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Introduction

The laws that govern the location and management of national parks, wildlife refuges, and other federal land preserves were designed to protect and "conserve" natural resources such as fish, wildlife, and other "natural objects" found in some of the nation's most highly treasured locations. It is clear, however, that the nature of conservation has changed substantially since Congress first enacted laws such as those from which the National Park Service and the U.S. Forest Service first derived their authority. Recent years have seen an increasing awareness that ecosystems depend on other systems and may be influenced by them from afar (Polis et al. 2004). Contemporary conservation strategies are often preoccupied with events outside protected areas, such as the maintenance of connectivity and the creation of buffer zones (McCook et al. 2009, Raatikainen et al. 2009). As the area of wild land outside protected areas declines, human-dominated ecosystems, such as farms, forestry plantations, and riparian zones, are becoming essential for the long-term sustainability of many animal and plant populations and communities, and entire ecosystems (Cumming and Spiesman 2006).

To add further complexity to the problem, the effects of climate change and other broad-scale anthropogenic influences (e.g., nitrogen deposition, introductions of invasive species) are anticipated to increase (MA 2005). These influences are expected to alter both the structure and functioning of natural systems, such that it will be impossible to keep them looking and functioning as they have in the past. As J.B. Ruhl has argued,

"environmental law is going to have to give up on the preservation strategy" that has sought for much of the last century to either protect nature as it exists in the parks and refuges from human-caused impairment, or to restore conditions as they existed during some historical baseline reference point (Ruhl 2010). Instead, there is broad consensus that resource management, and the laws that govern it, should shift toward protecting or restoring ecosystem resilience, including external influences and connections that are important for system persistence (although that consensus disappears if managing for resilience is interpreted as striving to maintain systems in a relatively static condition in the face of disturbances; Doremus 2010).

Given that management for resilience appears set to become a new paradigm for the role of protected areas in conservation (Walker et al. 2002), it is important to define what management for resilience means and to determine how best to implement such a management strategy. The starting point for definitions of resilience in this context is the notion of a social-ecological system: a fully integrated system of people and nature that behaves differently from either a social system or an ecosystem alone (Westley et al. 2002). Recognition of the social-ecological nature of conservation (conservation is done by people, for people; without people, there would be no need for conservation) represents a significant shift away from earlier notions of people as somehow independent of ecosystems and/or in a detached external role as 'manager' (Cundill et al. 2012).

Carpenter et al. (2001) provide a comprehensive definition of the resilience of a social-ecological system as (1) the amount of disturbance that a system can absorb while still remaining within the same state or domain of attraction; (2) the degree to which the

system is capable of self-organization (versus lack of organization or organization forced by external factors); and (3) the degree to which the system can build and increase its capacity for learning and adaptation. Resilience can also be thought of as the ability of a system to maintain its identity (Cumming and Collier 2005). Thus, the resilience of biodiversity in a protected area encompasses not only the ecosystem's ability to respond to physical changes, but also its ability to continue to function despite failed management or regulatory actions (Angelo 2009) and the ability of the social elements of the system to withstand political and economic pressures (for instance, a demand to open a park to drilling for oil).

Despite their acknowledged weaknesses, such as their potential to negatively impact the resource access rights of marginalized human communities, the creation and maintenance of protected areas remains one of the most important and widely applied strategies for biodiversity conservation. If the primary goal of protected areas is to conserve critical elements of biodiversity for the future, while continuing to provide ecosystem services to contemporary human communities (Bengtsson et al. 2003), then it is important that protected areas are made resilient (as far as possible) to whatever the future may bring. Analysis of the social-ecological resilience of protected areas from a legal perspective thus focuses on the questions of (1) what kinds of protected areas are best suited to protecting the resilience of natural systems; and (2) whether adequate legal structures exist to allow for the creation and management of such areas.

In the rest of this chapter, we first explain why the development of policy and management strategies at broad scales is critical for the existence of resilient social-ecological systems. We then summarize the legal regimes under which the agencies

responsible for managing the national parks, wildlife refuges, and similar land designation categories in the United States operate. We also explore the challenges and opportunities those regimes present for effective broad-scale management of protected areas, focusing on national parks and wildlife refuges as examples. We conclude that existing laws governing the national parks and wildlife refuges provide considerable flexibility for agencies to anticipate and react to climate change and other disruptions of natural systems through landscape-level management mechanisms, and that the responsible agencies have begun to exercise their discretion in ways consistent with the promotion of ecosystem resilience. At the same time, the laws governing management of the parks and refuges were largely enacted to fit a different conception of scientific reality than the one that now exists, and entrenched policies adopted under those laws may no longer fit that reality. As a result, there is an increasing mismatch between legal mandates and protected area resilience. Both statutory and administrative changes are needed if national parks and wildlife refuges are to maintain social-ecological resilience.

Broad-scale Planning and Management Strategies for Protected Areas

Resilience is an emergent, whole-system property that arises from the interactions between different system components and their environment (Levin 2005). The focal scale of analysis that is adopted in addressing any scientific problem is dictated by the phenomena that are under study. Explanations for phenomena usually come from patterns and processes at lower hierarchical levels than the focal scale (e.g., the outcome of an election depends on the behaviours of individual voters); and patterns and processes at higher hierarchical levels impose constraints on outcomes at the focal scale (e.g.,, state

laws are subordinate to federal laws and the national constitution) (Allen and Starr 1982). To understand the resilience of protected areas therefore requires a multi-scale, hierarchical approach that considers both the broader constraints on protected areas and the finer-scale mechanisms that drive their emergent dynamics.

Current approaches to the design of conservation networks emphasize the need to conserve representative examples of ecosystems and ecological communities within a given area, as well as focal or 'target' populations and species (e.g., valuable, rare, charismatic, endemic, and/or endangered species and populations (e.g., Margules and Pressey 2000, Lindenmayer et al. 2002, Baskett et al. 2007, Diniz et al. 2008)). Multi-scale conservation planning efforts in the U.S., such as The Nature Conservancy's 'Conservation by Design' framework (TNC 2003), begin at a national level with coarse ecoregions and then zoom in hierarchically to finer grains of analysis and increasingly smaller extents (Poiani et al. 2000). Although 'Conservation by Design' deliberately considers a set of species that use the landscape at different scales, it does not directly incorporate a scale-based awareness of the accompanying human elements of the problem (and their feedbacks and interactions with ecosystems) and pays little attention to institutions.

As part of broad-scale conservation planning initiatives, a range of quantitative approaches (e.g., Marxan and C-Plan (Pressey et al. 1996, Ball and Possingham 2000, Possingham et al. 2000)) have been developed to facilitate the objective selection of new areas to prioritize for addition to existing reserve networks. While such approaches can be extremely useful in phrasing the problem and aiding decision makers, the outcomes are strongly dependent on the spatial data sets (e.g., breeding bird survey data, national

land cover maps, and digital elevation models) that are used as inputs to the reserve selection algorithms (Geselbracht et al. 2009). Most conservation-related data sets are static, in the sense that they consist of aggregations of data that often come from multiple years of field observations or one-off mapping exercises. While reserve selection approaches are spatially extensive, therefore, they often lack temporal depth and detail. This in turn means that they have little to say about the resilience of the broader landscape and can easily be derailed by the emergent dynamics that result from interactions between different landscape constituents (particularly, people and ecosystems). For example, the expansion of a reserve network may increase local land prices, making the plan harder to implement; fire management to maintain critical habitats on small land parcels may become increasingly difficult as a landscape becomes increasingly populated; and unanticipated changes in resource use (e.g., increased water extraction or greater demand for timber) can modify conservation priorities. Although spatially explicit conservation planning in its current form captures many important elements of the problem of reserve design for resilience, it does not provide a rigorous approach to designing reserve networks for resilience (e.g., see the example presented by Leroux et al. 2007).

In a changing world, the traditional approach to the creation and management of parks, refuges, and reserves (i.e., to treat them as static and discrete entities that should remain essentially the same with reference to a historical state) is clearly inadequate. As argued by Camacho (2010, p. 221), 'Reserves – the fundamental strategy of conventional natural resources management – embody this model of ecology that emphasizes stasis and natural stability'.' Climate change, for example, is likely to fundamentally alter - and

in some cases destroy (as in the Arctic) - existing ecological systems (Craig 2010). If reserve networks are to persist, they must be built with system resilience to future perturbations in general and climate change in particular in mind. This in turn means understanding the nature of broad-scale threats and developing approaches to maintain system attributes, at multiple scales, that have been demonstrated to lead to greater resilience in other contexts.

At local scales, system attributes that influence resilience include (amongst other things) key components (organisms, actors, soils, infrastructure, etc.), interactions, and feedbacks; diversity, in both the social and the ecological systems; and system elements that contribute to system continuity and memory (Cumming et al. 2005). The resilience of a given reserve will be influenced by a number of spatial attributes too, including, for example, its morphology (e.g., reserve size and shape, including perimeter to area ratio), the nature of its boundaries (e.g., hard or soft, permeable or not, by both people [e.g., poachers] and organisms [e.g., cattle, dispersing wild ungulates]), the arrangement of its parts (e.g., location of catchments and water resources, position along an elevational gradient) and its proximity to sources of propagules and perturbations (Cumming 2011a, b). At a regional scale, the spatial properties of the reserve network that are most relevant to resilience include not only their connectivity to one another and to other ecological sources and sinks, but also their socioeconomic context, the degree to which they are influenced by spatial feedbacks and subsidies (spatial feedbacks occur when A influences B and B influences A, and A and B are in different locations, as with rural supply and urban demand), and regional perturbations and drivers such as the economics of resource-

related supply and demand, pest outbreaks, and extreme weather events (Cumming 2011a).

Not all problems will require management at regional scales (Cosens 2011). Species losses in the national parks in the United States have, however, often resulted from the unavailability of sufficient lands to provide habitat and meet other species needs (Keiter 2010, p. 92). For example, species such as the Florida panther require large areas for dispersal, both to escape parental territories and find mates. Because it is often impossible to exclude large disturbances from small protected areas, mosaics of intensively managed landscapes interspersed with smaller 'pristine' reserves often lack resilience. Even the larger national parks are not isolated entities, or islands, that are somehow separate from the larger world (Keiter 2010, p. 91).

These considerations, taken together, imply that there is a need for a system of nature protection that better matches the dynamism and the multi-scale nature of the real world. In essence, this means creating institutions that will facilitate the existence of 'dynamic reserves' with different zones that may be exploited in different ways at different times (Carpenter and Brock 2004). For example, sections of a river may be closed to fishing during the fish breeding season; timber extraction may be restricted to periods of the year when it has lower impacts on breeding or migratory birds; and a no-tolerance zone for campfires may be extended during particularly dry times of year. Such regulations may be applied at different scales (e.g., local, district, or region) depending on the spatial and temporal scales of the process that is being managed. Dynamic reserves will need to extend beyond the parameters of current publicly owned protected areas, such as national parks and wildlife refuges, and hence will affect lands owned by states and private individuals. The multiplicity of tenure regimes occurring in the vicinity of protected areas will present significant management challenges, if, for example, private owners favor development that governments managing nearby reserves believe will cause detrimental spillover effects (Berkes et al. 2006). In particular, effective management of these extended reserves will require appropriate incentive structures, such as payments to private landowners who grant conservation easements or otherwise agree not to develop, for the coordination of a diversity of stakeholders (Bengtsson et al. 2003).

Agency Management Authority

As Alejandro Camacho has recognized, the existing legal framework for management by federal agencies of public land systems such as parks and wildlife

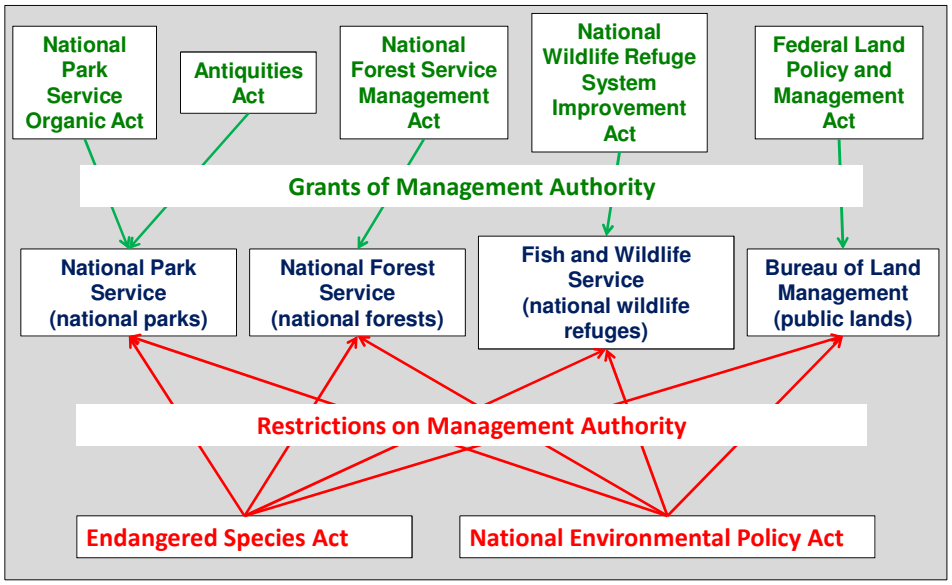
refuges 'was not designed to facilitate a wide-scale ecosystem-based or landscape-based approach that blurs the distinctions between legally separate public lands. . . . [F]requent, wide-scale, and synchronized interaction between agencies was simply not contemplated by existing natural resource management laws, so that coordinated ecosystem-based management is still the exception in natural resource governance.' (Camacho 2010, p. 208). Figure 1 illustrates the allocation of authority among the federal land management agencies, as well as the source of some statutory restrictions on that authority or on private activity on lands managed by those agencies. A key question is whether, despite the absence of such an ecosystem-based focus, agencies such as the National Park Service (NPS) and the United States Fish and Wildlife Service (FWS) can nevertheless manage the resources over which they have jurisdiction, in combination with lands owned or managed by other public and private entities, in ways that enhance the resilience of parks, refuges, and preserves in the face of the unprecedented disruptions that are expected to result from climate change and the continued encroachments caused by development.

The more than 500 million acres of land owned by the federal government is divided into multiple systems administered by different federal agencies. Some of these systems, such as the National Park System, the National Wildlife Refuge System, and the National Wilderness Preservation System, are 'dominant use' systems that are devoted to a limited number of uses that include recreation, wildlife protection, and resource preservation. The NPS administers the 80 million acres of national parks and national monuments under the National Park Service Organic Act. That Act declares the purpose of these areas to be to conserve 'the scenery and the natural and historic objects and the

wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations' (National Park Service Organic Act § 1). The Antiquities Act of 1906 authorizes the President to designate as national monuments 'historic landmarks, historic structures, and other objects of historic or scientific interest' that are situated on federal lands (Antiquities Act § 431). The NPS must prepare management plans for the national parks and monuments that, among other things, include measures for the preservation of the area's resources (Id. § 3). Commodity uses such as logging, grazing, and mining are either prohibited or tightly restricted in the national parks and monuments.

Figure 1

Federal Land Management Agency Authority and Restrictions



The National Wildlife Refuge System, which comprises about 90 million acres, is administered by the FWS. Under the National Wildlife Refuge System Improvement Act of 1997 (NWRSIA), the mission of the FWS is to administer a network of lands and waters for the conservation, management, and restoration of fish, wildlife, and plant resources and their habitats for the benefit of present and future generations of Americans. The statute affords priority to the conservation of wildlife, plants, and their habitats, defining conservation to mean sustaining, restoring, and enhancing healthy populations (NWRSIA § 668ee(4)). The Act allows compatible wildlife-dependent recreational uses, including hunting and fishing, in the refuges. Recreational uses are compatible if they will not materially interfere with or detract from the mission of the Refuge System or the purposes of individual refuges (Id. § 668ee(1)).

Other systems, such as the National Forest System and the public lands administered by the Bureau of Land Management (BLM), are governed by statutes that allow a range of "multiple uses" that include not only recreation and natural resource protection, but also timber production, range management, and mineral production. Even these systems include areas set aside for preservation purposes, however. Congress may designate areas of the national forests and the BLM public lands as wilderness, just as it may do in the national parks, monuments, and wildlife refuges (Glicksman 1999). The National Wilderness Preservation System, which comprises more than 100 million acres, is the subject of another chapter in this book and will not be discussed further here. The National Forest Service has designated nearly 60 million acres of land as roadless areas in which timber harvesting and road construction are tightly restricted (Glicksman 2004). The BLM's organic act, the Federal Land Policy and Management Act (FLPMA), authorizes the agency to identify 'areas of critical environmental concern.' These are areas 'where special management attention is required . . . to protect and prevent irreparable damage to important historic, cultural, or scenic values, fish and wildlife resources or other natural systems or processes.' Land use plans must give priority to the protection of these areas, and they are not available for the full array of multiple uses (FLMPA §§ 1702(a), 1711, 1712(c)(3)). The reference to protection of natural processes seems to be consistent with an ecosystem management focus. The Wild and Scenic Rivers Act provides protection for congressionally designated rivers. The areas affected by the designation include private as well as public lands. Use restrictions vary, depending on whether a river has been designated as wild, scenic, or recreational.

U.S. laws also allow for the protection of marine protected areas (MPAs), but there is no single law that governs the creation of MPAs. Moreover, the range of permissible uses varies considerably, from multiple use management similar to that which exists in the national forests and BLM lands to smaller 'no-take' areas governed by a preservation mandate similar to the ones that govern national parks and wildlife refuges. One observer has concluded that 'MPAs will not be effective in preserving marine mammals if the MPAs are surrounded by uncontrolled areas where pollution, habitat destruction, and overfishing exist' (Abate 2009, p. 274).

One example of spatial planning to protect MPAs might provide a model for protection in the U.S. not only of MPAs, but reserves more generally. The Great Barrier Reef Marine Park Act, adopted by the Australian legislature in 1975, established the Great Barrier Reef Marine Park Authority. The Authority manages the Reef primarily through a zoning system that imposes different levels of restrictions based on the zoning designation (including zones for general use, habitat protection, conservation park, buffer, scientific research, marine national park, and preservation). Over the years, the percentage of Reef waters subject to the highest levels of protection has increased significantly in response to monitoring that revealed a failure to achieve ecosystem protection at lower protection levels (Sivas and Caldwell 2008, pp. 247-48). By at least one account, the Park is the 'foremost example of a zoning system that has been successfully applied in the context of a large, nationally significant MPA' (Baur et al. 2004, p. 565).

Climate Change as a Spur to Increased Emphasis on Resilience: Opportunities and Challenges

Until fairly recently, the NPS has not incorporated the need to manage parks to enhance ecosystem resilience, particularly in the face of climate change, into its management directives in any significant way. In its 2006 Management Policies, an internal document designed to guide NPS employees fulfilling their statutory duties, including implementation of management plans, for example, the NPS mentioned the concept of resilience only once (in connection with recreational boating campgrounds) (NPS 2006). The Policies referred to climate change only twice. First, the NPS recognized that 'accelerated climate change may significantly alter park ecosystems"' (Id., p. 53). But it required only that the parks gather and maintain baseline climatological data for reference, not that they use that data in any particular way to enhance resilience in the face of climate change. Second, it encouraged park managers to educate visitors about the influence of climate change, again without mandating that managers prepare for or react to climate change threats or events in any particular way that would enhance the agency's ability to achieve its statutory mission.

In 2010, however, the agency issued its Climate Change Response Strategy. The Strategy includes six principles to guide the development and implementation of an integrated science-management response capacity for the NPS and its partners. Among these principles are several that comport with the concepts of resilience thinking and management at a landscape scale as discussed above. The agency committed itself, for example, to building connections at local to regional scales within the agency and with other agencies and stakeholders. It also committed to the use of adaptive management

(Walters 1986, McLain and Lee 1996, Gunderson 1999), recognizing the need to be 'structured for adaptability, grounded in experience,' and to rely on 'approaches to learning and management that evolve as knowledge increases' (NPS 2010, at 9). It relied on Secretarial Order 3289, which established a Department-wide approach for increasing science-based understanding of climate change and coordinating an effective response to the resources it manages, as supporting authority for this approach (Secretarial Order 3289). The Strategy identified increasing the resilience of natural systems as an important approach to climate change adaptation. One of its objectives is to collaborate with federal, state, and local partners and programs to develop tools, such as vulnerability assessments and scenario planning (Peterson et al. 2003), to help develop adaptation plans at appropriate scales. Another goal is to collaborate to develop 'cross-jurisdictional conservation plans to protect and restore connectivity and other landscape-scale components of resilience' (NPS 2010, at 16). The agency recognized that protecting and restoring corridors and connectivity across landscapes 'will require strong collaboration with partners and programs to share knowledge, develop repositories of genetic resources, and, where appropriate, develop cross-jurisdictional conservation' (Id.).

Announcing resource management goals that are consistent with enhancing the resilience of park and refuge ecosystems is one thing. Implementing those strategies is another (e.g., see Hillborn 1992, Walters 1997). As the NPS has recognized, current laws may present challenges to the goal of achieving resilient ecosystems in the face of threats such as climate change. The 2010 NPS Climate Change Response Strategy noted that '[m]ost resource protection laws with which the NPS must comply were not written considering a changing climate. As a result, it is necessary to reestablish service-wide

consistency in interpreting the NPS mission and mandates' so that climate change adaptation efforts can be fashioned in ways that comply with laws governing management of the National Park System (NPS 2010, at 23)

The questions the agency must face in doing so are difficult. One question is how to reconcile the need for human intervention to adapt to climate change with the core statutory mandate to conserve the 'natural objects' within the parks and to 'leave them unimpaired for the enjoyment of future generations' (NPS Organic Act § 1). One study found that NPS staffers regard the NPS Organic Act as a barrier to the agency's efforts to adapt to climate change as a result of its emphasis on preservation and naturalness, which has led to agency policies that minimize intervention and management in the parks (Jantarasimi et al. 2010). This same legal focus may hinder efforts to promote resilience in park ecosystems more generally.

The legislation that governs administration of the national wildlife refuges and provides the FWS with its management authority accommodates resilience thinking more easily. The FWS must ensure maintenance of the 'biological integrity, diversity, and environmental health' of the refuge system, and plan and direct the growth of the system 'to contribute to the conservation of the ecosystems of the United States.' (NWRSIA § 668dd(a)(4)(B)-(C)). According to a leading expert on refuge management, this mandate 'introduces broader, synthetic, ecological process concepts to the management objectives' of the national wildlife refuge system, and 'advances a holistic, ecological standard for evaluating conservation' (Fischman and Adamcik 2011, at 23-24). Administration of the national wildlife refuge system on a landscape scale would be fully consistent with these prescriptions.

Indeed, the FWS has taken steps to manage ecosystems rather than individual wildlife species or individual refuges. The agency has described the goals of some refuges in terms of broad ecosystem-based goals. Its policies implementing the 1997 Act's mandate to maintain the biological integrity, diversity, and environmental health of the Refuge System proclaim that fragmentation of the System's wildlife habitats is 'a direct threat to the integrity' of the System. As a result, uses reasonably anticipated to reduce the quality or quantity of habitats, or fragment habitats on a refuge, will not be deemed a compatible wildlife dependent use (U.S. Fish and Wildlife Service 2011b).

Even more significantly, the FWS's 2010 strategic plan lists as one of its foundational principles an 'emphasis on conservation of habitats within sustainable landscapes.' According to the plan, the FWS will apply Strategic Habitat Conservation as its framework for landscape conservation. This approach aims to conserve terrestrial, freshwater, and marine habitats within sustainable landscapes to conserve target populations of species or suites of species and the ecological functions that sustain them. The plan commits the FWS to managing toward future landscape conditions by

predicting and working with the effects of climate change. The goal is to facilitate the transition of ecosystems from current, natural states to new conditions resulting from climate change. These include mimicking or assisting natural adaptive processes such as species dispersal or migration to avoid catastrophic conversions that might occur otherwise. Realignment may be appropriate for ecosystems that have already been significantly disturbed (U.S. Fish and Wildlife Service 2010).

Available Legal Tools for Managing Resilient Landscape-Level Parks and Refuges

Cooperative Resource Management to Achieve Resilience

Notwithstanding the potential difficulties in implementing landscape-level management programs to achieve ecosystem resilience posed by the century-old National Park Service Organic Act, that statute, the NWRSIA, and other federal natural resource management laws provide the NPS and the FWS with a variety of tools to implement conservation strategies that are built on the formation of dynamic reserves. The broad discretion the NPS has to regulate use of the national parks and monuments 'by such means and measures as conform to the fundamental purpose' of those places should facilitate the NPS's ability to take actions that enhance the resilience of park ecosystems in the face of climate change and other threats. The Interior Secretary's authority to issue 'such rules and regulations as he may deem necessary or proper for the use and management of the parks, monuments, and reservations under the jurisdiction of the National Park Service' reinforces this discretion (16 U.S.C. § 3).

Indeed, these laws and others described below provide the NPS with surprisingly broad explicit authority to engage in the kind of landscape-scale management efforts that

will be necessary to protect ecosystem resilience in the parks. The agency has acted on that authority. NPS management policies recognize that

> Cooperative conservation beyond park boundaries is necessary as the National Park Service strives to fulfill its mandate to preserve the natural and cultural resources of parks unimpaired for future generations. Ecological processes cross park boundaries, and park boundaries may not incorporate all of the natural resources . . . that relate to park resources. . . . Therefore, activities proposed for adjacent lands may significantly affect park programs, resources, and values. Conversely, NPS activities may have impacts outside park boundaries. . . . [P]arks are integral parts of larger regional environments . . .
>
> (NPS 2006, § 1.6)

The agency's management policies therefore commit the NPS to cooperative endeavors with other federal, regional, state, and local agencies, with tribes, and with neighboring landowners and nongovernmental organizations.

The agency has explicit authority to enter cooperative management agreements where a unit of the NPS is located adjacent to or near a state or local park area to ensure effective and efficient management of the parks, or for the purpose of protecting natural resources of park units through collaborative efforts on land inside and outside of National Park System units (NPS Organic Act §§ 1a-2(*l*)(1), 1j). These powers should assist the NPS in fulfilling its commitment to collaborate with other public and private landowners in devising management approaches that enhance resilience on a landscape scale. Such cooperative agreements may address problems likely to result from climate change, such as invasive species within or adjacent to park system units (Crowl et al.

2008), and may provide for restoration of natural resources, including native wildlife habitat or ecosystems. (Id. § 1j-(b)) Similarly, the Organic Act authorizes the NPS, in managing national monuments contiguous to national forests, to cooperate with the National Forest Service. (Id. § 2)

Likewise, the NWRSIA makes available to the FWS tools that enable it to enlarge the scope of the resources it protects beyond the boundaries of the refuges themselves. The Act requires the FWS, for example, to 'ensure effective coordination, interaction, and cooperation with owners of land adjoining refuges and the fish and wildlife agency of the States in which units of the System are located.' In addition, the statute mandates that the FWS 'ensure timely and effective cooperation and collaboration with Federal agencies and State fish and wildlife agencies during the course of acquiring and managing refuges' (NWRSIA § 668dd(a)(4)(E), (M)). None of these provisions dictates the form of the required cooperative efforts.

These statutory provisions authorize the NPS and the FWS to engage in cooperative management efforts, but do not require the agencies' desired partners to respond favorably when the NPS makes cooperative overtures or otherwise assure the success of such cooperative ventures. The obstacles to cooperative management among federal agencies are especially problematic when the desired partner of the NPS or FWS operates under a statutory mandate or is pursuing a mission whose priorities conflict with the steps the NPS or FWS deem necessary to enhance resilience and protect ecosystem integrity. The Forest Service and the BLM, both of which operate under multiple use mandates, may have no discretion to deny activities with the potential to disrupt ecosystem resilience, such as the issuance of hardrock mining activities. Even if these

agencies have such discretion, they may not regard the approaches of the two dominant use agencies to be consistent with their multiple use mandates. NPS officials have cited differences in agency missions and the absence of an agency with the authority to resolve disputes among the land management agencies as reasons why interagency cooperation has failed in some instances to protect park resources (Shafer 2010).

The federal land management agencies have embarked on some cooperative ventures that aim to achieve landscape-level ecosystem management. Joseph Sax and Robert Keiter, for example, have described the NPS's

> embrace [of] regionalism as the primary long-term strategy for protecting [Glacier National Park's] ecological integrity. The overall goal is to knit the entire Glacier region together as an entity with the park at the core of the larger ecosystem, primarily by creating transboundary management forums, institutions, or incentives consistent with the park's conservation objectives

(Sax and Keiter 2006, at 300-01). A web of natural resource management laws played a role in the NPS's effort to fashion a plan for protecting the integrity of the regional landscape surrounding Glacier. Sax and Keiter identify the Endangered Species Act(ESA), NEPA, and the Wilderness Act as imposing 'managerial consistency across boundaries.' (Id. at 307). The regulations issued by the Council on Environmental Quality (CEQ) to implement NEPA, for example, require agencies to consider the cumulative effects of an agency proposal and 'other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions.' (CEQ regulations § 1508.7) The ESA requires agencies to consult with the FWS to insure that their actions do not jeopardize listed species or

adversely affect critical habitat (Endangered Species Act § 7(a)(2)). Under the FWS's regulations, an agency considering whether the statute requires consultation must consider 'the effects of the action as whole,' including indirect effects. (FWS regulations, § 402.14(c)) Indirect effects include things like private land development that a federal action makes possible. An agency that fails to properly take those effects into account risks the issuance of an injunction that blocks its proposed action. As a result, agencies have an incentive to consider the consequences not only of their own actions, but of related or resulting actions by others, including other federal agencies, states, tribes, and private landowners. That incentive may foster agency consideration of, and coordination with, others with the ability to control activities that are beyond the jurisdiction of the proposing agency. Sax and Keiter have surmised in connection with the presence of grizzly bears in and around Glacier National Park that the ESA has 'forced other federal agencies to cooperate in management planning that crosses boundary lines, and provoked the development of a program of cumulative effects modeling that encourages forest service managers to adopt an expansive, long-range perspective in their planning processes.' (Sax and Keiter 1987, at 248)

Similar initiatives have begun elsewhere, such as in the Northern Rockies. Efforts such as the Yellowstone to Yukon Initiative have sought 'to break down the traditional jurisdictional boundaries that impede rational management of wildlife and water systems.' (Id. at 301) More specifically, one of the Initiative's goals has been 'to create a linear network of interconnected nature reserves extending from the Yukon Territory to Yellowstone National Park to protect the grizzly bear, wolf, and other wide ranging wildlife species.' (Id. at 302) According to Sax and Keiter, however, the Initiative has

not yet succeeded in fully achieving regional managerial integration, in part because of community resistance stemming from the Initiative's impact on pre-existing mineral development project.

Sax and Keiter detect within the last twenty years or so 'a pronounced shift in thinking and management away from formal enclaves (such as the park and the [adjacent national] forest) and toward the region seen as an integral ecological unit, in particular as the habitat needs of target wildlife populations.' (Id. at 306). They explain this shift as the product of several extra-legal factors, including the increased emphasis among national forest users on recreation as opposed to commodity production, a reduced dependence among surrounding communities on commodity production as the driver of the local economy, and communities that increasingly regard themselves as inhabiting a regional environment. Where these features exist in other locales in which disturbances threaten resilience, federal land managers may be able to fashion similar landscape-level ecosystem management strategies. Education can assist in fostering among residents in a region containing a critical and threatened ecosystem a sense of belonging to a regional environment, and in convincing them that preservation of a fully functioning ecosystem will be to their economic benefit because of the ecosystem services that it provides and the tourist revenues that it can help generate. These kinds of endeavors have succeeded in other contexts, such as in efforts by the International Gorilla Conservation Project and the Institute for Tropical Forest Conservation to protect African gorillas (Sawyer and Sawyer 2011, pp. 390-91). Similarly, education and outreach apparently have helped local governments to persuade residents of the Anacostia River watershed to buy into restoration and enhancement initiatives (Arnold 2011, pp. 852-53). The FWS has used

education and outreach to supplement its efforts under the ESA to protect the Mexican Wolf (Greaves 2009). Efforts to convince farmers and ranchers to take voluntary measures to protect lesser-prairie chickens in New Mexico had mixed success (Paez 2009, pp. 580-81).

The FWS also has made efforts to integrate protection of resources within and outside refuge boundaries. The FWS Manual, an internal agency guidance document whose legal status is variable and subject to dispute, provides:

> Events occurring off refuge lands or waters may injure or destroy the biological integrity, diversity, and environmental health of a refuge. Given their responsibility to the public resources with which they have been entrusted, refuge managers should address these problems. It is critical that they pursue resolution fully cognizant and respectful of legitimate private property rights, seeking a balance between such rights and the refuge manager's own responsibility to the public trust.

(U.S. Fish and Wildlife Service 2011b) The agency's preference is to reach a solution through direct negotiations with the private landowner, agency, or other entity that is the source of the problem. For example, the FWS has purchased private land outside the Lower Rio Grande Valley National Wildlife Refuge along the river to create a wildlife corridor that extends to the Gulf of Mexico, and has worked with state wildlife agencies and NGOs to assist in habitat restoration in the South Texas area (U.S. Fish and Wildlife Service 2012).

If those kinds of efforts fail, the FWS may engage in collaborative discussions with state or local authorities or other organizations that can help in cooperative

resolution of the problem. The next step typically will be to work with state or local regulators. As a last resort, the FWS will pursue available legal remedies, 'with full respect to private property rights.' The agency also has created a series of Landscape Conservation Cooperatives, which it describes as public-private partnerships that recognize that climate change challenges 'transcend political and jurisdictional boundaries and require a more networked approach to conservation — holistic, collaborative, adaptive and grounded in science to ensure the sustainability of America's land, water, wildlife and cultural resources.' (U.S. Fish and Wildlife Service 2011a).

Still, a clash of agency cultures and missions stands as a formidable obstacle to these cooperative efforts, and suggests the need for a mediating force. The Interagency Climate Change Adaptation Task Force created by President Obama in 2009, and co-chaired by the CEQ, the Office of Science and Technology Policy, and the National Oceanic and Atmospheric Administration, may be capable of resolving disputes among the federal land management agencies that relate to the impacts of climate change on ecosystem resilience. President Obama also issued an executive order requiring federal agencies to 'participate actively' in the Task Force's development of a national strategy for adaptation, and develop policies and practices compatible with that strategy (Executive Order 13514, 2009). Among the Task Force's guiding principles is inducing agencies to implement adaptation approaches that seek 'to increase ecosystem resilience and protect critical ecosystem services on which humans depend to reduce vulnerability of human and natural systems to climate change.' The Task Force also recognized the need for a national approach to problems that cut across sectors and agencies, including strengthening coastal and ocean resilience and protecting fish, wildlife, plant resources,

and their habitats. (CEQ 2010) In 2011, the CEQ issued instructions for implementing adaptation planning in conformity with the adaptation executive order. The instructions require agencies to assess the vulnerability of the resources they manage to climate change, identify priority adaptation actions, and submit to the CEQ adaptation plans for implementation. (CEQ 2011)

A quarter of a century ago, George Coggins rendered this pessimistic assessment: 'History . . . demonstrates that the prospects for preventing and abating threats through intergovernmental coordination alone are bleak' (Coggins 1987). It remains to be seen whether, notwithstanding that dubious track record, the Task Force and CEQ directives will induce agencies, individually and through coordinated initiatives, to take effective steps to increase ecosystem resilience in the face of climate change.

Boundary Revisions

Changing the boundaries of the national parks and wildlife refuges, or creating a spatiotemporally variable buffer zone around protected areas (e.g., to extend the area of strongly protected wetlands and/or no-go areas during periods when migratory or breeding birds are present), may offer another approach to managing reserves at the scale, and in the locations, necessary to promote ecosystem resilience. Spatially variable boundaries have been used in other environmental protection contexts. Louisiana, for example, has restricted the application of pesticides in buffer zones between inhabited residences and targeted crops that vary in breadth depending on factors such as wind speed and method of application (ground or aerial) (Feitshans 1999).

The NPS has the power to make minor boundary revisions that it deems necessary for the proper preservation, protection, or management of an area of the national park

system (Land and Water Conservation Fund Act § 460*l*-9(c)(1)). The National Park Service Organic Act also vests in the NPS the responsibility to develop criteria to evaluate more significant proposed changes to the existing boundaries of individual park units if those boundaries do not adequately allow for the protection and preservation of the natural resources integral to the unit (National Park Service Organic Act § 1a-12). In proposing specific boundary changes to Congress, the NPS must consult with affected state and local agencies, surrounding communities, affected landowners, and private organizations before applying the criteria (Id. § 1a-13). The NPS's criteria support making boundary adjustments to prevent harm caused by activities on adjacent lands (e.g., pesticide applications or inappropriate use of fire) that pose a direct and substantial threat to the continued existence of the park's primary resources and values.

The NPS has stated, however, that adjustments to address external threats 'should be considered a last resort when cooperative efforts have been fully explored and found to be inadequate,' and that it does not endorse the creation of buffer zones. Moreover, the NPS has cautioned that boundary adjustments to protect wildlife populations whose habitat requirements or migratory patterns extend over large areas 'are likely to be seriously limited by feasibility considerations.' As a result, it has urged addressing regional natural resource issues through cooperation with other landowners (such as through the acquisition of fee interests or easements by non-profit organizations for conservation purposes) and other governments (such as through local zoning constraints) as an alternative to expanding park boundaries (National Park Service 1991). Notwithstanding concerns about excessive expansion of the parks estate, Congress has

moved lands administered by the National Forest Service and the BLM into the national parks to enable the NPS to fulfill its preservation mandate (Shafer 2010).

Congressional or Presidential Actions to Link Lands in Larger Landscapes

The existence of protected areas, such as wilderness areas, in federal land systems under the management of agencies other than the NPS and the FWS provides opportunities 'to link protected areas together to protect much larger and more ecologically intact landscapes' (Keiter, p. 82). The Antiquities Act of 1906 vests in the President the unilateral authority to create national monuments from less protected land systems, to protect 'objects of historic or scientific interest' (Antiquities Act § 431). Courts have upheld presidential designations of places that were later transformed into national parks, such as the Grand Canyon and Jackson Hole. A dramatic example of the Act's potential for sweeping large tracts of federal land into a protective regime is President Jimmy Carter's reservation of 56 million acres in Alaska as a series of national monuments (Coggins and Glicksman 2007). Presidents have exercised their authority under the Antiquities Act to create national monuments on lands administered by the multiple use agencies as a means of protecting adjacent national parks, monuments, and recreation areas from development that threatened resource degradation. Interior Secretary Bruce Babbitt, for example, justified President Clinton's designation of the Grand Staircase-Escalante National Monument as a way to protect Bryce Canyon and Capital Reef National Parks and the Glen Canyon National Recreation Area (Shafer 2010).

Congress has expanded existing parks such as Denali, Death Valley, and the Joshua Tree National Park to reconnect fragmented landscapes. These expansions

become more viable if they have the support of surrounding communities who regard national parks and similar preserves as sources of economic opportunity (Keiter p. 82, 95-96). Researchers have concluded that protected areas such as parks and refuges succeed in protecting biodiversity and resilience only if local communities understand and embrace protective efforts, which requires education to build social and political support (Moral and Sale 2011).

Another potentially promising tool for achieving landscape-scale management efforts that enhance resilience is the National Heritage Area (NHA) program. As the NPS has explained, 'National Heritage Areas (NHAs) are designated by Congress as places where natural, cultural, and historic resources combine to form a cohesive, nationally important landscape' (NPS 2011). The federal government does not own lands designated as NHAs. Rather, the NPS provides technical, planning, and matching financial assistance to communities in which these areas are located. The NPS approves management plans for NHAs, but the plans are largely crafted and are implemented by partnerships of local governments, private landowners, and nongovernmental organizations. As of September 2012, Congress had designated about 50 NHAs in different kinds of landscapes spread across the country. Some have succeeded in restoring dysfunctional ecosystems. The Yuma Crossing NHA in southwestern Arizona, for example, helped to restore wetlands through the removal of nonnative vegetation and planting of trees. Previous efforts at wetlands restoration in the area had foundered as a result of patchwork land ownership patterns and conflicting land use goals. Moreover, NHAs can be used in conjunction with national park management to provide the kind of buffers needed to promote ecosystem resilience. As a NPS report recognized, '[w]hen a

heritage area is adjacent to a national park or a national park is within a heritage area, both parties benefit from the expanded opportunity to interpret and protect resources over a larger landscape' (National Park System Advisory Board 2006, at 3, 14).

Condemnation or Acquisition of Private Lands

Another way to expand the impact or influence of management of current federal parks and refuges to encompass landscapes large enough to provide ecological memory is to arrange voluntary sales of private lands to the government or use the power of eminent domain to purchase conservation easements or fee title to private lands adjacent to preserves. Acquisition efforts should be directed toward resources essential to the preservation or restoration of ecosystem functions, such as lands that reconnect federal lands in headwaters with downstream areas. In the past, Congress has provided the NPS with condemnation authority to assist in the preservation of landscapes adjacent to national parks such as the Cape Cod National Seashore. The FWS may be able to use funds generated by the sale of migratory bird hunting stamps to help acquire new lands for the National Wildlife Refuge System (Fischman and Adamcik 2011).

The ESA, discussed in Chapter **, also authorizes the Secretary of the Interior to use land acquisition authority under statutes such as the Fish and Wildlife Act of 1956, the Fish and Wildlife Coordination Act, and the Migratory Bird Treaty Act, and using funds available under the Land and Water Conservation Act, to acquire 'by purchase, donation, or otherwise' lands or interests in lands to assist in conserving fish, wildlife, and plants. (Endangered Species Act § 1534)

Federal land exchanges (either with private parties or between agencies) may serve the same functions as acquisitions, and sales of federal lands that are not essential

for the conservation of ecosystems may help finance some of the acquisitions (Leshy 2010). Trades between the NPS and the Forest Service have sought to create more ecologically appropriate boundaries for Rocky Mountain National Park, for example (Shafer 2010). The FWS has the authority to acquire lands by exchange under the NWRSIA (NWRSIA § 668dd(b)(3)). This authority enables the agency to integrate management of the lands found within the refuges themselves with private landowners and with management of state parks and preserves, and to acquire lands adjacent to current refuge lands if doing so will enhance the Act's ecosystem conservation purposes.

The states can play a useful role in contributing lands that can be used to aggregate parks and other preserves large enough to assist in protecting or restoring ecosystem resilience. In the past, state acquisitions have assisted in the aggregation of lands that were eventually included in national parks such as Shenandoah and Great Smoky Mountains. As Robert Keiter has recognized, nonfederal options for resource protection have grown with the expansion of state and local park systems (Keiter 2010, p. 81). The federal government can finance state acquisitions of lands for outdoor recreational purposes under the Land and Water Conservation Fund Act. The federal government provides funds from sources such as offshore oil and gas leasing to the states to purchase lands for these purposes, although this mechanism could be made more powerful by dedicating money from the fund to acquisition of lands for conservation purposes, instead of requiring annual appropriations by Congress (Leshy 2010). The statute restricts the ability of states to convert lands acquired with federal money to nonrecreational purposes without the approval of the Interior Secretary (Coggins and Glicksman 2007; Coggins and Glicksman 1984). The states have the capacity to assist in

federal ecosystem protection efforts in other ways. In recent years, groups of western states have created processes for providing coordinated protection of wildlife corridors. Tax breaks could induce private landowners to participate as well (Keiter at 102).

Regulatory and Related Actions to Protect Resilience

If it is not possible to aggregate sufficiently large tracts of land in the hands of sympathetic public or private owners to provide landscape-level resource management for resilience, the NPS and the FWS may be able to exercise their regulatory authority to abate external threats. The Property Clause of the Constitution vests in the federal government the authority to regulate conduct on nonfederal lands that threatens to harm federal holdings. Despite the Supreme Court's broad interpretation of that power (Appel; Camfield v. United States; United States v. Alford), the scope of the federal land management agencies' authority to abate threats originating off federal lands (so-called external threats) is unclear. 'Congress seldom exercises [its power to control external threats], the land agencies seldom claim it, and the Department of Justice seldom asserts it in federal land litigation.' (Coggins and Glicksman 2007; Stupak-Thrall v. United States)

Coordination among federal agencies in addressing external threats, including the appearance of invasive species or the spread of insect infestations or pathogens that threaten forests, tends to be especially difficult, legally and practically (Sax and Keiter; Glicksman 2009). The NPS and other agencies nevertheless have successfully invoked on occasion their authority to abate activities, such as spraying pesticides (United States v. South Florida Water Management District) and forcing reductions in air pollution that would have affected the Grand Canyon (Central Arizona Water Conservation District v.

EPA), that created threats to federal lands and resources. The FWS has also claimed authority to address external threats such as invasive species and habitat destruction (FWS 2000).

Lessons from the work of Lin Ostrom and her collaborators (e.g., Ostrom et al. 1999, Ostrom 2003, 2007, 2009) suggest that the protection of common property resources is facilitated by the existence of clearly defined, graduated sanctions. Another option in abating external threats may thus be to define spatially explicit 'Thresholds of Potential Concern' (TPCs; (Biggs and Rogers 2003)) that use science to identify a clear, explicit set of criteria that indicate a looming decline in system resilience (or a potential loss of identity). When a TPC is crossed, legislation would trigger the imposition of restrictions on the intensity or nature of activities that could be undertaken in a given area. For example, if forest loss in the broader landscape is a concern for the protection of forest-dependent animals, a reduction in tree cover below a certain percentage of its historical extent might trigger restrictions on the licensing of timber companies to harvest trees beyond a certain volume. Once the system has revegetated, such restrictions could be relaxed.

Examples of this kind of approach already exist under U.S. environmental laws. Under the ESA, for example, incidental take statements in a FWS biological opinion must define the extent of permissible incidental take. If the level is exceeded, the agency sponsoring the project must reinitiate consultation with the FWS, and the take statement must specify monitoring or reporting requirements that enable the FWS to determine whether the trigger for further consultation has been crossed (Wild Fish Conservancy v. Salazar). In other contexts, the exceedance of pre-set thresholds automatically requires

management actions, either by agencies or regulated entities. Under the Clean Water Act, for example, Oregon has issued permits to the operators of storm sewer systems that contain 'benchmark' numbers based on state water quality standards that, if exceeded, trigger an adaptive management process for the imposition of more effective best management practices (Dunn and Burchmore 2007). If it could be implemented in a way that was politically viable, legislation that explicitly includes graded restrictions or sanctions for different zones around protected areas might create a strong incentive for responsible environmental management by all parties concerned.

Future Congressional Actions

Ultimately, efforts such as those described above may be inadequate to allow management of parks, refuges, and other preserves at a sufficient scale to provide the regional resilience that will be needed to withstand severe perturbations. The combination of development that continues to reduce the size of spaces devoted to conservation and the emergence of more dramatic climatic change at some point may outstrip the ability of resource managers, such as the NPS and the FWS, to promote resilient ecosystems at broad extents under the current legal regime (Rockstrom et al. 2009).

If physical realities preclude even well informed agency efforts to manage for resilience, Congress should consider revising the legal framework that has governed federal land management for most of the past century by realigning agency jurisdiction to facilitate cohesive and coordinated management of ecosystems, rather than continuing to rely on the somewhat artificial boundary lines between parks, refuges, forests, and other federal land systems. As at least one scholar has recognized, this kind of revision would

not require a rejection of all boundary lines. Instead, 'it demands redrawing spatial boundaries and time frames to suit the particular purposes of the ecological analysis.' (Breckenridge 1995, at 374)

Consolidation of federal land systems is one option. Some have proposed combining the land systems managed by the two dominant use agencies, the NPS and the FWS (Coggins and Glicksman 1999; Keiter 2005). Others have argued, however, that consolidation might reduce opportunities for innovation and adaptive management, and that past agency consolidations have produced unwieldy and complacent organizations. (Fischman 2002; Zellmer 2004). At a minimum, it would be helpful if the organic statutes for the NPS and the multiple use agencies contained explicit authority to management for ecosystem resilience, or at least contained provisions like the one in the NWRSIA establishing a policy in favor of maintaining biological integrity.

One way to provide parks and preserves of a scale compatible with natural landscape dynamics would be to add significant new lands to the parks and refuge systems. Political support for a significant expansion of the federal land base does not exist and is unlikely to develop, however, if for no other reason than the displacement of private ownership it would entail. It is unlikely that the federal land base could be expanded enough to achieve effective government control to ensure landscape-level resilience in any event. Nor is extensive federal regulation of private land use viable. Land use regulation has long been largely, though not exclusively, the prerogative of local governments. The existing federal environmental regulatory programs that tend to generate the most heated opposition are those, such as the ESA's taking prohibition and the Clean Water Act's dredge and fill permit program, that look like land use control

mechanisms. As John Leshy has argued, federal regulatory initiatives designed to make private land bear much of the burden of biodiversity protection would be 'controversial [and] fiercely resisted' (Leshy 2010, p. 124).

Accordingly, efforts at statutory reform will likely need to focus on providing enhanced authority for federal resource managers to coordinate their efforts with state and private landowners. In particular, one attractive option may be for the federal government to provide monetary incentives for private landowners, similar to the payments made under the Conservation Reserve Program to farmers who take wetlands out of production (Coggins and Glicksman 2007, § 19:26), to refrain from engaging in the kinds of development that threaten the goal of management for ecosystem resilience.

Finally, Congress may need to amend the laws that govern the national parks, wildlife refuges, and other preserves to deal with intractable questions that federal land managers will likely face if climate change results in the loss of resources that induced Congress to create a particular preserve in the first place. In such cases, how can the management agency comply with a mandate to leave natural resources unimpaired if climate change results in plant or animal range shifts that make a park unsuitable for species that previously thrived there (NPS 2010, at 23)? Explicit statutory authorization to manage for the maintenance of ecological processes is desirable, even if the components of the ecosystems in question differ from those traditionally found there. The NPS insists that '[p]resent NPS management policies are probably sufficient to guide many potential climate change response actions' (id.), but Congress may need to either amend the enabling legislation for specific parks if they contain detailed prescriptions that no longer reflect the on-the-ground realities, or provide general authority to manage

for resilience notwithstanding dramatic physical changes that frustrate the ability to retain the iconic features for which a preserve is known.

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