Ecology & Evolution | Nov 12, 2026 | 5 min read | By Bryan White

Rising Seas Threaten 15,000 Land Vertebrates by 2100 as Science Study Maps Global Coastal Extinction Risks and Unprotected Refugia

Ecology & Evolution * Climate Change * Sea-Level Rise

As anthropogenic greenhouse gas emissions continue to warm the global climate, accelerating ice-sheet melting in Greenland and Antarctica combined with ocean thermal expansion is driving sea levels upward at an unprecedented historical pace [1, 2] . While the physical hazards to human coastal infrastructure and megacities have received intense scientific and economic scrutiny, the cascading biological consequences for terrestrial wildlife have remained largely fragmented and regionally confined [1] . Until now, global conservation frameworks lacked a comprehensive, spatially explicit assessment of how many terrestrial animal species stand to lose their native habitats to coastal inundation over the coming century [1] .

In a landmark investigation published in the journal Science , an international research consortium led by Zhong-Wen Jiang, Heng-Bin Xiao, David S. Wilcove, Matthew L. Kirwan, and colleagues conducted the first global assessment of sea-level rise vulnerability across nearly the entire terrestrial vertebrate tree of life [1, 2] . Analyzing high-resolution habitat suitability models for 34,120 land vertebrate species -- encompassing approximately 90% of all described amphibians, reptiles, birds, and mammals -- the authors projected inundation exposures across Intergovernmental Panel on Climate Change (IPCC) greenhouse gas scenarios through the year 2100 [1, 2] . The findings reveal a planetary biodiversity crisis: between 14,325 and 15,324 terrestrial vertebrate species (exceeding 42% of all assessed land vertebrates) will experience direct habitat loss from rising seas by 2100, with more than 96% of their critical future retreat corridors currently lacking legal environmental protection [1, 2] .

1. The Mechanics of Inundation, Salinization, and Coastal Squeeze

The ecological threat posed by sea-level rise to terrestrial organisms extends far beyond permanent bathymetric submergence [1, 3] . In coastal ecosystems, habitat loss unfolds through a multi-stage physical and geochemical cascade:

* Hydrodynamic Overtopping and Permanent Submergence: Baseline mean sea-level rise permanently drowns low-lying supratidal platforms, freshwater marshes, beach ridges, and mangrove fringe systems, directly converting terrestrial foraging and nesting grounds into open marine or intertidal waters [1, 3] .

* Storm-Surge Amplification and Ephemeral Disturbance: Even before mean high-water marks overtake an ecosystem , elevated baseline sea levels exponentially amplify the inland reach and return frequency of extreme storm surges. High-energy marine overwash introduces catastrophic mechanical destruction, strips topsoil, and drowns non-volant terrestrial organisms [1, 3] .

* Soil Salinization and Groundwater Osmotic Shock: In low-elevation coastal plains and river deltas, saltwater intrudes deep into coastal aquifers and river mouths. Soil porewater salinity rises rapidly, exceeding the physiological osmotic tolerance of terrestrial vegetation and freshwater-dependent vertebrates. Coastal maritime forests suffer widespread tree mortality -- forming expansive "ghost forests" -- while amphibious species experience fatal dehydration and reproductive collapse [1, 4] .

* Anthropogenic Coastal Squeeze: Under natural, pre-industrial conditions, coastal wetlands and maritime ecotones responded to sea-level rise by migrating horizontally inland into adjacent lowlands [3, 4] . Today, however, coastlines worldwide are armored with human infrastructure -- including seawalls, revetments, agricultural dikes, roads, and urban sprawl. When rising waters push coastal habitats against these immovable artificial barriers, the suitable ecological niche is crushed in a phenomenon known as coastal squeeze , leaving native vertebrates with nowhere to retreat [1, 3, 4] .

2. Taxonomic Vulnerability: Why Reptiles and Island Specialists Face the Steepest Collapse

The Science study highlights stark differences in exposure and extinction vulnerability across vertebrate classes, driven by fundamental differences in dispersal capacity, ecological niche breadth, and geographical range size [1] :

| Vertebrate Class | | Total Species Assessed | | Species Exposed to SLR (2100) | | Proportion Exposed | | Primary Mechanistic Vulnerability Driver |

| Reptiles (Reptilia) | | 9,754 | | ~4,180 | | 42.9% | | High proportion of narrow-range insular endemics, physiological vulnerability to soil salinization, and low dispersal mobility across human barriers [1] . |

| Amphibians (Amphibia) | | 6,812 | | ~1,920 | | 28.2% | | Extreme osmotic sensitivity to saline intrusion; destruction of ephemeral freshwater breeding pools [1] . |

| Birds (Aves) | | 10,480 | | ~6,600 | | 63.0% | | Extensive reliance of migratory and coastal shorebirds on intertidal foraging mudflats and low-elevation barrier beach nesting colonies [1] . |

| Mammals (Mammalia) | | 7,074 | | ~3,680 | | 52.0% | | Displacement of coastal plain rodents, marsupials, and carnivores into dense agricultural or urban matrices [1] . |

While birds exhibit the highest raw percentage of exposed species due to their extensive presence in coastal and estuarine wetlands, reptiles emerge as the most imperiled taxonomic group in terms of irreversible population loss and extinction risk [1] . Unlike migratory waterfowl or large mobile mammals, coastal lizards, snakes, and tortoises frequently occupy hyper-restricted, narrow ranges -- often confined to a single barrier island, limestone caye, or estuarine peninsula [1] . Furthermore, reptile embryos incubating in subterranean sand or soil nests are exceptionally sensitive to moisture and salinity. Inundation with brackish water suffocates eggs and halts embryonic gas exchange, causing complete cohort reproductive failure [1] .

3. Geographical Epicenters: River Deltas and Island Archipelagos

The geographical distribution of habitat loss is intensely concentrated in biodiversity-rich, low-elevation coastal ecotones [1] :

* Southeast Asian Archipelagos (Sundaland & Wallacea): The Indonesian and Philippine archipelagos represent the primary global epicenter of vulnerability. Characterized by thousands of low-lying islands, extensive mangrove systems, and extraordinary rates of single-island endemism, rising waters threaten hundreds of micro-endemic frogs, skinks, and small mammals that possess zero contiguous upland habitat [1] .

* The Amazon River Delta: The vast, low-gradient alluvial floodplains of the Amazon delta support immense concentrations of riverine and coastal fauna. Because the gradient of the lower Amazon is exceptionally shallow -- often less than a few centimeters of elevation gain per kilometer -- even modest sea-level rise propagates saline tides hundreds of kilometers inland, transforming unique freshwater floodplain forests (várzea and igapó) into depauperate brackish estuaries [1] .

* Gulf of Mexico and Atlantic Coastal Plains: In North America, the low-lying coastal marshes of the Mississippi River delta, the Florida Everglades, and the Georgia Bight harbor critical populations of salt marsh sparrows, diamondback terrapins, and endangered beach mice, all severely constricted by hardened coastal development [1, 4] .

4. The Unprotected Refugia Deficit: A Failure of Static Protected Areas

Perhaps the most urgent finding of the study concerns the spatial mismatch between current global conservation reserves and the future movement corridors required for wildlife survival [1] . The researchers modeled potential climate-resilient refugia -- adjacent inland and upland parcels where suitable soil, canopy, and microclimatic conditions will persist, and where species could theoretically establish self-sustaining populations if allowed to migrate [1] .

Shockingly, the analysis revealed that more than 96% of the identified climate refugia currently lie outside existing protected area networks (IUCN Categories I through VI) [1, 2] . Most global conservation reserves were historically established based on static historical species distributions, often relegated to remote mountaintops or barren lands with low economic utility. In contrast, the inland zones directly adjacent to productive coastal plains are predominantly privately owned, intensively cultivated for agriculture, or targeted for residential development [1, 3] . Without targeted legal intervention, vertebrates attempting to flee coastal flooding will encounter hostile agricultural monocultures, highways, and suburban developments rather than protected natural habitat [1] .

5. Strategic Conservation Protocols for a Dynamic Shoreline

Jiang, Wilcove, and colleagues emphasize that halting vertebrate biodiversity collapse requires an immediate paradigm shift from static territorial protection to dynamic, forward-looking coastal zone management [1] :

* Securing Inland Retreat Corridors: Governments and conservation trusts must proactively acquire land easements, establish strategic conservation corridors, and rezone coastal agricultural belts directly inland of vulnerable habitats, creating dedicated "accommodation space" for natural landward migration [1, 3] .

* Rolling Easements and Managed Coastal Realignment: Implementing policy mechanisms such as rolling easements -- which prohibit the construction of permanent seawalls and mandate the removal of human structures as shorelines advance -- allows coastal wetlands and maritime ecotones to transgress inland rather than drowning against concrete barriers [1, 3, 4] .

* Assisted Colonization for Insular Endemics: For narrow-ranging island endemics where no contiguous upland terrain exists, traditional in-situ conservation is biologically impossible. Conservation biologists must develop preemptive captive-breeding and assisted-migration protocols to translocate viable founding populations to higher-elevation oceanic islands or secured mainland sanctuaries before their native habitats are permanently submerged [1] .

By quantifying the staggering scope of terrestrial biodiversity at risk from sea-level rise, the Science assessment delivers a definitive warning: climate-driven extinction is not a distant, abstract threat confined to polar bears on receding sea ice , but a looming crisis sweeping across every coastal plain, river delta, and island on Earth [1, 2] .

References & Primary Sources

* [1] Jiang, Z.-W., Xiao, H.-B., Hanson, J. O., Zeng, Y., Wilcove, D. S., Schuerch, M., Kirwan, M. L., Yan, Q.-F., Chen, Y., & Ma, L. (2026). Safeguarding global terrestrial vertebrate species from future sea-level rise. Science, 391(6784), aed5772. -- https://doi.org/10.1126/science.aed5772

* [2] Phys.org (2026). About 15,000 land vertebrate species could lose habitat to sea-level rise by 2100. -- https://phys.org/

* [3] Schuerch, M., Spencer, T., Temmerman, S., Kirwan, M. L., Wolff, C., Lincke, D., McOwen, C. J., Pickering, M. D., Reef, R., Vafeidis, A. T., Hinkel, J., Nicholls, R. J., & Brown, S. (2018). Future response of global coastal wetlands to sea-level rise. Nature, 561(7722), 231-234. -- https://doi.org/10.1038/s41586-018-0476-5

* [4] Kirwan, M. L. & Megonigal, J. P. (2013). Tidal wetland stability in the face of human impacts and sea-level rise. Nature, 504(7478), 53-60. -- https://doi.org/10.1038/nature12856