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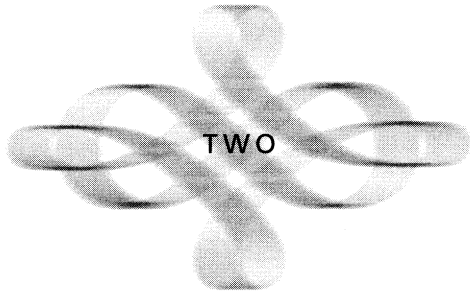

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MELINDA HARM BENSON AND MATTHEW E. HOPTON

Biological diversity can be considered both temporally (i.e., evolutionary time) and/or spatially and reflects the number, variety, and variability of organisms. It includes diversity within species (i.e., genetic and morphological), between species (i.e., alpha and beta), and among ecosystems (i.e., beta and gamma). Over the past few hundred years, human activities have increased species extinction rates by as much as 1,000 times above the background rates that were typical over Earth's history (Figure 2.1) (Millennium Ecosystem Assessment 2005; but see He and Hubbell 2011). In the United States, there are approximately 1,900 species listed as threatened or endangered, with potentially thousands more at risk (U.S. Fish and Wildlife Service [USFWS] 2011a). The challenge of addressing biodiversity loss and the inevitable but largely unknown consequences associated with it presents a "wicked problem" characterized by complexity and high uncertainty (Farley 2007).

The current approach to wildlife management and the wicked problem of biodiversity loss in the United States is the subject of this chapter. We examine the nature in which existing legal frameworks and institutions address these issues and the extent to which they are compatible with a resilience-based approach. After providing a working definition of resilience, we then provide an overview of relevant state and federal

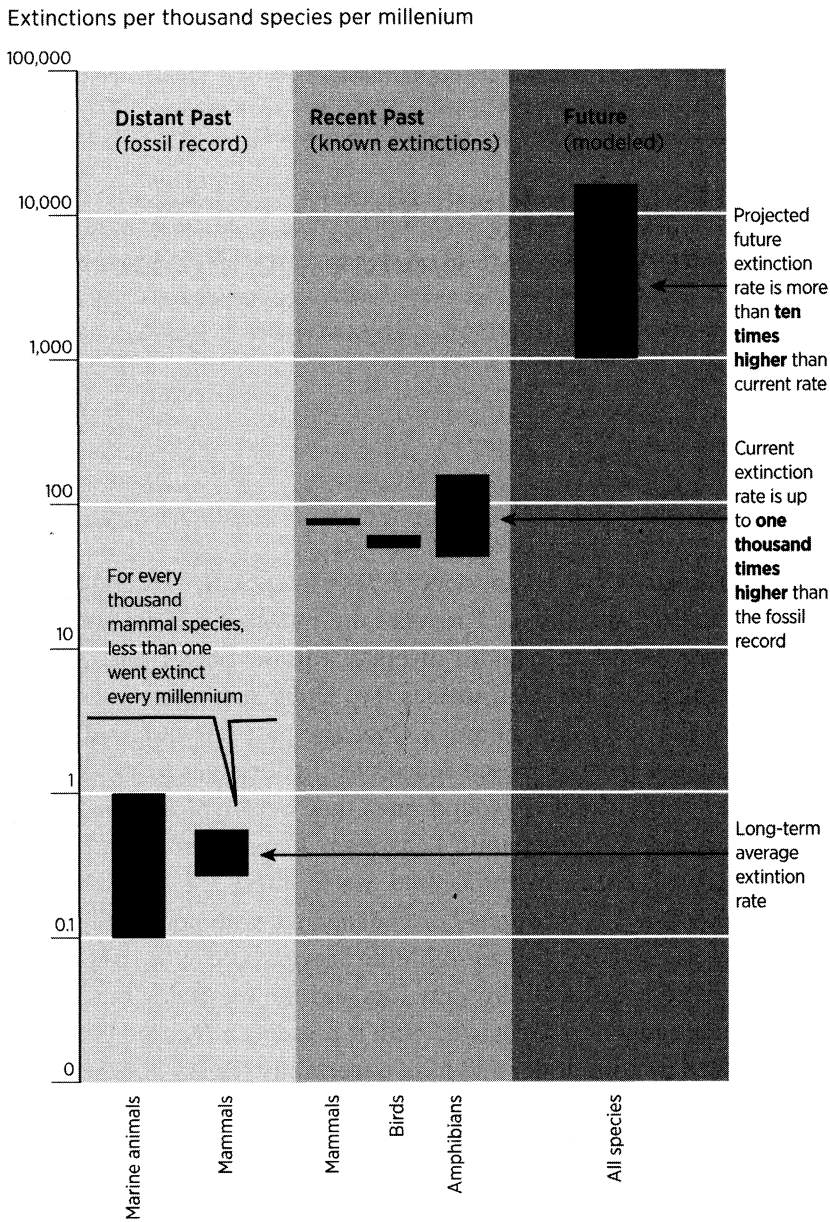

FIGURE 2.1. Millennium Ecosystem Assessment on extinction rates. *Source*: Millenium Ecosystem Assessment.

approaches to wildlife management and biodiversity protection in the United States. We place particular emphasis on the Endangered Species Act of 1973 (ESA), currently the strongest federal law capable of addressing biodiversity loss. We then explore the extent to which the ESA and other wildlife laws are compatible with resilience theory and provide some recommendations for legal and institutional reform based on a resilience-based perspective of social-ecological systems.

Resilience, Biodiversity, and Management

Resilience, as used in this context, describes a suite of social or ecological system properties. Brand and Jax (2007) have acknowledged the differing definitions of resilience and point to the need for increased conceptual clarity to maintain the practical relevance of this concept. We use the description put forth by Carpenter et al. (2001), which characterizes resilience in three ways: (1) the amount of change the system can undergo and still retain the same controls on function and structure; (2) the degree to which the system is capable of self-organization; and (3) the ability to build and increase the capacity for learning and adaptation. Resilience is not only dependent on the functional diversity of a system, but also dependent on the range of responses (i.e., response diversity) within functional groups (Bellwood et al. 2004) and the redundancy of functions. Functional redundancy results when there are multiple species that can fill the same function or role in an ecosystem. In response diversity, individuals within a species or species within a functional group vary in their ability to deal with or respond to perturbations to system properties (Solbrig 1994), thereby enabling some species to survive and the system to continue operating. In cross-scale redundancy, members of the same functional group have influence at different scales. A functional group is a construct of organisms that typically perform the same function or processes (i.e., specific ecosystem-level biogeochemical processes [Vitousek and Hooper 1994]) in an ecosystem (Bellwood et al. 2004).

The difference between functional redundancy and response diversity is that functional redundancy will be ineffective if every species of the same functional group interacts in the same manner (Bellwood

et al. 2004). For this reason, the value of high functional richness and redundancy is lost if redundant species do not "respond" differently to different stimuli (Bellwood et al. 2004). Response diversity is critical, as the interaction between species and stimuli is scale dependent (Nystrom 2006). Resilience results from species diversity, which increases the redundancy of species (Lawton and Brown 1993), and the increased biodiversity can increase the range of responses by individual species within such functional groups; the result is species may fill a function both within and across ecosystems (Solbrig 1994).

The multiple but distinct scales of self-organization and the distribution of function within and across scales also create resilient systems (Peterson et al. 1998). A system's resilience is dependent on the interactions between structure and dynamics at multiple scales (Garmestani et al. 2009). Because we cannot identify which species, functions, or responses are "key" to ecological resilience, caution dictates the wisdom of preserves of large regional species pools in heterogeneous locations to increase the chances that resilience will be maintained over time (Virah-Sawmy et al. 2009).

Resilience-based management focuses on specific attributes or drivers of complex ecological systems and crafts guiding principles for human intervention to improve long-term performance of the systems (Zellmer and Gunderson 2009). Within a social-ecological system, resilience reflects a system's capacity to absorb recurrent disturbances to retain essential structures, processes, and feedbacks. Resilience thinking acknowledges the potential for regime shifts, while providing a framework for building adaptive capacity within social-ecological systems.

Wildlife Management and Biodiversity Protection Efforts in the United States

Most environmental and natural resource management approaches in the United States involve a mix of state and federal laws that came into being long before resilience became a theoretical orientation with regard to ecological systems and do not incorporate current scientific understanding or knowledge. The area of biodiversity and wildlife conservation is no exception. In general, individual states are recognized as

having a legitimate sovereign interest in the task of regulating wildlife and the taking of wildlife within their borders. This approach dates back to English common law, which held that all valuable wild species were owned by the sovereignty and "Game could be hunted and harvested only with the Crown's permission" (Freyfogle and Goble 2009, 22). This state regulation of wildlife came with English colonialists to the New World, and the notion remains a part of the American legal system. Along with it came an important limit on this power; "the king was obligated to manage wildlife in the interests of the entire realm, not for personal benefit," and so contemporary wildlife management is subject to public trust principles (Freyfogle and Goble 2009, 23).

State control over wildlife has resulted in a fragmented system, in which each state creates its own rules and limits on the harvest of wildlife. It was almost immediately obvious that this was problematic, particularly with regard to migratory species. States had little incentive to limit harvest within their jurisdiction only to see the benefits obtained elsewhere. A primary example of this problem can be found in the extinction story of the American passenger pigeon (*Ectopistes migratorius*). Once one of the most abundant bird species in North America, the American passenger pigeon provides a cautionary tale of wildlife mismanagement (Forbush 1927). Its demise was the result of a combination of three factors relevant to biodiversity protection—a lethal combination of limited perception, fragmented management authority, and new technology. First and foremost, the species was perceived to be an inexhaustible resource. Pigeons were so numerous their flocks literally darkened the skies during their migration, and it was considered inconceivable they would ever be anything else. As a result, there were virtually no limits on their harvest. The second primary factor was increased technological capacity. While netting and gunshot were used to kill pigeons in great numbers, it was the advent of two new technologies that brought the species' rapid decline: the railroad and the telegraph. Combined, they allowed hunters to track the birds wherever they went, and soon entire flocks were captured and brought to market before they could reproduce and replenish their numbers. Third, state ownership of wildlife meant that each state was responsible for regulating harvest of the pigeon and other migratory birds only within their own borders, and states were reluctant to set limits on profit making in

their own states when the benefits were sure to be reaped outside their borders. There were some last-ditch attempts at a multistate agreement placing limits on harvest, but these efforts came too late for the pigeon. The species went extinct in 1914 (Forbush 1927).

Jurisdictional limitations associated with state management have continued to relegate many state programs to a fairly limited focus in terms of wildlife management. Fontaine (2011) notes that in 2002, Congress created the State Wildlife Grant program to provide funding to state fish and wildlife management agencies, with the goal of maintaining biodiversity and avoiding the federal listing of species under the ESA. Still, he observes that state programs tend to focus on either regulating the harvest of game species or offsetting federal ESA listings, leaving the vast majority of species without any regulation or legal protection (Fontaine 2011).

Goble and Freyfogle (2002) place federal wildlife laws into three main categories (Table 2.1). The first category contains laws concerned with regulating and/or prohibiting the harvest or "take" of specific species. They include the Lacey Act (1900, 1981), the Migratory Bird Conservation Act of 1929, the Wild Free-Roaming Horses and Burros Act of 1971, and the Marine Mammal Protection Act of 1972. In the second category are those laws focused on funding, managing, and maintaining specific wildlife habitats. Funding-focused statutes in this category include the Migratory Bird Conservation Act of 1929, the Migratory Bird Stamp Act of 1934, and the Land and Water Conservation Fund Act of 1965, Refuge management statutes in this category include the National Marine Sanctuaries Act of 1972 and the National Wildlife Refuge System Administration Act of 1966 which was substantially amended in 1997 in a manner that provided a fourth unifying vision for the more than 545 national wildlife refuges across the United States. Next, there is the category of land and water management statutes that address wildlife and biodiversity issues as one aspect of a larger suite of management duties. These include the National Park Service Organic Act of 1916, the Wilderness Act of 1964, Wild and Scenic Rivers Act of 1968, the National Forest Management Act of 1976, and the Federal Land Policy and Management Act of 1976. Finally, there is the ESA, arguably the one law in the United States specifically and exclusively concerned with protecting

TABLE 2.1 Key Federal Wildlife Statutes

Statutes	Purpose, policy, and key provisions
1. Laws with a species-specific focus	
Lacey Act of 1900	Enacted in 1900, when illegal hunting threatened many game species; first federal wildlife statute with a national scope. It prohibits trade in wildlife, fish, and plants that have been illegally taken, transported, or sold.
Migratory Bird Treaty Act of 1918	Implemented the 1916 Convention between the United States and Great Britain (for Canada) for the protection of migratory birds. Later amendments implemented similar treaties with Mexico, Japan, and Russia.
Wild Free-Roaming Horses and Burros Act of 1971	"It is the policy of Congress that wild free-roaming horses and burros shall be protected from capture, branding, harassment, or death; and to accomplish this they are to be considered in the area where presently found, as an integral part of the natural system of the public lands." "All wild free-roaming horses and burros are hereby declared to be under the jurisdiction of the Secretary for the purpose of management and protection in accordance with the provisions of this Act."
Marine Mammal Protection Act of 1972	Congress declared that all species and population stocks of marine mammals are or may be in danger of extinction or depletion due to human activities, and these mammals should not be permitted to diminish below their optimum sustainable population; prohibits the hunting, killing, capture, and/or harassment of marine mammals, and enacts a moratorium on the import, export, and sale of any marine mammal, along with any marine mammal part or product within the United States. First federal law with explicit ecosystem focus.
2. Laws with a habitat acquisition and management focus	
Migratory Bird Conservation Act of 1929	This law established a Migratory Bird Conservation Commission, which was empowered to approve areas recommended by the secretary of the interior for acquisition with Migratory Bird Conservation Funds. These areas were selected specifically to maintain and develop refuges for North American birds.
Migratory Bird Stamp Act of 1934	Requires use of a migratory bird stamp for hunting and raises funds for the conservation of migratory waterfowl by the 1916 migratory bird treaty between the United States and Great Britain (for Canada). All moneys received from stamp sales are used for migratory bird conservation.
Land and Water Conservation Fund Act of 1964	Authorizes federal assistance to the states in planning, acquisition, and development of needed land and water areas and facilities, and provides funds for the federal acquisition and development of lands to enhance the quality and quantity of outdoor recreation. The primary sources of income to the fund are revenues from federal drilling offshore for oil and gas development.

(*Continued*)

TABLE 2.1 Key Federal Wildlife Statutes (*continued*)

Statutes	Purpose, policy, and key provisions
National Marine Sanctuaries Act of 1972	Enacted to protect significant marine habitats and special ocean areas, such as national marine sanctuaries. It authorizes the designation and management of areas of the marine and Great Lakes environment that are considered to be nationally significant and that merit federal management. Designated areas are managed for multiple uses deemed compatible with resource protection.
National Wildlife Refuge System Administration Act of 1966, as amended in 1997	Consolidated the various categories of lands into a single National Wildlife Refuge System. Amended in 1997, the National Wildlife Refuge System Improvement Act provides an organic act for the refuge system and sets forth unifying management principles for the more than 545 national wildlife refuges across the United States.
3. Other laws with mandates that include a combined species and habitat focus	
National Park Service Organic Act of 1916	Authorizes the designation of national parks and monuments ". . . to conserve the scenery and the natural and historic objects and the wildlife 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." While not directed at wildlife protection per se, the law's preservation mission creates opportunities for habitat conservation and species protection. Hunting is not generally allowed in national parks.
Wilderness Act of 1964	Establishes the National Wilderness Preservation System, an area in which "the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain." Wilderness areas are generally roadless, undeveloped federal lands without permanent improvements or human occupation and are managed so as to preserve their natural conditions.
Wild and Scenic Rivers Act of 1968	Allows for the designation as "wild and scenic" rivers that possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values. Wild and Scenic rivers are preserved in free-flowing conditions (i.e., no dams), and their immediate environments are protected for the benefit and enjoyment of present and future generations.
National Forest Management Act of 1976	Amending the Forest and Rangeland Renewable Resources Planning Act of 1974 and in accordance with the Multiple-Use, Sustained-Yield Act of 1960, this law authorizes the secretary of agriculture to develop a program for lands managed by the U.S. Forest Service. The law directs management of renewable resources on these lands based on multiple-use, sustained-yield principles, as well as the development and implementation of resource management plans for each unit of the National Forest System. It is the primary statute governing the administration of national forests. The law includes a specific requirement related to management of a diversity of plant and animal communities.

Federal Land Policy and Management Act of 1976	Constitutes the organic act for the Bureau of Land Management and directs its lands to be managed based generally on multiple-use and sustained-yield principles. This law specifically directs public lands be managed to protect the quality of ecological resources and to provide food and habitat for fish and wildlife. It also provides for the protection of public lands of critical environmental concern.
4. Law with a biodiversity focus	
Endangered Species Act of 1973	Provides for the protection of species threatened with or in danger of extinction. This law explicitly references the need for conservation of not only species but also the ecosystems on which they depend. It authorizes a process for the listing of species under the act and for the designation of critical habitat necessary for species recovery. Details regarding statutory provisions are found in Table 2.2.

Note: This list is not comprehensive. See Goble and Freyfogle (2002) for a complete review of applicable statutes.

species and the ecosystems on which they depend, which will be discussed extensively below.

As can be seen from this brief summary and the outline of statutory purposes provided for each of these laws, federal wildlife protection in the United States reflects a piecemeal approach. Early on, federal efforts attempted to address the limits on the ability of individual states to conserve wildlife and began with efforts to protect migratory birds. The funding and acquisition of wildlife habitat complemented these initial efforts to protect migratory species and coincided with early decisions to reserve forest lands under federal protection and designate national parks beginning in the late 1800s and continuing through the Great Depression. The focus of these laws was largely human-centered enjoyment of hunting and other recreational values related to wildlife. It was not until the 1960s and 1970s that the rise of the ecology movement set in motion the enactment of a suite of natural resource protection laws with a more ambitious and slightly less anthropogenic focus that mixed both individual species and habitat and land management concerns. For the most part, these laws reflect the "multiple use-sustained yield" principles of the era that continue to be a primary governing principle to this day (Nie 2009). Only one law sought to protect species directly and exclusively, and thereby indirectly can protect biodiversity: the ESA.

The Endangered Species Act: Our Current Approach to Biodiversity Protection

The ESA is the strongest federal protection against species loss (Salzman and Thompson 2010). It was passed into law in 1973 during a time of unprecedented optimism in the United States with regard to our ability to have both a healthy environment and unlimited economic prosperity (Shellenberger and Nordhaus 2007). It embodies a view of species as parts—components of a larger ecosystem that are worth saving, even when there is little understanding regarding why they might be important. The ESA has become the major driver of most large-scale biodiversity protection and habitat restoration efforts in the United States (Benson 2012). To understand why the ESA has been so influential, it is important to understand the basic requirements of ESA and how they operate. The key provisions of the ESA are summarized in table 2.2.

TABLE 2.2 Key Provisions of the Endangered Species Act

Provision	Statutory section	Description and enforceability
Purpose and policy; ESA section 2	16 U.S.C. § 1531	To provide: "a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species."
Definition of "take; ESA section 3	16 U.S.C. § 1532	"Take" is broadly defined to include any actions that harm species, including "habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering."
Listing; ESA section 4	16 U.S.C. § 1533(a)(1)	The listing is deemed appropriate if the continued existence of the species is jeopardized by one or more of the following factors: (1) the present or threatened destruction, modification, curtailment of the species' habitat or range; (2) overutilization for commercial, recreational, scientific, or educational purposes; (3) disease or predation; (4) inadequacy of existing regulatory mechanisms; or (5) "other factors" affecting the species' continued existence (16 U.S.C. § 1533(a)(1)). Several hard deadlines for acting on listing decisions are given.

Critical habitat designation; ESA sections 3 and 4	16 U.S.C. §§ 1532 (5)(A), 1533(a)(3)(A)	"Critical habitat" is defined as: (1) specific areas within the geographical area occupied by the species at the time of listing, if they contain physical or biological features essential to conservation, and those features may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species if the agency determines the area itself is essential for conservation. Economic factors are considered in designation. Alteration of critical habitat triggers the consultation requirement. Critical habitat must be designated concurrently or within one year of decision to list.
Recovery plans; ESA section 4(f)	16 U.S.C. § 1533(f)	Recovery plans must contain: (1) objective measurable criteria for delisting the species; (2) site-specific actions; and (3) estimates of the time and cost for implementing the recovery plan. This is a guidance document that is not independently enforceable under ESA section 11.
Consultation process; ESA section 7	16 U.S.C. § 1536	Requires all federal agencies to consult with the appropriate wildlife agency to ensure their actions are not likely to jeopardize the continued existence of listed species or result in destruction or adverse modification of critical habitat. Compliance is mandatory; failure to engage in consultation legally enforceable.
Prohibition against "take"; ESA section 9	16 U.S.C. § 1540	It is illegal to "take" a listed species (see definition above) without a permit under sections 7 or 10. Seldom enforced against private parties due to burden of proof issues—must show "actual injury" to listed species.
Habitat conservation planning and nonessential/ experimental populations; ESA section 10	16 U.S.C. § 1539	Exceptions to "take" prohibition. Allows for permits for incidental take to be granted in association with the development of habitat conservation plans on private lands and the establishment of and maintenance of experimental populations to facilitate recovery.
Citizen enforcement mechanism; ESA section 11	16 U.S.C. § 1540 (g)	Section 11 provides for civil and criminal penalties for ESA enforcement. Subsection (g) allows any citizen to petition for listing of a species and/ or to compel the government to perform nondiscretionary duties under the law (e.g., engage in consultation under section 7).

When Congress passed the ESA, it recognized that depleted species are of "esthetic, ecological, educational, recreational, and scientific value to our Nation and its people" and expressed concern that many native plants and animals were in danger of becoming extinct (USFWS 2011b). The ESA was therefore passed into law with the ambitious purpose of providing "a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species" (ESA § 1531).

The main mechanism for biodiversity protection under the ESA is the placement of individual species on the official list of species that are either in danger of extinction or under the threat of becoming endangered (i.e., "threatened or endangered"). The list is created and maintained by the two federal agencies with the primary responsibility for ESA implementation and enforcement: the USFWS for land and freshwater species and National Marine Fisheries Service for marine and anadromous species. The decision regarding whether to list a species as threatened or endangered is supposed to be based on "the best scientific and commercial data available" (ESA § 1533(b)(1)(A)). Economic or other social considerations are not considered. Listing is deemed appropriate if the continued existence of the species is threatened by one or more of the following factors: (1) the present or threatened destruction, modification, curtailment of the species habitat or range; (2) overutilization for commercial, recreational, scientific, or educational purposes; (3) disease or predation; (4) inadequacy of existing regulatory mechanisms; or (5) "other factors" affecting the species' continued existence. These listing factors provide the government with a great amount of discretion regarding the decision whether to list a species.

Any citizen or group of individuals can petition the government to list a species under the ESA. In fact, most of the species currently listed receive protection as a direct result of citizen petitions. Once a petition is received, the government has 90 days to make a finding regarding whether the petition presents sufficient information to require further review. If a determination is made that the listing of a species may be warranted, the government announces that it will conduct a review of the relevant scientific information. This is often referred to as a 12-month status review, and as the name suggests, the agency has one

year to make a decision. At the end of the 12 months, the agency can do one of three things: (1) it can reject the listing petition, (2) it can determine that listing is "warranted but precluded" by other petitions, or (3) it can propose to list the species. If the government decides to propose the listing of a species, it then has one additional year to issue a final listing decision. The final listing decision then triggers a number of other obligations under the ESA, including the development of a recovery plan, the designation of critical habitat for the species, and a review of the listing decision every five years. Not only does a citizen petition force consideration of a particular species, it sets off a cascade of duties and deadlines. At each stage in the process, the government may be challenged in court. Many of the deadlines are "hard" (the 12-month status review, the final listing decision, and the critical habitat designation) in the sense that, as soon as the government misses the deadline, it is in violation of the ESA and vulnerable to a lawsuit. This process is one reason why ESA enforcement results in so much litigation, which in turn makes it one of the more controversial environmental statutes of its era.

Once a species is listed, a number of protections immediately fall into place. It becomes illegal to "take" a listed species, with limited exceptions. The term "take" is broadly defined to include any actions that harm the species, including "habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering" (50 CFR § 17.3). Listing triggers the requirement that the appropriate wildlife agency designate critical habitat for the species either concurrently with the listing of the species or within one year of listing. Though the critical habitat designation includes all habitat area considered essential to the conservation of a listed species, this is one area in which economic considerations can come into play, and the agency is allowed to consider the economic or other impact of the designation on humans.

Critical habitat becomes important with regard to the activities of federal agencies, because the proposed adverse modification of critical habitat triggers the ESA's consultation requirement. Under Section 7 of the ESA, all federal agencies are required to consult with the appropriate wildlife agency to ensure their actions are not likely to jeopardize the continued existence of listed species or result in destruction or adverse modification of critical habitat. The consultation process applies to all

federal "actions," a term broadly defined by the courts to include not only direct construction projects but also the granting of licenses and contracts and the promulgation of regulations (Sullins 2001). For example, the annual delivery of water under Federal Bureau of Reclamation water service projects has been a source of much ESA litigation and is the main reason why the ESA has been described "as the major federal environmental constraint on water" (Tarlock 2004, 2008).

Once an action agency determines that its proposed activity may affect a listed species or its critical habitat, it proceeds in one of two directions (Figure 2.2). If the activity "may affect, but is not likely to affect" the species, the consultation required is "informal." Informal consultation involves the action agency and the appropriate wildlife agency to share information regarding the proposed activity to assist the action agency in determining whether formal consultation is necessary. If the agencies conduct a "Biological Assessment" and determine the proposed activity is not likely to adversely affect the species or its critical habitat, no further consultation is required.

If, however, either through informal consultation or because the action agency is already certain the action "may affect and is likely to affect" the species, formal consultation is required. Formal consultation is a comprehensive process that results in the issuance of a Biological Opinion, an analysis of whether the proposed action would be "likely to jeopardize the continued existence of the species or adversely modify designated critical habitat" (ESA § 7). If a jeopardy determination is made, the Biological Opinion identifies any "reasonable and prudent alternatives" that would allow the action agency to move forward with the proposed activity. Biological Opinions include an Incidental Take Statement, anticipating that some "take" of species may result from the proposed project. The Incidental Take Statement includes terms and conditions designed to reduce the impact of the anticipated "take" that are binding on the action agency (USFWS 2007).

Finally, the ESA provides for the development of recovery plans for listed species. Recovery plans must contain objective measurable criteria for delisting, the species site-specific actions, and estimates of the time and cost for implementing the recovery plan. In theory, the recovery plan functions as the central organizing tool for guiding the recovery process for each species and for implementing the ESA as a whole.

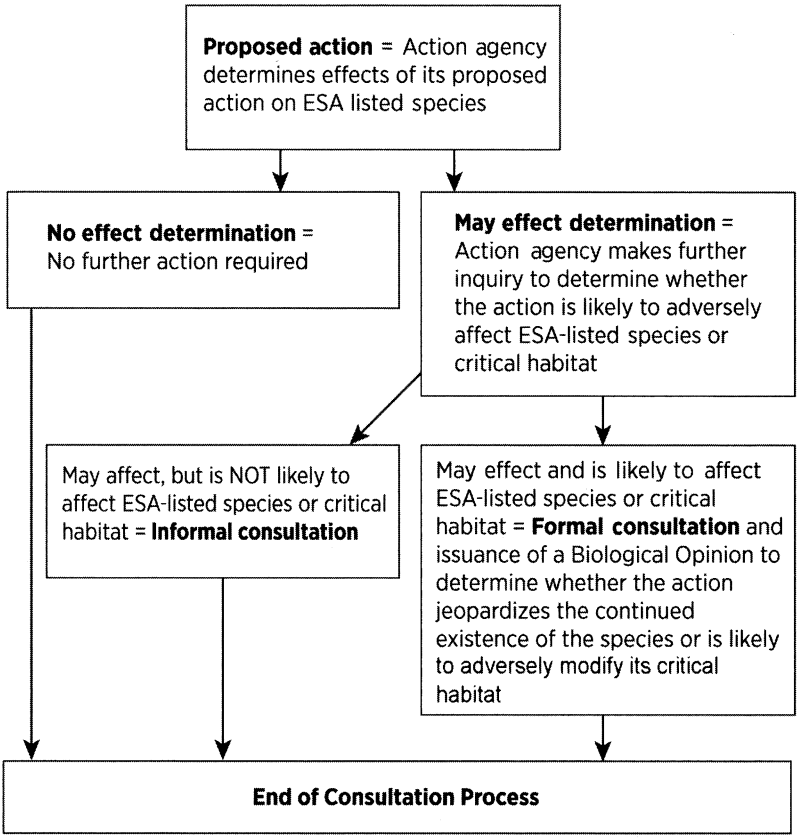

FIGURE 2.2. The ESA consultation process.

In actual practice, however, the lack of easily enforceable deadlines for developing and updating recovery plans, combined with the fact they are guidance documents and not independently enforceable, means they are often less influential than perhaps originally intended.

In summation, the ESA is a relatively simple and straightforward statute. Its uncompromising attitude toward species recovery and its many legally enforceable deadlines has made it one of the more controversial and highly litigated environmental laws in the United States. First and foremost, the ESA is helpful, because it gives biodiversity a seat at the table. There is little question the ESA has had enormous benefits

related to the protection of biodiversity (Scott et al. 2005). Although some critics claim the ESA has been unsuccessful in achieving species recovery, it depends on which half of the glass you choose to focus. Since its enactment, only forty-two species have been delisted—and of those fifteen were delisted because they recovered. On the other hand, the ESA is estimated to have prevented 2,227 species from going extinct (Salzman and Thompson 2010). Moreover, the mere possibility of listing a species under the ESA often inspires efforts to protect the species, pre-empting the need for listing.

Without some legal mechanism for actually valuing biodiversity and other ecosystem services more broadly, the ESA has become a primary tool in the area of wildlife management and biodiversity protection. There are many other biodiversity protection tools provided for in the ESA, including programs designed to create incentives for owners of private lands, among them are habitat conservation plans and safe harbor agreements not discussed here. It is important to acknowledge the ESA has resulted in an unprecedented level of effort for the protection of species (Goble 2005). However, as will be discussed in the next section, the general framework and approach to wildlife protection reflected in and operationalized by the ESA has its limits.

Limitations of the Endangered Species Act and Other Current Wildlife Laws from a Resilience-Based Perspective

Although the law as currently enforced focuses on individual species, the overarching purpose of the ESA is to protect and recover imperiled species and the ecosystems on which they depend. Legislative history indicates that Congress is concerned with ecosystems, as demonstrated "in the legislative history's proclamation that the ESA's 'essential purpose' is 'to protect the ecosystems upon which we and other species depend' " (Blumm and Kimbrell 2004, 351). Viewed from the perspective of resilience theory, the ESA has several limitations. The first point is perhaps the most obvious. The ESA focuses on the well-being of individual species rather than that of ecosystems, and it has long been recognized that a better approach would be to protect large areas of land as well as interacting components of ecosystems (function, processes,

communities, etc.; Franklin 1993). Whereas the law itself acknowledges the importance of the "ecosystems upon which endangered species and threatened species depend," the actual implementation of the law is currently geared toward the listing and eventual recovery of individual species. If the goal is to protect biodiversity, the number of species needing protection for system resilience is too great to approach protection for each one on an individual basis (e.g., Franklin 1993). While enforcement agencies occasionally list several species conjunctively, success or failure of management efforts is tied to the recovery of individual species and not ecological resilience. Even the critical habitat designations for species center on the needs of individual species rather than the ecosystem. One unintended consequence of this approach is that there are often conflicts over the competing needs of species. A recent example can be found in the needs of the Steller sea lion (*Eumetopias jubatus*)—a species protected under the Marine Mammal Protection Act—and endangered Chinook salmon (*Oncorhynchus tshawytscha*) in the Pacific Northwest. Litigation has ensued over attempts to control sea lions as they encroach further into the Columbia River system in search of food, thereby inhibiting salmon recovery efforts (Milliman 2011). Aldo Leopold famously wrote "To keep every cog and wheel is the first precaution of intelligent tinkering" (1949, 190). One of the unintended consequences of the ESA is that it has concentrated management efforts on "parts" at the expense of a more complex assessment of the resilience of social-ecological systems.

The second limitation of the ESA relates to the fact the law only begins to protect species when they are threatened with or in danger of extinction. For this reason, the ESA has been referred to as an "emergency room" approach to protect species (Salzman and Thompson 2010, 277). It is initiated only when there is specific scientific information supporting the decision that a species is on the brink of extinction. This is problematic from a resilience standpoint for two reasons. First, the emphasis of resilience-based management is on the capacity of a system to maintain essential processes and feedbacks based on self-organization. The system is functional to the extent that it does not require external intervention by humans to maintain itself. By its very nature, an ESA listing of a species and the associated protections the species receives do not kick in until management efforts to save the

species are required. The management efforts can range from relatively straightforward (i.e., banning DDT to save peregrine falcons [*Falco peregrinus*]) to much more complex (recovery needs for anadromous fish species, e.g., salmon [*Oncorhynchus* spp.], in the Columbia River Basin and the associated harvest issues, operation of dams, etc.). Second, because species only receive protection when they are in precipitous decline, there is limited capacity for the level of experimentation often necessary to better understand the needs of the endangered species or its role in the ecosystem. Although the ESA does provide for the designation of nonessential/experimental populations of imperiled species under Section 10(j), reintroduction efforts, hatcheries, and other processes that take place under this provision are highly regulated and limited in their flexibility.

The third major limitation of the ESA from a resilience perspective is the ESA's main enforcement focus on federal agency actions. Much of the ESA's implementation has focused on litigation-driven listing decisions, including actions related to USFWS's ability to meet the various deadlines associated with the listing process. As a result, the focus regarding ESA implementation is often on this listing process itself. While listing is important, it is only the beginning of a long process. Furthermore, the focus on federal agency action is very limiting, given that private land comprises approximately 60 percent of land in the United States, and the percentage of important remaining habitat (e.g., forest lands at 72 percent) is often much higher (USFWS 2001; U.S. Department of Agriculture 2002). As a result of the ESA enforcement and design, many of the habitat alterations that threaten species, such as land use planning decisions, fall outside federal jurisdiction. Most species protection on private lands occurs through voluntary agreements under the safe harbor and habitat conservation planning provisions of the law (Sullins 2001). The consultation process is mandatory. It is also time-consuming. Although the consultation process addresses the adverse modification of critical habitat, the focus is only on the need of the listed species and the ESA's prohibition against the alteration of critical habitat provisions only applies to federal actions.

Finally, and perhaps most importantly, the ESA struggles to accommodate a resilience perspective, because the law itself is based on outdated assumptions regarding ecological equilibrium and stationarity

and it builds in an assumption that biological systems are basically static systems composed of a suite of unchanging variables. The policies and goals of the law focus on restoration and recovery, as opposed to resilience and adaptive capacity (Thrower 2006). Therefore, while legal scholars such as Robin Craig (2010) are starting to realize that "stationarity is dead," assumptions about stationarity are alive and well in our environmental laws. Failure to embrace the complexities associated with ecological systems, including their capacity for regime change, makes the ESA limited in terms of its capacity to address the challenges ahead—most notably the "no analog" future brought by global climate change (Ruhl 2008a). The use of a list as the major vehicle for species protection reduces the focus to one of parts rather than systems, even though the threats to those species are almost always systemic.

Conclusion

For wildlife management in the United States to be more integrative of resilience theory, several changes must be made. The recommendations below may seem dramatic, but they are achievable without congressional amendment of the ESA. Whereas the ESA as currently enforced focuses on individual species, its overarching purpose is to protect not only imperiled species but also their associated habitats: "the ESA's 'essential purpose' is to protect 'the ecosystems upon which we and other species depend' " (Blumm and Kimbrell 2004, 351). First and foremost, there is a need to shift our management strategies from a species-centered to a systems-based approach. Moving from a focus on specific species or even particular habitats to one that seeks to understand system dynamics will allow our efforts to better capture the complexity associated with the challenges of biodiversity loss. Although ecology, by its very nature, takes a systems approach, conservation biology is increasingly focused on systems (e.g., Nassauer 2006), but the laws that currently govern state action (as described in Table 2.1) do not reflect these approaches and this understanding of the natural world.

A systems-based approach will require several basic shifts in our current thinking and management approaches (Benson and Garmestani 2011). Chief among the shifts required will be a more integrated

approach to governance that includes a willingness to reassess demands placed on ecological systems by our social systems (e.g., water allocation priorities and land use decisions) in recognition of the interconnectedness of social-ecological systems (e.g., Nassauer 2006; Benson and Garmestani 2011). New approaches need to allow for the formulation of meaningful responses that foster biodiversity while increasing our understanding of the systems involved (Nassauer 2006). Adaptive management is a vehicle for achieving the integration of resilience theory into decision making to protect biodiversity (Holling 1978). A central tenet of adaptive management is the embrace of uncertainty and complexity in natural systems and recognition that "management involves a continual learning process that cannot conveniently be separated into functions like 'research' and ongoing 'regulatory activities,' and probably never converges to a state of blissful equilibrium involving full knowledge and optimum productivity" (Walters 1998).

Although adaptive management is increasingly embraced by federal agencies and is now a major organizing principle for many ESA efforts (Williams et al. 2009), the underlying theory of resilience is not necessarily being embraced, because the law itself does not easily accommodate a resilience perspective. There are exciting developments on the integration of adaptive management for species conservation from outside the ESA context that may provide important guideposts for the future. Examples include the Conservation Measures Partnership's development of a set of "Open Standards for the Practice of Conservation" designed to facilitate conservation project design, management, and monitoring to help practitioners improve the practice of conservation (Grantham et al. 2010) and the Draft Strategic Plan for Responding to Accelerating Climate Change for the National Wildlife Refuge System (2010), which embraces ecological resilience as an organizing principle.

The second and related issue is that managing for resilience will require us to be more proactive in our management efforts and to support the functioning of system feedbacks and processes before they are endangered and on the brink of regime change. This will require a better understanding of how systems function and what properties (i.e., species and their interactions) impart resilience to a given system. As discussed above, the ESA emergency room approach has a limited capacity to meet the challenges ahead. Just as an emergency room is

no place for the treatment of chronic conditions, biodiversity protection requires a more preventative strategy. Furthermore, the ESA listing process, which takes a linear approach to species listing and management, does not accommodate the reality that many species are and will continue to be "conservation-reliant," in the sense that maintenance of viable populations of many species will require continuing, species-specific intervention (Scott et al. 2005, 2010). In their coining of the term *conservation-reliant*, Scott et al. (2005, 2010) argue for a new relationship to the concept of recovery under the ESA. They suggest that viewing "recovery" as a continuum of states rather than a simple "recovered/not recovered" dichotomy may enhance our ability to manage such species within the framework of the ESA. A resilience-based framework would also strengthen the role and authority of recovery planning as an organizational tool.

Next, there is a need to embrace more intentionally polycentric approaches to governance, including approaches that go beyond traditional jurisdictional boundaries and authorities. A systems-based approach will need to take on the challenges and opportunities associated with both management gaps and the overlapping nature of jurisdictional issues related to wildlife management, including nongovernmental efforts to protect species such as the Nature Conservancy's conservation inventories and Conservation by Design strategy (Noss 1987; Nature Conservancy 2000). As Cosens (2010) recently observed, "adaptive governance moves from a focus on efficiency and lack of overlap among jurisdictions to a focus on diversity, redundancy, and multiple levels of management that include a role for local knowledge and local action" (239). To date, the ESA and its enforcement have focused mainly on federal actions, whereas state wildlife management focuses on game species. More ambitious approaches are needed that take advantage of current state, federal, and private authorities in a coordinated way. Fortunately, our capacity to generate, coordinate, and share data and other information related to biodiversity has never been greater. Seemingly ever-increasing technological capacities related to geographic information science, remote sensing, and other tools allow for a much more integrated approach to experimentation, decision making, and governance.

Finally, a resilience perspective will move management to a much-needed focus beyond notions of preservation, restoration, and optimization.

Virtually all of our current management approaches are based on assumptions of system equilibrium and are made at spatial and temporal scales that do not reflect the current understanding in ecology and conservation biology. They also tend to focus on anthropocentric notions of optimization and efficiency. The early environmental history of wildlife protection and migratory birds provides an excellent example. However, as Walker and Salt (2006, 141) note, "optimization (in the sense of maximizing efficiency through tight control) is a large part of the problem, not the solution. . . . When the aim is to increase the efficiency by trying to tightly control it, we usually do so at the cost of the system's resilience." Similarly, Grantham and others (2010) observe that "conservation planning is a dynamic process, the science of which has generally focused on one-time-only assessments of optimal protected area configuration" (436). They suggest a shift to a more adaptive approach to the conservation planning process that more deliberately includes incorporating learning back into conservation design.

The challenge of moving away from optimization and preservation focuses is made more necessary when we are confronted with the realities of climate change. The future will require us to be more intentional in assessing the role of management in climate change mitigation and adaptation. For the most part, state and federal management approaches still fail to face this reality. ESA is perhaps the predominant example, in that it assumes recovery efforts based on historic ranges for species and does not easily accommodate the notion of shifting habitats, migration patterns, and the need for ongoing management. And yet, the ESA has been used by environmentalists to drive climate change action at the federal level, successfully moving for the listing and critical habitat designation of the polar bear (*Ursus maritimus*) as the first mammal listed with climate change as the primary threat to its recovery (Ruhl 2008).

The challenges associated with current and projected rates of biodiversity loss are great. Resilience thinking has the capacity to allow for a more meaningful response to these challenges, providing a conceptual basis for understanding regime change and providing a framework for maintaining or improving adaptive capacity. From a governance perspective, any real integration of resilience theory will require a number of changes in our approach to governance, including new laws and institutions that better equip us to face and acknowledge that regime

shifts are occurring, can be natural or human-induced processes, and will continue to occur. Questions surrounding the appropriate roles of mitigation and adaptation responses will frame the future of biodiversity protection. To date, the ESA has dominated in the federal approach to biodiversity protection. However, for the reasons outlined in this chapter, it is now time to address wicked problems that are beyond the capacity of ESA's statutory framework. By moving to a more complex, systems-based approach, we can craft biodiversity protection approaches that are more reflective of our increasing understanding of the complexity of both social and ecological systems.

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