



Complex, interacting issues shape landscape-scale mitigation policy needs

Compensatory mitigation is a key strategy used to balance competing mission requirements of protecting and developing resources for the Department of the Interior and elsewhere. While mitigation is driven on an action-by-action basis, the harms to resources and the offsets of those harms occur within complex landscapes of varying sizes, with landscape-scale implications. A review of relevant science and policy research resulted in identifying 21 main topics of relevance to landscape-scale mitigation (LSM) policy in four domains. **Natural processes** such as landscape connectivity and dynamic outcomes are key constraints. Environmental justice and varying social norms have **socio-ecological implications** of LSM. Landscape-level **economic considerations** such as market dynamics may shape LSM policy. And key mitigation **management or policy options** such as forms of mitigation and translocations span scales. Crafting and implementing policies that address this suite of issues is expected to maximize the effectiveness of LSM and improve outcomes as required by the Department’s complex mission.

The Department of the Interior and its bureaus and offices have statutory, regulatory, and policy obligations to protect and manage the Nation’s natural and cultural resources. These diverse requirements can lead to conflicts in how to carry out our mission. For example, various laws require protecting species, habitats, and archaeological resources. At the same time, there are requirements to carry out or permit actions like energy development, mineral production, or other uses that may harm those resources requiring protection. How we resolve such competing interests has shifted over time; today, one key concept for balancing competing requirements is mitigating the effects of our actions. Given competing needs for actions in a particular place—conserving a resource vs. developing a resource for human use—the preferred order of mitigation is to (1) avoid harms to the protected

resource; (2) minimize harms to the protected resource; then (3) allow harm to the protected resource but offset or compensate for the effects of the harm. This is the well-known *mitigation hierarchy*, typically summarized as “avoid-minimize-compensate,” which is foundational in mitigation science, policy, and actions.

Considerable attention has been paid to the science and practice of compensatory mitigation at local scales, in part because of its roots in (local) wetland mitigation. Less attention has been paid to (a) how individual compensatory mitigation actions affect or are affected by landscape-level dynamics or (b) how large infrastructure projects—especially linear features like roads and transmission lines¹²—affect landscapes and can be mitigated. A recent review summarized the issues in four major domains (Table 1).

Table 1. Twenty-one key landscape-scale mitigation topics organized in four domains.

Domain	Topic	Domain	Topic
Natural processes	Landscape ecology	Economics	Regulatory predictability
	Connectivity and corridors		Price (in)elasticity
	Metapopulations, etc.		Equivalency Analysis (EA)
	Heterogeneity		Landscape EA
	Timing of mitigation		Timing and investment
	Dynamic outcomes and adaptation		Effects on broader economy
Socio-ecological	Environmental justice	Mgmt. & Policy	Action coordination
	Resource “migration” through mitigation		Core mitigation concepts at landscape scale
	Cultural resource impacts		Mitigation translocation
	Sociopolitical dynamics		Jurisdictional fragmentation
			Mitigation approaches (e.g., banks)

Natural processes shape and constrain how landscape-scale mitigation (LSM) plays out. For example, the patchiness of resources and connectivity among patches are both essential features that must be considered beyond the site of a single action or offset. Notably, some concepts only apply at landscape scales; there is no “local” analog. These include landscape heterogeneity; complex dynamics that emerge at scale; and the ability to ensure representation, resilience, and redundancy of resources. Timing of mitigation in the context of the landscape is critical: it may be decades before ecosystem services are fully restored at sites for offsets. Finally, while use of “reference” conditions for determining desired outcomes can be helpful, ensuring dynamic outcomes for adaptive capacity and resilience will be particularly important for policy in the face of climate and other environmental change.

Carrying out mitigation for natural and cultural resources has important **socio-ecological implications**. For example, when a harm (e.g., draining a wetland) takes place in one area, the offset often takes place in another. While the “migration” of the resource and its services for a single action may have very small effects, systematic patterns may emerge at landscape scale. For example, wetland mitigation has shown clear socioeconomic and racial biases and environmental injustices. Another complexity is the role of mitigation with cultural resources. Policies can prioritize supporting environmental justice and considering the full landscape of cultural resources and potential impacts to them, rather than a local and myopic view.

Economic considerations are a significant factor driving policy- and decision-making for mitigation at multiple scales. The economic value of harmed resources is a regular part of quantifying restoration needs and any related penalties, often facilitated through Equivalency Analysis (EA). Recent developments in Landscape EA mean that the landscape-scale value of specific sites can be more readily quantified. Research on mitigation bank supply and demand suggest that credit prices are relatively inelastic and therefore not very sensitive or amenable to policy adjustments. Timing of mitigation has an economic nexus at the landscape scale, in particular with opportunities to pool and invest compensation funds to undertake larger, future offset actions. Last, it is worth noting that mitigation is part of a larger economic landscape of communities, and therefore can have direct or indirect impacts, such as on tourism.

There are several key **management and policy options** related to LSM. One of the most important is the need for landscape-level coordination not just for mitigation actions, but among other forms of restoration and conservation. Core “local mitigation” concepts, like durability of offsets, additionality, and adaptive management, have clear LSM analogs that policies should address. Some management and policy topics are only relevant at landscape scale, like the role of mitigation translocations (that is, moving resources to new locations in a landscape) and jurisdictional fragmentation. Marine and nearshore environments have tended to see less LSM attention, but require consideration, especially when available evidence suggests caution. Last, three key mitigation approaches—in-lieu fee, mitigation banking, and permittee-responsible mitigation—have risks associated with spatially consolidating offsets that policies can address and ameliorate.

In addition to each of the detailed topics of the four domains describe above, a **crosscutting theme of the need for coordination for LSM** emerged from the literature and from practitioners. Additional investment—or a coordinated alignment of current investments—would facilitate coordination across multiple scales and ensure the “dots are connected.” The investments could be in technological or social infrastructure. For example, the forthcoming *Conservation and Restoration Atlas* is a promising technological solution that may provide a national-level view of mitigation, restoration, area-based conservation, and other conservation actions to facilitate landscape-level coordination. A complementary option may be to convene workshops to catalog the many landscape-level resource management efforts that are spread across the US and then link them in a central hub or federated resource. Notably, this will mean multi-scale scoping since the focus of such efforts depends on the resources, from small watershed-based scope to regional efforts such as migratory bird flyways. Policy guidance to support this coordination and to address core issues in LSM will result in better outcomes in all the Department’s mission areas.

For more details: Malcom, Boone, Richardson, Miller, and Lee. 2024. Complex, interacting issues shape landscape-scale mitigation policy needs. PPA Report R-2024-01. Available from <https://doi.gov/ppa>