Beyond Reserves and Corridors: Policy Solutions to Facilitate the Movement of Plants and Animals in a Changing Climate

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As the Earth's climate changes, many species will have to move across human-dominated landscapes to track suitable climates and changing ecosystems. Given the magnitude of projected future climate change, expanding and connecting reserve networks—two of the most commonly recommended adaptation strategies for protecting biodiversity in a changing climate—will be necessary but insufficient for preventing climate-induced extinctions. In the present article, we explore additional policy options that could be implemented to facilitate species movements in a changing climate. We discuss both existing and new policies that have the potential to increase landscape permeability, protect species on the move, and physically move species to address climate change.

Keywords: climate change, adaptation, species movement, policy

As the Earth's climates changed in the past, many species moved vast distances, retreating to remote refugia and expanding across continents (Davis and Shaw 2001). Species have begun to move again in response to recent, human-induced climatic changes (Parmesan 2006). In comparison to the species of the past, it will be more difficult for today's species to track the climatic changes ahead. Today's climates are moving 27–45 feet per day (Loarie et al. 2009). These shifts, which surpass those at end of the last glacial period roughly 16,000 years ago, will probably outpace the mobility of many species. Furthermore, much of the surface of today's Earth is dominated by human-altered landscapes, and most remaining natural areas are fragmented and isolated (Vitousek et al. 1997, Hoekstra et al. 2005).

It may be possible to facilitate climate-driven range shifts by increasing the size, number, and connectivity of networks of protected lands (Hole et al. 2009). Additional protected lands can theoretically provide stepping stones and refuges for species moving across the landscape, and corridors potentially facilitate dispersal between protected areas. Although there is evidence that corridors can be designed to facilitate the movement of some species (Tewksbury et al. 2002), we know little about the ability of most species to use such features. Some attempts have been made to use projected shifts in species' ranges to design climate-proof reserve networks (Vos et al. 2008). Others have suggested using geophysical characteristics (topography, soils, and bedrock), rather than an understanding of species–climate relationships, to design protected-area networks that are robust to climate change (Anderson and Ferree 2010).

Although expanding protected-area networks will be a necessary response to protect many species from climate change, it will often be insufficient. Species with limited mobility—because of their physiology, behavior, or natural barriers (e.g., organisms in isolated wetlands or headwater streams)—may be unable to use these stepping stones. Expanding reserves and corridors will also be infeasible or very costly in many places. Complementary approaches to place-based protection will be required to facilitate the movement of these species. In the present article, we discuss potential policy approaches for enhancing species movements in the United States. We focus on policies that create permeable landscapes (lands and waterways), protect species, and physically move species. In some cases, it may be possible to use existing laws and policies to facilitate species movements. It will also be necessary, however, to develop new legal structures and policies, because virtually all laws and policies governing the use of natural resources in the United States were written without consideration of climate change.

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Because the outcomes of conservation measures are necessarily uncertain in a rapidly changing climate, policymakers will need to facilitate careful monitoring of outcomes and to create mechanisms to trigger appropriate adjustments in management. Managers will also need tools for identifying conservation strategies with multiple benefits for both human and natural communities—"no regrets" strategies that have payoffs regardless of whether assumptions about wildlife adaptation to climate change prove to be correct.

Creating permeable landscapes

Reserves and corridors will be able to cover only a relatively small portion of the landscape (Scott et al. 2001). Therefore, protecting biodiversity in a time of rapidly changing climate is likely to require the management of lands between the protected areas—the *matrix lands* (Franklin and Lindenmayer 2009). With relatively modest changes in management, some lands intensively used for resource extraction, agriculture, or residential or commercial development can be managed to increase their permeability for at least some species. Doing so will require a varying set of both "sticks" and "carrots" (Gunningham and Young 1997). The "sticks" are the regulations governing the use of land and water; these regulations will need to be updated to better address biodiversity needs. The "carrots" are the various forms of technical assistance and financial incentives that government can provide to private landowners, tribes, and others who control land and water.

Forest landscapes. Perhaps the best examples of matrix management are in forestry, where creative approaches to variable-retention harvests have provided habitat for some species in areas that would otherwise be expanses of inhospitable clearcuts and early successional forests (Kohm and Franklin 1997). There is evidence that some forest-dwelling small mammals and arthropods are more abundant in variable-retention harvest plots with higher densities of trees left standing (Aubry et al. 2009). Other forest-interior species avoid moving through open areas altogether (e.g., Sieving et al. 1996). Both federal and state regulations and financial incentives can be used to alter harvest practices to address these habitat needs. For example, the laws governing the management of federal timberlands require the land-managing agencies—the US Forest Service (USFS) and the Bureau of Land Management—to consider wildlife needs in planning timber harvests and other management actions. The National Forest Management Act goes further, requiring USFS land-management plans to "provide for the diversity of plant and animal communities" (16 U.S.C. § 1604(g)(3)(B)).

In July 2010, the USFS released the *National Roadmap for Responding to Climate Change*, which set forth a useful mechanism for ensuring that federal forests help facilitate species movement and otherwise conserve biological diversity. The roadmap calls on managers of individual national forest units to carry out science-based assessments of the relative vulnerability of all ecosystem components and their ability to adapt to climate change and then to use the assessments to select priority actions and to monitor the implementation of those actions. This framework ensures that managers have the information needed to evaluate the costs and benefits of alternative management scenarios. The framework, however, lacks clear policy direction, and it is therefore unclear how individual forest supervisors will choose among options or whether they are even obligated to manage for species movements. In particular, policy direction will be needed to help managers resolve conflicts between the needs of well-established species and those expected to arrive as a result of climate change.

Many of the federal conservation-incentive programs for state and private forest managers are focused on improving the capacity to support biodiversity. These could be updated to address the specific challenge of facilitating species movements. For example, under the 2008 Farm Bill, state forestry agencies are required, as a precondition for federal funding, to complete "statewide assessment and resource strategies" for state and private forest lands (16 U.S.C. § 2101a). Among the specified planning priorities are "enhancing… biological diversity,... wildlife, wildlife corridors, and wildlife habitat" (16 U.S.C. § 2101(c)(3)). According to USFS guidance, these assessments and strategies are expected to address how forests are to be managed to "adapt to global climate change." To increase the likelihood of on-the-ground-success, the USFS could invest in those states with the most robust strategies for facilitating species movement.

Agricultural landscapes. There are several ways to make agricultural lands more suitable for native flora and fauna. For example, multifunctional agricultural systems can provide crop production, wildlife habitat, and carbon storage through a combination of intensively farmed land and more native or restored environments (Boody et al. 2005). The US Conservation Reserve Program (CRP)—the country's largest private-lands environmental improvement program—provides financial incentives for erosion protection, water quality improvements, and wildlife habitat restoration across 34 million acres. Roughly $1.8 billion per year is used to pay farmers to return a portion of their lands to more natural vegetation. Not surprisingly, CRP lands have been shown to harbor higher abundances of birds and bird nests than agricultural fields (Best et al. 1997). These lands may also facilitate the movement of plants and animals among other, more natural areas. Ironically, however, the CRP demonstrates the fundamental problem with current US agricultural policy: It is predicated on the implicit proposition that cropland not explicitly set aside for conservation cannot be expected to protect natural resources or to provide nonagricultural ecosystem services (Angelo 2010). This premise is buttressed by the nearly complete exclusion of agriculture from federal environmental laws (Ruhl 2000).

Given the political power of industrial agriculture, fundamental changes are likely to come only slowly, at best.

Small changes, however, might have significant effects on landscape permeability to movement. For example, prior to the Nixon administration, the Department of Agriculture had recommended agricultural best practices that included maintenance of semiwild field borders, such as windbreaks, shelter belts, and filter strips (Eubanks 2009). Reestablishment of such soft borders would improve the permeability of agricultural landscapes for wildlife. In addition, there is some evidence that more sustainable and biodiversity-friendly agricultural practices can increase farm incomes and support wildlife (Boody et al. 2005). This suggests that technical assistance combined with financial incentives to spur transition to agroecological landscapes may be an effective policy.

Another crucial step will be to ensure that bioenergy policies do not reverse the gains that are being made toward wildlife-friendly practices on agricultural lands. The Energy Independence and Security Act of 2007 mandated an aggressive increase in renewable fuels production, totaling 36 billion gallons by 2022. Meanwhile, renewable electricity standards mandating that a substantial percentage of electricity be produced from renewable sources, including biomass, have been enacted in 25 states and are currently under consideration in Congress. Over time, these policies will produce substantial income for agribusiness, with dollar amounts likely to far exceed those from wildlife-oriented programs delivered through traditional Farm Bill programs. State and federal governments could increase the permeability of agricultural landscapes and help facilitate wildlife movement by requiring best practices for the siting and harvest of bioenergy feedstocks.

Coastal and freshwater landscapes. Freshwater organisms will face considerable challenges when attempting to move latitudinally or along elevational gradients in response to climate change (Olden et al. 2011). In addition to natural obstacles to movement, population responses will be greatly inhibited by the millions of dams, diversions, and impassable road culverts (Nilsson et al. 2005) that disrupt the passage or dispersal of individuals. Climate-induced changes to water availability and increasing human demand for water are likely to prompt the construction of new reservoirs, thus causing greater fragmentation in the future. Furthermore, as sea levels rise, coastal estuary ecosystems and their associated species will need to move inland, a move that will often be limited by coastal roads and other development (Julius et al. 2008).

These problems are unfortunately exacerbated by flood insurance and disaster programs that currently offer subsidies for residential and commercial developers to build and rebuild in areas at risk from storms and floods—risks that will increase as sea levels rise and storms and floods intensify. These incentives thus foster the very type of development that reduces connectivity in coastal and riverine systems. Connectivity could be restored, while both protecting people and property and saving money for taxpayers, by reforming these programs to better account for environmental change. These programs could be updated to discourage development in hazard areas, to provide funding for voluntary relocation of at-risk communities, and to map risks to people and property on the basis of the latest climate change science. By instituting such reforms, Congress, the US Federal Emergency Management Agency, and state and local floodplain managers would enable coastal and riverine habitats to perform their natural functions, which include not only flood protection and groundwater storage but also the facilitation of movement of plants and animals across the landscape.

Laws governing reservoirs, dams, and other water infrastructure are likewise in need of reform to facilitate species movement. State and federal water reservoirs and dams are operated according to project-specific rules that are currently based on historical data on mountain snowpack and the timing and intensity of flood events. Similarly, below these reservoirs and dams, levees continue to be built and waterways continue to be channelized, despite the intensification of storms and floods that accompanies climate change. This increases the risk of floods to property and lives, while depriving communities of the groundwater infiltration that natural floodplains provide. The US Army Corps of Engineers and other managers of water infrastructure have an opportunity to facilitate species movement through riparian systems and to achieve numerous other environmental gains by updating the rules governing water projects to account for climatic and other environmental changes. Water infrastructure managers also have an opportunity to consider whether the restoration of natural floodplains would be a more effective strategy for conserving water for human uses than building new dams and reservoirs.

In recent decades, new water laws and programs have helped to improve habitat connectivity by removing or modifying human barriers to movement in riverine systems. Increasingly, small dams and diversions are being removed for ecological, social, and economic reasons, including the restoration of hydrologic regimes and the enhancement of longitudinal connectivity for fish movement. Similarly, barriers such as impassable culverts under roadways are being modified to allow for easier movement of fishes among complementary habitats to enhance population persistence (Roni et al. 2008). A robust program of dam and diversion removal and culvert modification (e.g., expansion of the US Fish and Wildlife Service's National Fish Passage Program) could build on these successful models to help ensure aquatic habitat connectivity across the country. The challenge will be to take such actions at large enough scales to make a difference.

In all of these federal activities, the National Environmental Policy Act (NEPA) will be a crucial tool for ensuring that relevant information is collected and a reasonable range of alternatives for mitigating and adapting to climate change is considered. Policymakers should issue guidance to ensure that species movement and other key climate change considerations are fully integrated into the NEPA process.

Energy generation and transmission laws. Wind, solar, and other renewable energy projects will be valuable tools for reducing carbon pollution and mitigating climate change. Without efforts to slow climate change, policies to facilitate species movements are very likely to fail. Nonetheless, the generation of energy from these sources (as well as from fossil fuel–based and nuclear sources) has the potential to significantly affect species movements. For example, wind turbines are known to have negative impacts on bats and birds (Erickson et al. 2001, Kunz et al. 2007). Reducing the impact of wind turbines on bird and bat populations will require that detailed information about species and habitats be obtained and addressed before siting decisions are made. It may also be necessary to regulate the size, speed, and timing of wind turbines.

The current legal framework for the siting and operation of new energy projects does not ensure that species movement is considered. This is a particularly opportune time to craft biodiversity-friendly design and siting guidelines for renewable energy because many of these projects are in their technological infancy and are seeking public subsidies or the use of public lands. In particular, concentrated solar energy developers are currently focusing on public lands on which to site their projects because such energy requires substantial land areas and private lands are highly fragmented. Public lands policy will need to be updated to ensure that the best scientific data on the value of land for habitat and species movement is gathered and energy projects are steered away from biologically important areas.

Laws governing energy transmission will also need updating to address species movement, especially considering the greater need for long-distance transmission that renewable energy engenders and the significant projected wildlife impacts of such transmission. Birds, in particular, are negatively affected by power lines to a degree that may be far greater than the harm inflicted by wind turbines (Erickson et al. 2001). Historically, transmission construction and siting decisions were made primarily by state public-utility commissions, often with only minimal consideration of environmental impacts. Although this largely remains true today, the situation is changing because of the geographic scale and interstate nature of energy transmission. In the Energy Policy Act of 2005, Congress directed the Department of Energy to assess the status of electricity transmission and gave the Federal Energy Regulatory Commission the authority to license transmission lines in some circumstances (16 U.S.C. § 1824). In addition, when transmission lines cross federal lands, federal natural resource agencies must grant rights of way. Each of these authorities could be updated to ensure that these agencies minimize fragmentation and maximize opportunities for species movement. Again, NEPA can play a crucial role in ensuring that all relevant alternatives are evaluated.

Laws governing residential and commercial development. Some of the most biologically diverse landscapes in the United States are those in and around population centers. As suburban and exurban development increasingly alters habitats by subdividing large parcels, new policies are needed to ensure that there is room for species movement. Strategies for building "green infrastructure" into state and local land-use decisions are well documented (Beatley 2000, Ewing et al. 2005). For example, by restricting residential development to targeted locations and by clustering buildings, New Jersey has integrated human settlements into its pine barrens without destroying their significant habitat values (N.J. Stat. Ann. §§ 13:18A-1 to -29). Such state and local laws may also need to be updated to add provisions focused on species movement. For example, policymakers could provide incentives to developers and residents to use plants that provide cover for wildlife, to remove barbwire fences, or to install lights that avoid harming birds and turtles.

Surface transportation laws. One of the most significant barriers to species movement is the four million miles of roadways that cover the United States. Roads hinder movement of many plants and animals (Forman et al. 2003) and cause further fragmentation of the landscape by enabling additional development. As are the energy and water infrastructure discussed above, transportation infrastructure is likely to undergo significant changes in the coming decade as the nation is forced to grapple with climate change. Whether installing high-speed rail to reduce the nation's automobile traffic and carbon footprint or relocating a coastal highway because of sea-level rise, departments of transportation will have the opportunity to install wildlife over- and underpasses and to take other biodiversity-friendly approaches. Integration of species movement and other key climate change issues into the NEPA process and to transportation design in general will allow decisionmakers to fully address the wildlife impacts of the transportation options under consideration.

Section 6001 of the federal surface transportation law will also serve as an important tool for ensuring that transportation decisions adequately address species movement. Added to the law in 2005, section 6001 requires that transportation planners consult with natural resource agencies to consider the impacts of their proposals on conservation plans and natural resource inventories and evaluate options with the greatest potential to restore and maintain ecological function. Conservation practitioners and managers have an enormous opportunity to inform decisionmakers on ways to protect and restore lands and waters needed for species movement by using and strengthening these procedures.

Beyond permeable landscapes

Policies that promote the creation of a more permeable matrix will be insufficient by themselves, both because many species will be unable to move through unprotected lands and because the scale of the changes will outpace many species' ability to move. Two broad and potentially overlapping categories of management action are available to assist these species.

Directly protecting species and habitats. In addition to altering the landscape to facilitate movement, it may be necessary to protect the species themselves to allow them to move through or persist in more intensely managed landscapes. This might be achieved by enacting and enforcing regulations that prevent the direct and indirect killing of such species. Such regulations would be targeted at very specific sets of species in very specific areas. Species with the most limited ability to move through the current landscape or with the greatest need to move in response to climate change would be designated for protection. Among the targeted species would be those with limited dispersal abilities, low reproductive rates, specific habitat requirements, and limited distributions.

Another approach would be to focus regulatory protections on key zones through which targeted species are likely to need to move in the near term. These zones could be established by simply identifying areas surrounding the species' current distribution (i.e., creating a buffer around its current distribution). Alternatively, more sophisticated methods could be used to identify areas that are likely to be climatically suitable for the species in the future (Phillips et al. 2008).

Each of these protection strategies can be implemented without new legislation, simply by using the authorities of the Endangered Species Act (ESA), supplemented with incentive payments to private landowners for actions (such as the protection of plants) that the act does not require. Although the ESA was not written with the purpose of mitigating the effects of future climate change, its approach is to address all threats to the survival and recovery of listed species, regardless of their origin. Moreover, the law is sufficiently flexible to allow take-prohibition rules to be designed to address the unique contexts of individual species and ecosystems and to allow designation and protection of critical habitats outside of historic species ranges (Kostyack and Rohlf 2010). There are practical limitations on how many species can receive such individualized attention, however, given the ever-growing number of at-risk species and the limited resources available for regulatory action and financial assistance to landowners.

Another possible approach to species protection is to increase the size of existing reserves or to create new reserves using land acquisitions (fee title or conservation easements) or management agreements or both. Such acquisitions and agreements would ideally capture a large portion of the geographical, ecological, and geophysical range of the species, thus increasing opportunities for organisms to adapt and evolve to changing environmental conditions. Several programs have emerged in recent years that use landscape-scale planning to improve the efficacy of reserve networks. One example is the State Wildlife Grants program, in which the federal government provides financial resources for states to develop and implement comprehensive wildlife conservation strategies focused on species that the states deem to be of greatest conservation concern. Over half of the states used this grant funding to develop spatially explicit maps of important habitats—maps that have guided the investments of both public and private land conservation organizations. Recently, states have begun updating their wildlife conservation strategies to take climate change impacts into account. This update process provides an opportunity to identify and address conflicts with human economic activity as species move across the landscape in response to climate change.

Assisted colonization. There will be species for which more permeable landscapes, restricted take regulations, landowner incentives programs, and protected areas will be insufficient. The rapidity of projected climate change may exceed the ability of some species to disperse, even through relatively hospitable environments (Parmesan 2006). The preservation of these species may require more active assisted colonization (also called *managed relocation*)—moving individuals or populations from currently occupied areas to locations where the probability of future persistence is likely to be higher (Richardson et al. 2009). Although some hail assisted colonization as pragmatic and forward thinking, there is good reason to be skeptical of its viability as a broad-based conservation strategy (Ricciardi and Simberloff 2009). Regardless, the risk of extinction as a result of climate change is too large to permit managers to entirely dismiss the use of assisted colonization as a possible conservation approach (Lawler and Olden 2011).

Although human society has a long history of intentionally introducing species to meet human demands for recreational fish and game, food, pest control (Elton 1958), and for conservation purposes in wildlife management (Seddon et al. 2007), making decisions on translocations today is complicated by the large volume of at-risk species awaiting conservation attention and by the absence of any single legal framework for evaluating whether and how to translocate (Joly and Fuller 2009).

The experimental populations provisions of ESA section 10(j) (16 U.S.C. § 1539(j)) provide a useful framework for transplanting endangered populations in new habitats (Shirey and Lamberti 2010). These provisions significantly relax the ESA's regulatory requirements and are likely to be especially useful where assisted colonization would encounter political resistance from landowners and others concerned about new ESA obligations.

Other provisions of the ESA can also facilitate assisted colonization. Section 4(f) of the act calls for federal wildlife agencies to implement plans (known as *recovery plans*) for the conservation of listed species (16 U.S.C. § 1533(f)). *Conservation*, in turn, is defined as "all activities" useful in restoring a species to the point where the ESA is no longer needed, including transplantation of populations (16 U.S.C. §1532(3)). Although this authority (like that defined in section 10(j)) applies only to species that have been listed as *endangered* or *threatened*, it gives the wildlife agencies broad discretion to carry out assisted colonizations outside a species' historic range.

The agencies could use their ESA authority to specify the criteria that they must employ in deciding whether to move forward with assisted colonizations for listed species. Current regulations, which prohibit such colonizations "absent a finding... in the extreme case that the primary habitat of the species has been unsuitably and irreversibly altered or destroyed" (50 C.F.R. §17.81(a)), may need to be reconsidered in light of the latest information on how climate change can render a historic range unsuitable.

Possible criteria for deciding whether to move a species outside its historical range might include the taxonomic uniqueness of the species, the species' economic or cultural significance, whether nonclimate stressors have been reduced or eliminated, whether translocation into unoccupied parts of historical range would achieve the desired results, whether barriers to dispersal can be eliminated or reduced, and whether protected areas for the species are sufficient to provide an opportunity for it to adapt and evolve (Richardson et al. 2009). Management actions that facilitate the species' movement or that enable it to adapt or evolve would receive priority consideration over any decision to move it outside its historic range. Before moving the species, managers would be required to thoroughly evaluate possible effects of assisted colonization on species in the proposed introduction area. Each effort would be treated as a carefully controlled experiment.

New regulations governing actors other than federal wildlife agencies are also needed, especially for threatened and endangered plants, which are not governed by the strict take prohibition that governs listed animals (Shirey and Lamberti 2010). At least one assisted colonization project has already been launched without any coordination with wildlife agencies because of the apparent absence of a regulatory structure. In the mid-1990s, a group of citizens called the Torreya Guardians began moving seedlings of the endangered Florida torreya (*Torreya taxifolia*), a conifer tree native only to a 65-kilometer length of the Apalachicola River, to North Carolina and points northward. To date, no federal regulations or guidelines have been written to address such private efforts, and very few state laws govern the translocation of plants (New Mexico Center for Wildlife Law and Defenders of Wildlife 1996).

A comprehensive approach to safeguarding biodiversity in a warming world

The policy changes discussed above could be accomplished by amending relevant statutes, regulations, and agency guidance in a piecemeal and haphazard fashion. These changes are, however, only examples of the wide array of adjustments to federal, state, and local law that must be made to address climate change. Some process for identifying and prioritizing policy changes must be launched to ensure that the most urgent and important actions to facilitate species movement and achieve other policy goals are taken first. The fish and wildlife adaptation strategy development process currently led by the US Department of the Interior and the National Oceanic and Atmospheric Administration, and similar processes underway at the state level, should serve as the vehicles for setting that priority.

Launched in response to a directive in the 2009 Department of the Interior appropriations bill, the federal effort is focused on designing a national strategy to assist fish, wildlife, and plants in surviving climate change. With the effort still in its infancy, federal officials have yet to decide what issues they will tackle and how they will tackle them. One important step will be to identify the revisions in federal natural resource laws, regulations, and agency guidance that will probably be necessary and then to prioritize those changes. Some of these revisions will address species movements. Similar approaches should be employed by federal, state, tribal, and private groups engaged in their own natural resource adaptation planning activities. All of these efforts would benefit from input from federal, state, and tribal agencies, conservation nongovernmental organizations, academic experts, and private industry.

In addition to the efforts to address natural resources, many adaptation-planning efforts focused on protecting human communities are also underway. It will be critical that adaptation strategies for human and natural systems be integrated. For example, as climate change alters water availability, proposed adaptation strategies for agriculture (e.g., increased water diversions, new reservoirs) may be inconsistent with the preferred adaptation strategies to facilitate aquatic species' movements. It will be crucial to integrate these planning efforts to ensure that, when possible, win–win solutions are found.

Of course, no adaptation strategy will complete the daunting task of rescuing biodiversity threatened by climate change unless funding is available to pay for its implementation. Climate change legislation approved by the House of Representatives and the Senate Committee on Environment and Public Works in 2009 provided a useful model of how this could be accomplished. Both bills (H.R. 2454 and S. 1733) called for a comprehensive natural resources adaptation strategy to be funded from the proceeds of the sale of permits to carbon emitters. This approach ensures that polluters cover a substantial part of the cost of the damages that carbon pollution causes to the environment while simultaneously creating financial incentives to reduce that pollution.

In conclusion, to facilitate species' range shifts and therefore the maintenance and establishment of functioning ecosystems in a changing climate, it will be necessary to create policies that promote permeable landscapes, protect the species that need to move the most, and regulate and facilitate assisted colonization when it is deemed necessary. Perhaps most important, policies to enable species movements will need to be woven into policies that address human adaptation to climate change. If they do not simultaneously address the needs of both human and natural systems, these policies are likely to protect neither.

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