How many endangered species are there in the United States?

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Only about 15% of the known species in the United States have been studied in sufficient detail to determine whether or not they are imperiled. Any estimate of the total number of imperiled species in this country must therefore rely on extrapolations from this small number of comparatively well-studied species to a much larger number of poorly studied ones. We review the best available data on the status of plants, animals, and fungi in the US and conclude that the actual number of known species threatened with extinction is at least ten times greater than the number protected under the Endangered Species Act (ESA). The key to developing a more accurate picture of the extent of species endangerment is to obtain more data on the following groups (in decreasing order of priority): (1) invertebrate animals; (2) fungi; and (3) marine organisms. However, given the slow pace at which species are being protected under the ESA, and the rapid rate at which natural areas are being destroyed, a more urgent task is to develop and refine approaches to conservation that complement species-by-species protection, most notably the use of coarse filters.

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How many endangered species are there in the United States? This seemingly straightforward question is, in fact, unanswerable at the present time, largely because we have no clear idea how many species – endangered or not – exist there. A recent tally found that over 200 000 species of fungi, plants, and animals have been described to date in the US (Table 1; Stein *et al.* 2000) but by all accounts, large numbers of species have yet to be discovered. For example, Peter Raven, Director of the Missouri Botanical Garden, has estimated that as many as a half million species remain to be discovered (Stein *et al.* 2000; B Stein pers comm). He based this estimate on the fact that approximately 7% of the world's known vascular plant species occur in the US. Since vascular plants are a reasonably well-studied group, this value is likely to be close to the actual percentage. By extending this percentage to other types of organisms, and by assuming a worldwide total of 10 million species, Raven reasoned that as many as 700 000 species may inhabit the US.

Raven's approach is acutely sensitive to estimates of the total number of species on earth, which have ranged over more than an order of magnitude (eg May 1988; Novotny *et al.* 2002). Yet application of even low values for global species richness leads one to conclude that hundreds of thousands of undescribed species occur in the US. Invertebrate animals, fungi, and protists undoubtedly constitute the vast majority of these unknown species, although over the past decade at least 63 new vertebrate species have been described in the US, as taxonomists gain a better understanding of the genetic relationships between populations. (This figure does not include previously described subspecies that were subsequently elevated to species status).

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If we do not know how many species occur in the US, we cannot be certain how many of them are at risk of extinction. But by making some reasonable assumptions, we can nonetheless estimate the number of *described* species that may be at risk of extinction. Such an estimate is a useful indicator of the scope of potential species losses. Our efforts to come up with a number may also shed light on neglected groups of species and other important data gaps that bedevil conservation efforts in the US and elsewhere.

Sources of information

Table 1 provides a breakdown by major groups of the 200 000+ species described to date in the US. If we knew how many of these species were in danger of extinction, we would have the answer to our question, at least with respect to known species. Under the Endangered Species Act (ESA) of 1973, the US Fish and Wildlife Service (USFWS; Department of the Interior) and the National Marine Fisheries Service (NMFS; Department of Commerce) are charged with identifying and protecting endangered species. These agencies currently (May 2005) classify 942 species (and an additional 327 subspecies and vertebrate populations) in the 50 states and District of Columbia as threatened or endangered (http://endangered.fws.gov/wildlife.html; NatureServe 2005). However, because adding a particular plant or animal to the endangered species list is a long and often controversial process, those who have studied the US endangered species list agree that it contains only a fraction of the total number of imperiled species (Master *et al.* 2000).

By far the most complete list of US imperiled species is maintained by the nonprofit organization NatureServe, in collaboration with member natural heritage programs in all 50 states. NatureServe assigns each species to one of seven global conservation status categories (ranks) to indicate its overall risk of extinction (Table 2). These assessments and their documentation are available on NatureServe's data portal (www.natureserve.org/explorer/) and are continuously peer reviewed and updated as new information comes to light. NatureServe status ranks correspond closely to similar assessments made by other conservation science organizations (Master *et al.* 2000). For example, species considered critically endangered, endangered, vulnerable, or near-threatened under the Red List system of the World Conservation Union (IUCN) and species considered endangered, threatened, or of special concern by the American Fisheries Society are generally classified as possibly extinct, critically imperiled, imperiled, or vulnerable (ie ranked GH, G1, G2, or G3) by NatureServe. O'Grady *et al.* (2004) found that the systems employed by NatureServe and the IUCN yield similar rankings for species and that these rankings are correlated with the species' predicted extinction risk, as determined by population viability analyses.

To date, NatureServe has assigned global conservation status ranks to approximately 30 000 species in the US, or to approximately 15% of the country's known flora and fauna. Regrettably, even among the US species that have been discovered and described by scientists, the vast majority are so poorly known that they cannot be assigned a status rank. Therefore, any estimate of the total number of imperiled species in the US must be made by extrapolating from a few well-studied organisms to a much larger number of poorly studied ones.

We focus on those taxonomic groups for which over 95% of the species known to occur in the US have been assigned global conservation status ranks by NatureServe. For the purposes of this study, we define an endangered species as any species with a global rank of GH, G1, or G2. Ours is a very conservative definition of endangerment, in the sense that it excludes species with a rank of G3, some of which are classified under the ESA as endangered or threatened (eg piping plover [*Charadrius melodus*], jaguar [*Panthera onca*], loggerhead turtle [*Caretta caretta*], and 35 plant species). We also exclude from our tally all subspecies and population segments, all species that are rare in the US but relatively common in other countries, and all species for which there is persuasive evidence that they have become extinct. Table 3 provides a summary of the numbers of species in each category.

Endangerment patterns

The status of nearly all US vertebrates with the exception of marine fish is known with a high degree of accuracy. The percentage of imperiled species within each vertebrate class ranges from a low of 7% (mammals) to a high of 25% (amphibians); the overall value for vertebrates, again excluding marine fish, is 13% (Table 3).

In the case of invertebrates, only 11 groups, representing 4698 species (~3% of known species of invertebrates in the US) have been evaluated in sufficient detail to meet our 95% criterion. These include: freshwater mussels; freshwater snails; crayfishes; fairy, clam, and tadpole shrimps; butterflies and skippers; Saturniidae, Sphingidae, *Papaipema*, and *Catocala* moths; grasshoppers; tiger beetles; dragonflies and damselflies; stoneflies; and mayflies. In addition we include terrestrial snails from the continental US because all known species have been assigned a status rank. The terrestrial snails of Hawaii have not been ranked by NatureServe; however, all of them are almost certain to be classified as either endangered or recently extinct, with status ranks of GX–G2. Within these invertebrate groups, the percentage of imperiled species varies greatly, from a low of 6% (butterflies and skippers) to a high of 61% (freshwater snails).

In the US, animal groups closely associated with fresh

Table 1. Number of known species in the US in three kingdoms

Fungi	*Plants*	*Animals*
Total: >37 800	Vascular: 16 230	Vertebrates: ~4900
	Nonvascular: 2223	Invertebrates: ~143 900
	Total: ~18 400	Total: ~148 800

Numbers represent described native species from all 50 states, including terrestrial, freshwater, and marine species to within the 200-mile territorial limit. Data are from Stein *et al.* (2000) and NatureServe (2005).

Table 2. NatureServe's global conservation status ranks and their definitions

Status[a]	*Description*
GX	**Presumed extinct** – Not located despite intensive searches and virtually no likelihood of rediscovery.
GH	**Possibly extinct** – Missing; known from only historical occurrences but still some hope of rediscovery.
G1	**Critically imperiled** – At very high risk of extinction due to extreme rarity (often five or fewer populations), very steep declines, or other factors.
G2	**Imperiled** – At high risk of extinction due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors.
G3	**Vulnerable** – At moderate risk of extinction or of significant conservation concern due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors.
G4	**Apparently secure** – Uncommon but not rare; some cause for long-term concern due to declines or other factors.
G5	**Secure** – Common; widespread and abundant.
GU	**Unrankable** – Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.
GNR	**Unranked** – Global rank not yet assessed.

[a]Note: "G" refers to global or range-wide conservation status for a species or ecological community.

water, such as mussels, crayfish, and shrimps, have higher percentages of imperiled species than do largely terrestrial groups, a pattern first noted by Master (1990). There are, however, curious exceptions to this pattern. The percentage of imperiled dragonflies and damselflies seems low relative to other freshwater invertebrates, while the percentages of imperiled terrestrial snails and grasshoppers seem unusually high relative to butterflies and moths. We can construct post hoc explanations for these anomalies – dragonflies and damselflies are strong flyers whose distributions are rarely restricted to a single watershed, whereas many snails and grasshoppers have extremely restricted distributions – but clearly, more research is warranted.

Within the vascular plants, flowering plants (monocots and dicots), gymnosperms (conifers and allied forms), and pteridophytes (ferns and allied forms) have been reasonably well surveyed. The percentages of imperiled species vary from 10% among gymnosperms to over 18% among dicots; the overall percentage of US vascular plants at risk of extinction is close to 17%. Within the nonvascular plants, only about two-thirds of the mosses, liverworts, and hornworts have been surveyed, not enough for inclusion in this analysis, but approximately 10% (136) of these are judged to be imperiled.

Forgotten fungi

Although fungi constitute approximately 17% of described species in the US, their conservation has attracted little attention. Only in the Pacific Northwest, where logging of old-growth forests may threaten certain species, have substantial efforts been made to identify at-risk fungi. To estimate the number of imperiled fungi in the US, we can examine the case of truffle-like (sequestrate) macrofungi in the states of Washington and Oregon. Truffle-like fungi are not a monophyletic group, but rather a collection of similar looking but unrelated species. Given their popularity in cooking, and the fact that many species occur in old-growth forests, they are better inventoried and monitored than most other types of fungi. Approximately 365 species of sequestrate macrofungi have been found in Washington and Oregon; 65 species (18%) are classified as imperiled by the US Forest Service (D Luoma pers comm), mostly due to logging of older forests. This percentage is close to the value for vascular plants, but it may be high when compared to all US fungi. NatureServe has assigned conservation status ranks to 1200 of the estimated 3800 lichens, and 6% of these species are considered imperiled. If we assume that 6–18% of known fungi are at risk of extinction, we add 2200–6800 species to the total number of imperiled species.

Tallying the numbers

The figures of 339 imperiled vertebrates and 2708 imperiled vascular plants are, in all likelihood, close to the actual values. With respect to invertebrates, application of even the lowest percentage value for any of the well-studied groups (ie 6% for butterflies and skippers) to all 144 000 known invertebrate species would equate to approximately 8600 at-risk invertebrates alone. Use of a higher percentage, for example 17%, which is the average of the insect groups listed in Table 3, would equate to nearly 25 000 imperiled invertebrate species. If we assume that approximately 10% of nonvascular plants are currently at risk of extinction, we can add an additional 200+ species to the roster of endangered species. For fungi, our best estimate, based on woefully inadequate data, is 2200–6800 imperiled species. Thus, a total of somewhere between 14 000–35 000 imperiled species – roughly 7–18% of the nation's known plants, animals, and fungi – appears to be a reasonable, conservative estimate for the US. This total is more than an order of magnitude greater than the number of species currently protected under the ESA.

Causes of endangerment

Knowing why species become endangered is as important as knowing how many are endangered. Several studies have examined the causes of species endangerment in the US, both for species classified as globally imperiled by NatureServe (Richter *et al.* 1997; Wilcove *et al.* 1998, 2000) and for species listed as threatened or endangered by USFWS and NMFS (Lawler *et al.* 2002).

Habitat loss is the most widespread cause of species endangerment in the US, affecting approximately 85% of imperiled species. Harm caused by nonindigenous species is the second most widespread threat, affecting 49% of imperiled species, followed by pollution (24%), overexploitation (17%), and disease (3%). The numbers total more than 100% because most species face multiple threats. Indeed, habitat loss is the top-ranked threat in terms of the number of species it affects for all of the groups studied by Wilcove *et al.* 1998), which included vascular plants, mammals, birds (Figure 1), reptiles, amphibians, freshwater fish, freshwater mussels, crayfish, tiger beetles, and butterflies. For the other threat categories, the rankings vary somewhat from group to group. For example, nonindigenous species are the second most frequent threat to vascular plants, birds, and butterflies. For groups with a large proportion of aquatic species (ie amphibians, fishes, freshwater mussels, crayfishes), the second-ranked threat is pollution, including nonpoint sources such as sedimentation. Overexploitation is an especially important threat to imperiled mammals (45%; second only to habitat loss), reptiles (66%; second rank), and butterflies (30%; third rank). Disease is generally at the bottom of the list in terms of the number of species it threatens, with the notable exception of birds, where it affects 37% of imperiled species, mostly in Hawaii.

In addition to threats and trends, NatureServe's ranking criteria (Table 2) emphasize population size and other factors related to rarity as major influences on a species' vulnerability to extinction. Thus, a species that is intrinsically rare but otherwise unaffected by human activities could be classified as imperiled. Wilcove *et al.* (1998), however,

Table 3. Species groups ranked by NatureServe

US species report card – species groups tracked in NatureServe's central databases

Taxonomic group	*Presumed extinct (GX)*	*Possibly extinct (GH)*	*Critically imperiled (G1)*	*Imperiled (G2)*	*Vulnerable (G3)*	*Apparently secure (G4)*	*Secure (G5)*	*Unrankable (GU)*	*Unranked (GNR)*	*Totals*	*Percent of species imperiled (%GH–G2)*
Vertebrates											
Mammals	1	1	11	16	45	92	253	1	1	421	7%
Birds	20	9	26	20	40	93	575	0	0	783	7%
Reptiles, turtles, and crocodilians	0	0	9	19	35	46	184	0	2	295	9%
Amphibians	1	1	29	35	43	45	104	0	0	258	25%
Freshwater fishes	16	4	91	68	110	189	318	0	2	798	20%
Vertebrates subtotals	**38**	**15**	**166**	**158**	**273**	**465**	**1434**	**1**	**5**	**2555**	**13%**
Invertebrates											
Freshwater mussels	16	18	84	41	48	46	42	3	0	298	48%
Freshwater snails	23	58	274	84	72	33	130	3	0	677	61%
Terrestrial snails	2	6	338	218	150	101	182	0	0	997	56%
Crayfishes	1	2	59	53	61	92	74	0	0	342	33%
Freshwater shrimps	0	4	8	5	8	14	40	0	0	79	22%
Butterflies & skippers	0	0	11	27	85	107	385	3	3	621	6%
Tiger beetles	0	0	6	4	14	19	60	0	1	104	10%
Stoneflies	0	16	40	74	133	165	197	0	0	625	21%
Mayflies	4	6	36	81	73	134	227	0	0	561	22%
Grasshoppers	0	21	61	106	43	90	209	55	1	586	32%
Dragonflies & damselflies	0	4	8	27	49	107	270	0	0	465	8%
Four moth groups (Saturniidae, *Catocala*, Sphingidae, *Papaipema*)	0	4	12	9	27	158	124	6	0	340	7%
Invertebrate subtotals	**46**	**139**	**937**	**729**	**763**	**1066**	**1940**	**70**	**5**	**5695**	**32%**
Vascular plants											
Dicots	9	122	925	1265	2213	3560	4296	24	156	12590	19%
Monocots	1	8	124	155	356	896	1384	4	27	2957	10%
Gymnosperms	0	0	5	6	9	32	61	0	0	113	10%
Pteridophytes	0	3	37	36	93	159	224	1	17	570	13%
Vascular plant subtotals	**10**	**133**	**1091**	**1484**	**2671**	**4647**	**5965**	**29**	**200**	**16230**	**17%**
Totals	**94**	**287**	**2194**	**2371**	**3707**	**6178**	**9339**	**100**	**210**	**24480**	**20%**

Groups are included if at least 95% of the species in the group have been assigned a global conservation status rank. For terrestrial gastropods, only species occurring in the continental US have been ranked and are included, although the unranked (GNR) Hawaiian species, if included, would be overwhelmingly ranked GX–G2. The percent of imperiled species excludes extinct (GX) species from the calculation. Many of these species are given "range ranks" (eg G1–G3), which indicate uncertainty in their conservation status. These range ranks are averaged (eg G2) for placement in the table above.

found that only 52 of 1880 species classified as imperiled (GH, G1, or G2) by NatureServe appeared not to be threatened by human activities.

After reviewing the threats listed in the recovery plans for 181 plants and animals protected under the ESA, Lawler *et al.* (2002) concluded that most threats "…are chronic, have occurred over a long time period, and are intense where they do occur. In addition, most species face multiple major threats rather than single major threats. The recovery of species under such conditions is likely to be quite difficult."

Consequences of endangerment

If the road to recovery for imperiled species is likely to be long and costly, decision makers and the public may demand an explanation for why such species ought to be saved. Numerous books and articles have been written about the reasons for conserving biological diversity (eg Norton 1988; Wilson 1999, 2002). These reasons include: aesthetic and moral justifications; the importance of wild species as providers of products and services essential to human welfare (Daily 1997; Panel 1); the value of particular species as indicators of environmental health or as keystone species crucial to the functioning of ecosystems; and the scientific breakthroughs that have come from the study of wild organisms.

From among the roster of imperiled species in the US one can find examples of most of these benefits. For example, the endangered scrub mint (*Dicerandra frutescens*) contains both a natural insecticide and a powerful antifungal agent (Eisner 1994). The decline of the bald eagle (*Haliaeetus leucocephalus*) and peregrine falcon (*Falco peregrinus*), both of which ended up on the US endangered species list, alerted people to the potential health hazards associated with the widespread spraying of DDT and other persistent pesticides. The reintroduction of gray wolves (*Canis lupus*) to Yellowstone National Park has not only attracted thousands of tourists to the Park, it has also resulted in a beneficial redistribution of the Park's elk (*Cervus elaphus*), which had been congregating in riparian areas and preventing the regeneration of willow and aspen stands, an important habitat for much of the Park's wildlife (Ripple *et al.* 2001). Hawaii's endemic honeycreepers, most of which are now extinct or endangered, are – quite literally – a textbook example of adaptive radiation and a continuing source of new insights into evolution. One area where endangered species may arguably play a less substantive role is in providing major ecosystem services, simply because most endangered species have limited geographical ranges and small populations. However, it is certainly possible that some currently endangered species were important providers of ecosystem services prior to their decline and will once again become so if their populations are restored.

Finally, our ignorance of the natural history of most species, especially endangered species, should temper any rush to judgment as to which, if any, are "expendable". Species that today appear to be of little consequence or importance to humanity may, upon further study, prove to be critically important. A prime example is the Pacific yew (*Taxus brevifolia*). Once disdained by loggers as a worthless "trash tree" and destroyed, it subsequently became the

Figure 1. *The Florida scrub-jay (*Aphelocoma coerulescens*), a globally imperiled (G2 ranked) species endemic to Florida.*

Panel 1. No fish, no fishery

People who are skeptical about the value of conserving species often single out particular species that have vanished and then ask, "So what?" In response, one might turn to the Great Lakes for an instructive example of a fishery that was fished to extinction. Commercial fishing in the Great Lakes began in the early 19th century and reached a peak in 1899, when 147 million pounds were harvested. Among the mainstays of that fishery were seven species in the genus *Coregonus*, variously known as ciscoes, chubs, whitefish, and bloaters.

Today, the Great Lakes still support a substantial fishery but the value of the catch is greatly diminished because of dramatic changes in species composition. Two *Coregonus* species (*C johannae, C reighardi*) and the Great Lakes populations of another (*C nigripinnis*) are now extinct; two others (*C zenithicus, C kiyi*) are in danger of extinction, having disappeared from every Great Lake except Superior, and the remaining three (*C artedi, C clupeaformis, C hoyi*) have vanished from at least one lake or are much reduced in abundance. Many fishers lost their jobs, and those who remained were forced to turn to other, less desirable species to make a living.

The decline of these *Coregonus* species can be traced largely to overfishing. Fishers began by targeting the largest species. As the bigger fish declined, they switched to nets with progressively smaller mesh sizes, targeting smaller and smaller species. In Lake Michigan, fishers at the start of the 20th century used gill nets with a mesh size of up to 4.5 inches. By 1950, the most commonly used mesh size was only 2.5 inches, and by the end of that decade it was less than 2.4 inches.

Also contributing to the demise of the *Coregonus* fishes were pollution from logging, farming, industry, and urbanization, as well as the spread of non-native fishes, most notably alewives (*Alosa pseudoharengus*) and smelt (*Osmerus mordax*). Alewives and smelt compete with ciscoes and consume their eggs. Moreover, as some of the ciscoes became increasingly rare, they hybridized with commoner species, hastening their demise. The end result was extinction or endangerment of the fish and the degradation of a once great fishery.

source of taxol, one of the most potent anticancer compounds ever discovered (Wilson 1999).

Towards a better safety net

By some estimates, fewer than half the plants, animals, and fungi native to the US have been discovered and described by scientists. Yet our analysis suggests that within the pool of described species, the number threatened with extinction is at least ten times greater than the number protected under the ESA.

The steps necessary to obtain a more complete inventory of all species in the US are beyond the scope of this study. The key to achieving a more accurate tally of endangered species among known species lies in obtaining more and better data on the following groups (in decreasing order of priority): (1) invertebrate animals, especially from among the groups listed in Table 3 because the global conservation status ranks of many of these species are known only within a range of values, reflecting uncertainty about their conservation status; (2) fungi; and (3) marine organisms, including marine fishes. We give top billing to the invertebrate animals partly because they constitute the vast majority of described species and partly because there is significant variance among invertebrate groups in the proportion of imperiled species. Gathering additional information on them is almost certain to be expensive and time-consuming (Lawton *et al.* 1998) and cannot be accomplished without sufficient numbers of adequately trained taxonomists. Scientists should also work to determine the conservation status of additional invertebrate species beyond those covered in Table 3. Doing so may provide useful insights into the conservation needs of habitats not well represented by the better-known invertebrate groups.

We lack sufficient information to rigorously estimate the cost of a national initiative to address these data gaps. However, it is worth noting that state and federal agencies currently invest approximately $22 million per year in inventory and monitoring work, not including university and National Science Foundation investments that are harder to quantify. For many years, some NatureServe member programs have been conducting county inventories, at an approximate cost of $150 000 per county (M Klein pers comm). Adding $50 000 per county to increase the coverage of at-risk invertebrates and fungi and multiplying by the number of counties (3143) in the US yields a cost of $629 million. Spreading the effort over 20 years, adding $3 million year^{-1} for additional taxonomic and identification assistance and $1 million year^{-1} for new and updated status assessments yields an annual average cost of $35 million. These figures do not, of course, include additional funds needed for conservation, education and outreach, database management, inventory and description of new (undescribed) species, description and mapping of ecological systems, and related activities necessary to ensure the continued existence of our biological diversity.

No additional data are needed to conclude that the ESA by itself will not adequately protect the US's imperiled species, now or in the foreseeable future. Over the past four presidential administrations, the mean number of species added annually to the federal endangered species list has varied from 10 (George W Bush's first term) to 65 (William J Clinton's term of office; Clark 2005). This six-fold difference translates into large differences over time in the total number of species receiving federal protection, but even the relatively high rate of additions during the Clinton Administration is insufficient to quickly erase the backlog of imperiled but unprotected species. The ESA is an essential part of national conservation efforts, but the need for additional tools to complement species-specific conservation measures is clear.

An oft-cited goal of conservation biologists has been to identify those groups that can serve as surrogates or indicators for lesser-known groups. Unfortunately, the evidence to date on the efficacy of this approach is equivocal. Most studies have found little or no congruence among hotspots of different groups, including hotspots of endangered species in the US (Prendergast *et al.* 1993; Dobson *et al.* 1997; Pimm and Lawton 1998; Chaplin *et al.* 2000; but see also Howard *et al.* 1998 and Lawler *et al.* 2003 for examples of places where there is apparent congruence of hotspots among different groups). In addition, there is mounting evidence that hotspots for terrestrial species do not correspond to hotspots for freshwater species. However, in one study, hotspots for at-risk terrestrial and freshwater species, when combined, did relatively well in capturing all species – endangered and non-endangered – in these groups at potential reserve sites (Lawler *et al.* 2003).

Another approach – using ecological communities as a kind of "coarse filter" to protect little-known species – is favored by many conservation biologists and non-governmental organizations. It also reflects the reality that species exist as part of complex ecosystems and therefore depend upon the presence of numerous other components (ie species and landscape features) for their survival. But this approach too will fail to protect many imperiled species if the distributions of rare invertebrates and fungi do not correspond to the way the ecological communities are defined (Noon *et al.* 2003). While some studies have found that coarse filters can be an effective means of protecting insect and bird diversity (Panzer and Schwartz 1998; Su *et al.* 2004), other studies have concluded that such approaches fail to capture the rarer species that are often of greatest interest to conservationists (Kintsch and Urban 2002; Noon *et al.* 2003). For this reason, many biologists have argued that the most efficient and effective approach to capturing biodiversity in a network of reserves is via a combined coarse–fine filter approach (Jenkins 1976, 1985; Noss and Cooperrider 1994; Groves *et al.* 2002). Even this combined strategy will fall short if: (1) the number of imperiled invertebrates and fungi is so great that conservation institutions cannot identify and protect them on a species-by-species basis (which seems to be the case in the US); and (2) the coarse filter does not correspond to the habitat requirements and distributions of these poorly-known species.

Although imperfect, we believe the combined coarse filter–fine filter approach holds the greatest promise for protecting endangered species in the US. The refinement and testing of the coarse filter component (ie delineating ecological communities and testing the efficiency with which those communities capture imperiled and vulnerable species in some of the better known groups of species; Table 3) is one of the most critical tasks facing conservation biologists in the US. Continuing and expanded inventories of known groups and searches for undescribed species are also undeniably important, as the efficacy of conservation depends greatly on accurate information about the "fine filter" species as well. However, given the rate at which natural areas are being degraded or destroyed in the US, conservation "shortcuts" such as an efficient coarse filter are urgently needed to prevent the loss of thousands of species.

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