The Role of Exotic Species Within Ecosystem Management

by Deborah R. Dyer

Introduction

Exotic species[1] are part of the landscape of the United States. According to one estimate, at least 4,500 exotic species have established free-living populations in this country.[2] Most exotic species are imported in association with human activity, transport, or habitat modification that provide opportunities for establishment.[3] Many exotics are beneficial.[4] Others are extremely harmful.[5] The human introduction of exotic species into purportedly natural ecosystems has been implicated in the extinction of many native species.[6] Thus, the toll of exotic species on ecosystems ranges from wholesale ecosystem changes, such as extinction of native species, to more subtle changes, such as biological diversity destruction.[7]

Federal statutes generally do not regulate management of exotic species within ecosystems.[8] States also lack efficient regulatory tools to manage exotic species on an ecosystem level.[9] Significant regulation gaps exist in both jurisdictions for management of exotic fish, wildlife, animal diseases, weeds, and species that affect nonagricultural areas.[10]

The issues involving the role of exotic species in ecosystem management are very complex. Part I of this paper examines some of these issues. This section explores the impacts of exotic species by looking at exotic trout in the Sierra Nevada. Next, Part II discusses federal environmental laws and policies for their ability to address the role of exotics in ecosystem management. Finally, Part III analyzes the difficulties exotic species present, including definitional problems and value judgment problems.

I. The Issue

A. The Bias Against Exotic Species in Ecosystem Management

The theoretical emphasis in preserving biodiversity through ecosystem management has focused on managing for native species, not exotic species. The Counsel on Environmental Quality (CEQ) defines the objective of biodiversity conservation as maintaining "naturally" occurring ecosystems and native species.[11] The CEQ has developed eleven principles of ecosystem management.[12] Although all principles focus on maintaining "natural systems and patterns," one is specifically designed to "promote native species and avoid introducing exotic species."[13] This preference toward native species is echoed by Edward Grumbine, a leading authority on ecosystem management. Grumbine advocates ecosystem management goals that include maintaining viable populations of all native species in situ.[14] He also advocates goals that represent all native ecosystem types across their natural range of variation.[15]

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Thus, the emphasis in ecosystem management has been on maintaining native diversity rather than diversity per se. Some commentators supporting this approach have stated that while introduction of exotics can increase species richness on a small scale, exotics do nothing but pollute the integrity of

an ecosystem.[16] Other supporters claim that exotics not only displace native species but also disrupt ecosystem functions.[17]

In contrast, detractors from the emphasis on native species dismiss the distinction between exotic and native species in ecosystem management.[18] They claim that the status of a species, whether exotic or native, is subjectively relative.[19] The result of such relativity is that there is no significance in applying the label "native" for ecosystem management purposes. However, the visible impacts of recently introduced exotics are so great that most authors feel justified making such distinctions.[20] One example of an exotic species negatively impacting an ecosystem is the introduction of borwn trout into the Sierra Nevada ecosystem.

B. A Case Study: The Impacts of Exotic Trout Species in the Sierra Nevada

Exotic species can have two types of impacts on an ecosystem. The first is a direct reduction of native species population.[21] The second, and closely related impact, is an effect on the general health of the ecosystem.[22] In order to understand these different impacts, a case study is helpful. Researchers have accumulated a vast amount of information on the impacts of exotic fish. Studies have found that exotic trout have caused both specific and general ecosystem changes in the Sierra Nevada ecosystem.[23]

1. Direct Reductions of Native Aquatic Species

A large variety of trout have been introduced into the Sierra Nevada.[24] Humans have placed exotic trout into over 70% of the natural lakes in the range.[25] Every introduction impacts native organisms.[26] For example, exotic brown trout[27] commonly feed on a wide variety of native fishes.[28] This has caused a significant decline in several native California populations, particularly salmonids.[29] In the Sierra, exotic trout species have negatively impacted the native Chinook salmon populations by preying on and competing with juvenile salmon.[30]

In addition to reducing native fish populations, exotic trout have also detrimentally impacted native amphibians,[31] including several species of native Sierran frogs and toads, salamanders, newts, turtles, and snakes.[32] Some of these populations are susceptible to local extinction due to their geographical isolation.[33] Exotic trout have further imperiled the delicate amphibian populations by voraciously feeding upon them. In addition to directly decreasing local populations, exotic trout have had negative ecosystem level effects.

2. Ecosystem Level Effects

Exotic trout have had three different ecosystem level effects. First, the trout have caused the extinction of some native species. The waters of the high Sierra Nevada historically had no fish.[34] Scientists believe that the high Sierra ecosystem formerly had large populations of crustaceans and aquatic insects. Introduced trout have depleted or extinguished those populations by preying upon them.[35]

Second, exotic trout can threaten native genetic integrity. In the lower portions of the Sierra Nevada ecosystem, brown trout hybridize with native fish populations.[36] Hybridization produces offspring with reduced growth rates and survival rates.[37] Another threat to native genetic integrity is hatchery fish.[38] Hatchery fish often do not contain the genetic information that wild populations use to

resist disease or environmental change.[39]

Finally, exotic species introduce foreign diseases into the ecosystem. Exotics may carry foreign viruses, bacteria, or parasites that threaten native species.[40] This may be one of the most severe threats exotic species pose to a native population.[41] In addition, high densities of introduced fish have negative effects on natives. Brown trout cause spatial alteration, displacing other species from their native habitats.[42]

II. The Federal Legal Framework

Most environmental laws do not differentiate between exotic and native species in ecosystem management, if they provide for ecosystem management at all. What follows is an examination of some of the federal laws and policies that may influence exotic species within ecosystem management.[43] These laws include the Endangered Species Act, the National Forest Management Act, the Clean Water Act, the National Environmental Policy Act, and the National Park Service Management Policies.

A. The Endangered Species Act

The Endangered Species Act (ESA),[44] on its face, provides for management on an ecosystem level.[45] The ESA does not, however, differentiate between native and exotic species. The protections in the ESA broadly extend to "any species,"[46] "any member of the animal kingdom,"[47] and "any member of the plant kingdom."[48]

The ESA contains two sections that the reader could construe to differentiate between exotic and native species within an ecosystem. The first is the definition of "endangered species."[49] This section defines endangered species as any species threatened with extinction "throughout all or a significant portion of its range."[50] As "range" is defined as the region where a species is normally found,[51] this raises the issue of interpreting "normally found." This section could be construed as prohibiting protection of a species outside its normal, native range. A species outside its native range is, by definition, an exotic species.

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The second section of the ESA that may speak to managing exotic species is the experimental populations section.[52] This section authorizes the Secretary of the Interior to release a population of endangered or threatened species outside the species' current range.[53] The language of this section strongly suggests that the ESA encourages protection of an endangered species outside of its normal range, meaning endangered exotics. In fact, since it allows the Secretary to introduce species into an area where the species is an exotic, this section authorizes the creation and protection of newly introduced exotics.

The ESA in an indirect sense protects native, endangered species and their ecosystems from the introduction of harmful exotics.[54] If the initial introduction of an exotic would harm a protected species or its habitat, the ESA prohibits that introduction.[55] Of course, the issue of causation would be difficult to overcome. The proponent of the prohibition would have to demonstrate that the introduction of the exotic would directly harm the protected species or its habitat. In addition, this prohibition would only

apply to exotics presently being introduced into an ecosystem, not exotics previously existing within the system.

B. National Forest Management Act

The National Forest Management Act of 1976 (NFMA)[56] may be an important tool for maintaining biodiversity on an ecosystem level.[57] Unlike most other environmental laws, NFMA directly addresses the issue of exotic species in the ecosystem, albeit briefly. NFMA mandates the management of fish and wildlife habitat to maintain viable populations of both existing native and desired exotic vertebrate species.[58] Presumably, Forest Service managers retain the discretion to decide which exotic vertebrate species are "desired." The regulations do not specify the criteria managers should base their decisions upon.

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It is interesting to note that NFMA's mandate does not extend to invertebrate species.[59] Thus, the Forest Service's discretion to manage exotic plant species may be limited. NFMA contains a provision that may be construed as a preference for native plants.[60] The last clause of section 1604(g)(3)(B) states that forest service management plans must preserve "the diversity of tree species similar to that existing in the region controlled by the plan."[61] While it is certain that some trees existing in National Forests are not native to the area they now inhabit, section 1604 prevents the Forest Service from creating forests of exotic tree species.[62] This is particularly important in light of the Forest Service's inclination to create monoculture forests of the species producing the best timber.[63]

C. The Clean Water Act

The Clean Water Act (CWA)[64] arguably endorses an ecosystem management approach. The CWA regulates the discharge of pollutants into the waters of the United States. Thus, it is both an issue-specific and a media-specific statute. However, an aquatic system could be considered a distinct ecosystem. Since water pollutants affect aquatic ecosystems, it is appropriate to briefly examine the CWA's directives to manage specific groups of species.

The objective of the CWA is in part to restore and maintain the biological integrity of the nation's waters.[65] This includes attaining fishable, swimmable waters. The CWA states that water quality levels should provide for the protection and propagation of fish, shellfish, and wildlife.[66] Since the beneficiaries of clean water necessarily include exotic, as well as native, species of fish, shellfish, and wildlife, it is safe to say that the CWA does not favor native over exotic species. It would be difficult to distinguish between the two in light of the policies of the CWA.

D. The National Environmental Policy Act

The National Environmental Policy Act (NEPA)[67] does not directly address ecosystem management.[68] Courts and agencies have consistently construed NEPA merely as a procedural statute.[69] Furthermore, NEPA is rarely interpreted to require ecosystem scale environmental analysis.[70] In addition to this limitation, NEPA makes no explicit mention of exotic species. To the contrary, many federal activities relating to exotic species are categorically exempt from NEPA.[71] For example, low-

impact range management activities by the Forest Service, such as seeding, are excluded from NEPA review.[72] Some U.S. Fish and Wildlife Service fish stocking programs are also exempt.[73] In light of these shortcomings, NEPA offers no guidance to land managers regarding exotics within ecosystems.

E. National Park Service Management Policies

There is some question whether the National Park Service (NPS) employs ecosystem management in the parks.[74] The NPS Organic Act mandates protection of the scenery and wildlife within national parks.[75] Many commentators argue that the Organic Act gives the NPS unexercised authority to manage ecosystems by asserting its power on transboundary issues.[76]

Whether or not the NPS sufficiently employs ecosystem management, it does manage exotic species[77] and native species[78] differently within park boundaries. The NPS strives to maintain native animal populations, while exotics are regulated for population control.[79] The NPS goals include the reintroduction of native species that have disappeared due to human influences on the ecosystem.[80] This policy is subject, however, to the discretion of Secretary of the Interior.[81] At the Secretary's direction, NPS personnel may destroy native species that are detrimental to the parks.[82] Thus, legally imposed management for native species is subject to value judgments based on the benefit (or detriment) of maintaining such species.[83] The same value judgments are applicable to the management of exotic species.

III. Analysis

A. Problems in Evaluating the Role of Exotics within Ecosystems

Many hurdles exist in determining what role exotics should play in ecosystem management. Several of these hurdles are definitional in nature. The first obstacle is the vagueness of the term "ecosystem" itself. An "ecosystem" is generally defined as "a community of organisms interacting with one another and the chemical and physical factors making up their environment."[84] Yet an ecosystem can be as small as a drop of water or as large as the entire planet.[85] If we set ecosystem boundaries at large enough levels, eventually all species belong within the one, relatively closed, ecosystem of planet Earth. The challenge is defining the term "ecosystem" at an appropriate scale. Where do we, as humans, draw the line and say that one species doesn't belong within a particular ecosystem? There is very little consensus on this issue.

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A second major difficulty in determining the role of exotic species in ecosystem management is temporal in nature. When is a species an exotic rather than a native? Ecosystems are not static systems;[86] species naturally disperse and colonize new areas, and the species in an ecosystem change over time.[87] Humans, however, have greatly increased the rate and scale of invasions through transport and habitat disturbance.[88] How long must an exotic exist in an ecosystem before it becomes a native?[89] Some commentators define a native species as one that existed in an ecosystem prior to Anglo-European settlement.[90] This definition, however, is based on an arrogance and bias of our culture. It also denies the prospect that humans, even Anglo-Europeans, may be part of the natural ecosystem and its evolution.[91]

A third difficult issue in evaluating management of exotics in ecosystems is uncertainty.

Scientific communities know very little about species integration on an ecosystem level.[92] Eradicating an undesirable species may detrimentally affect desirable native species dependent on the undesirable species.[93] For example, wildlife species that have learned to use the exotic as a source of food and shelter would face a loss of habitat without a sufficient substitute.[94]

B. Value Judgments Regarding Exotic Species

Analyzing the role of exotic species in ecosystem management necessarily requires value judgments: do the benefits of a particular exotic outweigh its impacts to the ecosystem? Exotic species in native ecosystems often benefit humans, providing recreational and economic uses, while eradication of exotics can create high management and ecological costs.

Recreation is one of the major multiple uses that the Forest Service and the Bureau of Land Management coordinate on public lands.[95] Exotic and stocked fish populations provide the majority of fishing opportunities for anglers.[96] In turn, these fish indirectly affect other benefits. The sale of fishing licenses and stamps benefits the California Department of Fish and Game. The Department uses this revenue to further its managerial and law enforcement goals. In addition, sport fishing is a large part of the economy of many small rural communities. These communities often depend on the patronage of visiting anglers. Of course, aquatic exotics may also cause economic loss if the exotic species is not of comparable or superior value to the native species it displaces.[97] Thus, in determining management goals for game fish, managers must consider the benefits of the exotic species and weigh them against the ecological impacts the species may have.

In addition to considering the direct effects exotic aquatics have on the ecosystem, managers should also consider the effect anglers themselves have on the ecosystem. The more game fish available in an area, the more likely anglers will frequent that area.[98] Excessive human use can cause incidental damage to an ecosystem.[99] This issue requires managers to weigh the benefits of human use against the costs of ecosystem damage. It is unlikely that managers will make decisions in favor of the ecosystem and against the recreational use.[100]

An example of the difficulties land managers have in determining the value of exotic species is the controversy surrounding cattle grazing on public lands. Cows are an exotic species that wreaks havoc on ecosystems, yet provides a great benefit to humans. The Forest Service[101] and BLM,[102] through grazing permits, provide for exotic cattle intrusion within the forest ecosystem. Cattle are present throughout many National Forests.[103] The cattle industry is expansive, and relies heavily upon grazing permits on public land.[104] Although recent political pressure induced Congress to review cattle grazing on public lands, Congress has taken no significant action. Yet cattle drastically impact ecosystems by degrading habitat and negatively impacting native species.[105] Paradoxically, it is unlikely that any of the laws discussed above could prevent cattle grazing on public lands.

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Another value judgment managers must make concerns the direct costs of species-specific management, including both ecological costs to the ecosystem and economic costs to the agency. Ecologically, the repercussions of managing against exotic species could be monumental. For example, removing exotic plants from an ecosystem risks increased soil erosion, increased carbon dioxide

releases, reduced water evaporation rates, and reduced pollution absorption.[106] Additionally, native wildlife may suffer irreparable damages through loss of habitat formerly provided by the exotic.[107] Further, removing exotic plants may only open a niche for another class of exotic invaders.[108] Economically, the costs to implement and monitor an exotic species management or eradication program could be astronomical.[109]

C. Proposal

Although economic factors are important in considering what weight to give exotic species in ecosystem management, they should not be controlling. Risk/benefit assessments intended to determine the value of an exotic should include the long term threats to the ecosystem in the equation. The short term economic gain from exotics such as game fish and cattle often benefit only small human populations or interests. The focus of evaluating the role of exotics must be on the ecosystems that exotics now inhabit. Only then will the benefits of effective ecosystem management be realized.

One way to ensure that management decisions consider exotics is to enact comprehensive legislation. Existing statutes are piecemeal and often contradictory.[110] As the law currently exists, one set of regulations may compel an agency to protect and manage for an exotic species, while another may require the agency to manage against such species.[111] Some policies require an agency to manage for exotics and natives equally, regardless of the comparative benefit or risk posed by a particular species.[112] In light of the danger of imposing a blanket rule over all exotic species, or all ecosystems, much of the discretion in management should still be left to the agency managers.

However, discretionary decisions must be firmly supported by science. There is too much uncertainty regarding ecosystems to leave general policy in the hands of managers. Part of the problem is conflicting definitions of the terms "exotic" and "native," and even "ecosystem." Thus, any comprehensive legislation should provide the means for continuing scientific research on the role of exotics and the potential impacts of a particular management scheme.

The policy should also focus on the ecosystem as a whole. Existing law does little to promote a focus on the entire landscape. Existing agency structure also inhibits viewing the entire ecosystem, and inhibits managing it on a proper level. For example, one agency may be operating under a directive contrary to the directive of the agency managing adjacent lands. Thus, legislation should promote interagency cooperation. It is difficult to keep an undesirable species out of one's own yard when the neighbors are encouraging its proliferation.

Conclusion

Existing federal laws do not adequately address the role of exotic species in ecosystem management. Their mandates may conflict in any given instance. Yet exotic species have many detrimental effects on an ecosystem, ranging from reduced native diversity and genetic integrity to increased extinction and foreign diseases.

This issue cannot be addressed by blanket policy statements. Assessing the impacts and benefits of exotic species is a very fact specific task. Managers need to consider the risks and the benefits of individual exotic species, as well as the impacts of a particular management plan will on the greater ecosystem.

This will not be an easy task. The elusiveness of the concept of "ecosystems," as well as the difficulties in applying the labels "native" and "exotic," are only a part of the issue. Other issues include scientific uncertainty and practical difficulties. The onus lies with policy makers, scientists, and land managers to develop a workable scheme that, above all, keeps the health of the ecosystem in mind.

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NOTES

[1] In this paper, the term "exotic species" encompasses what are often called "non-indigenous," "alien," or "non-native" species.

[2] OFFICE OF TECHNOLOGY ASSESSMENT, HARMFUL NON-INDIGENOUS SPECIES IN THE UNITED STATES 3 (1993) (hereinafter OTA REPORT).

[3] *See* OTA REPORT, *supra* note 2, at 5 (reporting naturally occurring movements of species into U.S. are uncommon).

[4] *See* OTA REPORT, *supra* note 2, at 3 (explaining beneficial exotics such as soybeans, wheat, and cattle form basis of U.S. agricultural industry).

[5] OTA REPORT, *supra* note 2, at 5. Approximately 15% of exotics in U.S. cause severe harm. *Id.* This harm extends to many national interests, including agriculture, industry, human health, and the protection of natural areas. *Id.*

[6] TOM DUDLEY AND MICHAEL EMBURY, NON-INDIGENOUS SPECIES IN WILDERNESS AREAS: THE STATUS AND IMPACTS OF LIVESTOCK AND GAME SPECIES IN DESIGNATED WILDERNESS IN CALIFORNIA 16 (1995).

[7] OTA REPORT, *supra* note 2, at 5.

[8] *Id.* at 11.

[9] *Id.*

[10] *Id.*

[11] COUNCIL ON ENVTL. QUALITY, EXECUTIVE OFFICE OF THE PRESIDENT, INCORPORATING BIODIVERSITY CONSIDERATIONS INTO ENVIRONMENTAL IMPACT ANALYSIS UNDER THE NATIONAL ENVIRONMENTAL POLICY ACT 5 (1993).

[12] *Id.*

[13] *Id.* at 6-8.

[14] R. Edward Grumbine, *What is Ecosystem Management?*, 8 CONSERVATION BIOLOGY 27, 28-29 (1994).

[15] *Id.*

[16] *See, e.g.*, REED F. NOSS AND ALLEN Y. COOPERRIDER, SAVING NATURE'S LEGACY: PROTECTING AND RESTORING BIODIVERSITY 4 (1994) (stating diversification can easily become homogenization, thus destroying entire ecosystems).

[17] P.M. Vitousek, *Biological Invasions and Ecosystem Properties: Can Species make a Difference?, in* ECOLOGY OF BIOLOGICAL INVASIONS OF NORTH AMERICA AND HAWAII, 163 (H.A. Mooney and J.A. Drake eds., 1986).

[18] H.B. Johnson and H.S. Mayeux, *Viewpoint: A view on Species Additions and Deletions and the Balance of Nature,* 45 J. OF RANGELAND MANAGEMENT 322, 323 (1992).

[19] *Id.*

[20] *See, e.g.,* DUDLEY AND EMBURY, *supra* note 6 (justifying distinctions between exotic and native species); Grumbine, *supra* note 14, at 28-29 (1994) (same); G. Newkirk, *Genetic Aspects of the Introduction and Culture of Nonindigenous Species for Aquaculture, in* EXOTIC SPECIES IN MARICULTURE 193 (R. Mann ed., 1979) (same); NOSS AND COOPERRIDER, *supra* note 16 (same); Kyla Seligsohn-Bennett, *Mismanaging Endangered and "Exotic" Species in the National Parks*, 20 Envtl. L. 415 (1990) (same); DISTRIBUTION, BIOLOGY, AND MANAGEMENT OF EXOTIC FISHES (Walter R. Courtenay, Jr., and Jay R. Stauffer, Jr., eds., 1984) (same).

[21] DUDLEY AND EMBURY, *supra* note 6, at 21.

[22] *Id.*

[23] Authors generally include fishery hatched trout of a native species in the terms exotic, introduced, transported or stocked fish. *See generally* Courtenay and Stauffer, *supra* note 20 (defining hatchery trout as exotic).

[24] *See* DUDLEY AND EMBURY, *supra* note 6, at 17 (listing major exotic species as brown trout, brook trout, golden trout, and cutthroat trout).

[25] DUDLEY AND EMBURY, *supra* note 6, at 21.

[26] Walter R. Courtenay, Jr., Biological Pollution Through Fish Introductions, *in* BIOLOGICAL POLLUTION 35, 56 (Bill McKnight, ed. 1991).

[27] Humans introduced brown trout, imported from Germany, to the North American continent in 1885. GEORGE LAYLOCK, THE ALIEN ANIMALS, 50 (1966). Introduction to the West Coast occurred in the early twentieth century. Brown trout are highly prized among anglers as game fish. *Id.* at 51-52.

[28] Jeffrey N. Taylor, et al., Known Impacts of Exotic Fishes in the Continental United States, *in* DISTRIBUTION, BIOLOGY, AND MANAGEMENT OF EXOTIC FISHES 322, 343 (Walter R. Courtenay, Jr., and Jay R. Stauffer, Jr., eds., 1984).

[29] Courtenay and Stauffer, *supra* note 20.

[30] DUDLEY AND EMBURY, *supra* note 6, at 22-23.

[31] *Id.* at 21-22.

[32] *Id.* at 22.

[33] *Id.* at 21.

[34] *Id.* at 24.

[35] *Id.*

[36] Taylor, *supra* note 28, at 346. In contrast to the waters of the higher Sierra Nevada, the waters at lower elevations historically supported native fish populations. *Id.*

[37] Newkirk, *supra* note 20, at 194.

[38] PETER B. MOYLE AND RONALD M. YOSHIYAMA, FISHES, AQUATIC DIVERSITY MANAGEMENT AREAS, AND ENDANGERED SPECIES: A PLAN TO PROTECT CALIFORNIA'S NATIVE AQUATIC BIOTA 15-16 (1992).

[39] *Id.*

[40] Christopher C. Kohler and Walter R. Courtenay, *American Fisheries Society Position on Introductions of Aquatic Species*, 11 FISHERIES 39, 40 (1986).

[41] *Id.*

[42] *Id.*

[43] Many laws govern the importation of exotic species into the United States from foreign countries. However, these laws generally view management of these exotic species on an arbitrary political level, rather than on an ecosystem level. As such, this paper does not discuss them. A non-inclusive list of such statutes includes: The Lacy Act (18 U.S.C. § 42); The Federal Plant Pest Act (7 U.S.C. §§ 150aa-jj); The Plant Quarantine Act (7 U.S.C. §§ 151-64, 167).

[44] 16 U.S.C. §§ 1531-44.

[45] *Id.* § 1531(b). Section 1531 states that the ESA's purpose is to "provide a means whereby *ecosystems* upon which endangered species and threatened species depend upon may be conserved . . . " (emphasis added). However, commentators have widely criticized the ESA for failing to promote management on an ecosystem level. *See, e.g.,* R. EDWARD GRUMBINE, GHOST BEARS: EXPLORING THE BIODIVERSITY CRISIS, 95 (1992) (stating ESA is incapable of solving ecosystem-scale problems); Robert B. Keiter, *Beyond the Boundary Line: Constructing a Law of Ecosystem Management* 65 U. COLO. L. REV. 293, 309 (1994) (discussing failure of ESA to protect ecosystems). The main limitation on the ESA's ability to protect an ecosystem is that there must be an endangered or threatened species present, which the USFWS has determined is dependent on that ecosystem. 55 Fed. Reg. 26189, 26190 (1990).

[46] 16 U.S.C. § 1532(6).

[47] *Id.* § 1532(8). This section broadly defines "fish or wildlife" to include "any member of the animal kingdom, including *without limitation* any mammal, fish, bird, amphibian, reptile, mollusk, crustacean, arthropod or other invertebrate . . . " *Id.* (emphasis added).

[48] 16 U.S.C. § 1532(14).

[49] *Id.* § 1532(6).

[50] *Id.*

[51] WEBSTER'S NEW UNIVERSAL UNABRIDGED DICTIONARY 1492 (2d ed. 1983).

[52] 16 U.S.C. § 1539(j)(2)(A).

[53] *Id.* The Secretary may authorize such a release if the Secretary "determines that such release will further the conservation of such species." *Id.*

[54] 16 U.S.C. § 1531(b).

[55] *Id.* § 1538(a)(1)(B) (prohibiting the "take" of any endangered species). *See also* 16 U.S.C. § 1532(19) (defining "take" as including "harm" to a species). The courts have construed the word "harm" as including the degradation of critical habitat. Palila v. Hawaii Dept. of Land and National Resources, 852 F.2d 1106 (9th Cir. 1988).

[56] 16 U.S.C. §§ 1600-14.

[57] *Id.* § 1604(g)(3)(B). Section 1604 states that the Secretary of the Interior must promulgate guidelines for land management which "provide for diversity of plant and animal communities based on the suitability and capability of the specific land area . . . . " *Id.* Regulations define diversity as "the distribution and abundance of different plant and animal communities and species within the area . . . ." 36 C.F.R. § 219.3 (1990). *See also* Jeb Boyt, *Struggling to Protect Ecosystems and Biodiversity Under NEPA and NFMA: The Ancient Forests of the Pacific Northwest and the Northern Spotted Owl,* 10 PACE ENVT. L. R. 1009, 1040 (1993) (explaining NFMA offers procedural framework within which managers may apply principles of ecosystem management).

[58] 36 C.F.R. § 219.19.

[59] Boyt, *supra* note 57, at 1040.

[60] 16 U.S.C. § 1604(g)(3)(B).

[61] *Id.*

[62] *See, e.g.,* James A. Siemans, *A "Hard Look" at Biodiversity and the National Forest Management Act,* 6 Tul. Envtl. L. Rev. 157, 168 (1992) (proposing clause could prevent Forest Service from creating forests of exotic trees).

[63] Paul F. Starrs, Basolith & Baseline, Public & Policy in the Sierra Nevada of California and Nevada, 24-26, revised text of paper presented at Sierra Nevada Ecosystem Project Policy Assessment and History Meeting, May 17, 1995.

[64] 33 U.S.C. §§ 1251-1387.

[65] *Id.* § 1251.
[66] *Id.* § 1251(a)(2).
[67] 42 U.S.C. §§ 4321-70.
[68] *See, e.g.,* Boyt, *supra* note 57, at 1036 (explaining NEPA does not directly address interrelationships that concern biodiversity and ecosystems).
[69] Strycker's Bay Neighborhood Council, Inc. v. Karlen, 444 U.S. 223, 227 (1980); Vermont Yankee Nuclear Power Corp. v. NRDC, 435 U.S. 519, 558 (1978).
[70] Keiter, *supra* note 45, at 314.
[71] OTA REPORT, *supra* note 2, at 18.
[72] *Id.*
[73] *Id.*
[74] *Compare* Seligsohn-Bennett, *supra* note 20, at 417 (stating Congressional mandates require NPS to preserve ecosystem) *with* Keiter, *supra* note 45, at 304-05 (explaining absence of explicit statutory ecosystem management mandate relieves NPS of ecosystem management obligation).
[75] National Park Service Organic Act of 1916 (codified as amended at 16 U.S.C. § 1 (1988)).
[76] *See, e.g.,* Keiter, *supra* note 45, at 305 (arguing NPS fails to exercise its authority on transboundary issues); Joseph L. Sax and Robert B. Keiter, *Glacier National Park and Its Neighbors: A Study of Federal Interagency Relations*, 14 ECOLOGY L.Q. 207 (1987) (same).
[77] The NPS defines "exotic" species as those which occur in a given area "as the result of direct or indirect, deliberate or accidental introduction . . . by humans." NATIONAL PARK SERV., U.S. DEP'T OF THE INTERIOR, MANAGEMENT POLICIES IV-11a (1978) (hereinafter NPS POLICY).
[78] The NPS defines "native" species as those which "presently occur, or once did occur prior to some human influence." *Id.*
[79] *Id.* at IV-12.
[80] *Id.* at IV-11.
[81] 16 U.S.C. § 3.
[82] *Id.*
[83] *See, e.g.,* Seligsohn-Bennett, *supra* note 20, at 417 (examining NPS history of relocating and exterminating endangered, native grizzly bears in Yellowstone park). *Cf. infra* note 89 (discussing application of policy to Assateague feral ponies).
[84] G. TYLER MILLER, JR. ENVIRONMENTAL SCIENCE: SUSTAINING THE EARTH A7 (1991).
[85] EDWARD O. WILSON, THE DIVERSITY OF LIFE 396 (1992).
[86] *See generally id,* at 163-82 (discussing difficulties of defining ecosystems).
[87] Keiter, *supra* note 45, at 301. *See also* NOSS AND COOPERRIDER, *supra* note 16, at 4 (examining ecosystem evolution).
[88] NOSS AND COOPERRIDER, *supra* note 16, at 4.
[89] An example of the difficulties in labeling a species either "native" or "exotic" is the Assateague ponies. *See generally*, R. KEIPER, THE ASSETEAGUE PONIES (1985). Asseteague is an island off the coast of Virginia inhabited by a herd of wild ponies. The island is managed by the National Park Service. *Id.* Under the NPS management policies, the ponies are considered exotic species. NATIONAL PARK SERV., U.S. DEP'T OF THE INTERIOR, ASSATEAGUE ISLAND NATIONAL SEASHORE FERAL PONY MANAGEMENT PLAN 2 (1985). Biologists consider this particular population of ponies the descendants of horses that survived a Spanish shipwreck in the late 1500s. KEIPER at 15. Thus the ponies have lived in the area for up to 400 years, and yet the NPS still considers them "exotics" and manages them under a different plan than "natives." Seligsohn-Bennett, *supra* note 20, at 427. This classification allows the NPS to regulate or eradicate the population if its presence "disrupts the faithful presentation of the historic scene." *Id.* Ponies may be even more deeply entrenched in the "historic

scene" than the NPS realizes, as horses and ponies originated in North America more than two million years ago, and became extinct on this continent about 8000 years ago. J. BERGER, WILD HORSES OF THE GREAT BASIN 11 (1986). One theory is that the early human inhabitants of the continent hunted them into extinction. Seligsohn-Bennett, *supra*, at 426. If this theory were true, the NPS management policies towards species eradicated by human activity would apply to the ponies, requiring NPS to reintroduce and manage the ponies as "native" species. *Id.* at 427.

[90] *See, e.g.,* STARKER LEOPOLD, ET AL., WILDLIFE MANAGEMENT IN THE NATIONAL PARKS 14 (1963)

[91] *See, e.g.,* Stephen H. Spurr, *Wilderness Concepts*, 16 IDAHO L. REV. 439, 441-43 (1980). Spurr states that characterizing a species as either exotic or native characterizes it only from the standpoint of humans' relationship to it. He advocates a biocentric view of nature, a view from the wilderness community itself. Then, he states, we will realize that an ecosystem exists only at a given instant in time and at a given instant in space. *Id.*

[92] *See, e.g.,* Cynthia Carlson, *NEPA and the Conservation of Biological Diversity*, 19 ENVTL. L. 15, 18-19 (1988); WILSON, *supra* note 85, at 80.

[93] *See, e.g.,* Carlson, *supra* note 92, at 18-19.

[94] Walter E Westman, *Park Management of Exotic Plant Species: Problems and Issues*, 4 CONSERVATION BIOLOGY 251, 252 (1990).

[95] GEORGE C. COGGINS, ET AL., FEDERAL PUBLIC LAND AND RESOURCES LAW 888-89 (1993) (explaining substantial economic interests at stake in recreation management decisions).

[96] *See generally* DUDLEY AND EMBURY, *supra* note 6, at 7-8.

[97] Newkirk, *supra* note 20, at 193.

[98] DUDLEY AND EMBURY, *supra* note 6, at 25.

[99] *Id.* Damage can include excessive trail use and subsequent erosion, trampling of natural vegetation, litter and other waste production, and heightened levels of human pathogens such as *Giardiasis*.

[100] One case in point is the controversy surrounding fish stocking programs in Granite Chief Wilderness Area in the Tahoe National Forest. The Forest Service recommended terminating the stocking program due to the negative impact on the area by large numbers of anglers. DUDLEY AND EMBURY, *supra* note 6, at 25. California Department of Fish and Game continued to stock these areas, encouraging heavy day use. *Id.*

[101] Grazing occurs on 101 million acres of National Forest land. COGGINS, *supra* note 95, at 20.

[102] Grazing occurs on 170 million acres of BLM land. *Id.*

[103] DUDLEY AND EMBURY, *supra* note 6, at 7-8.

[104] Public lands constitute 12% of the total forage in the West. COGGINS, *supra* note 95, at 20.

[105] DUDLEY AND EMBURY, *supra* note 6, at 12-13.

[106] Westman, *supra* note 94, at 254-56.

[107] *Id.*, at 255.

[108] *Id.*, at 254-55.

[109] *See generally, id.* (describing California Department of Parks and Recreation's proposal to remove all Eucalyptus trees from parks and economic difficulties associated with proposal).

[110] *See supra* notes 44-83 and accompanying text (discussing environmental laws relating to ecosystem management and exotic species).

[111] *Compare* Endangered Species Act, (*supra* notes 44-55 and accompanying text) *with* National Park Service Management Plan (*supra* notes 74-83 and accompanying text).

[112] *See, e.g.*, Clean Water Act (*supra* notes 64-66 and accompanying text), National Environmental Policy Act (*supra* notes 67 to 73 and accompanying text).