with spatial range data available in the IUCN Red List (*n*=346). Percentages represent the percentage of species' total ranges located south of the U.S.-Mexico border*