# Will Amphibians Croak under the Endangered Species Act?

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*Herpetologists often complain that, despite amphibians' being one of the most threatened vertebrate classes, there is a dearth of funding and capacity to tackle the global crisis afflicting them. We compared the average funding per species listed under the US Endangered Species Act (ESA) to quantify funding favoritism across vertebrate classes in the United States and compared ESA listings with NatureServe evaluations of endangerment in order to examine listing bias. We found that, on average, listed US amphibians receive one-quarter of the ESA funding that other vertebrate classes do. This inequality is compounded by listing bias, with 82% of the amphibians found to be at risk by NatureServe remaining unlisted under the ESA. We recommend that federal, state, and private conservation groups take reactive and proactive measures to build capacity to sustain this important class of vertebrates for future generations.*

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**The widespread loss of amphibians is a defining** characteristic of the sixth great extinction (Wake and Vredenburg 2008). More than 40% of the known amphibians are in serious decline, with at least 122 species having become extinct since 1980 (Stuart et al. 2004, Hoffmann et al. 2010). The dire status of the taxon is likely underestimated relative to more well-known vertebrate classes, because for 24% of the world's 6260 amphibians there are insufficient data to determine their population status (Hoffmann et al. 2010).

Many amphibians living in the United States are as threatened as their more publicized tropical counterparts (Lannoo 2005, IUCN 2009). At least 36 of the 300 recognized species in the United States are listed as *critically imperiled* or *presumed extinct* (NatureServe 2011). Several amphibian species in the United States survive only because of intensive, *ex situ* breeding programs. The Wyoming Toad (*Bufo baxteri* Porter) was extirpated in the wild in 1994 and now persists only in captive populations (Odum and Corn 2005). Similar fates are shared by at least six other US amphibians now managed in *ex situ* programs (Muths et al. 2001, Fellers et al. 2007, Chelgren et al. 2008, Richter et al. 2009, Beauclerc et al. 2010, Gaston et al. 2010, Lannoo 2012). There is broad, international, scientific consensus on the breadth, depth, and potential causes of the amphibian crisis, as well as extensive press coverage (Stuart et al. 2004, Wake and Vredenburg 2008, Collins and Crump 2009, Hoffmann et al. 2010). However, our capacity to mitigate threats, including disease, habitat loss, invasive species, overharvesting, climate change, and pollution, remains woefully inadequate (Mendelson et al. 2006). This has prompted complaints from frustrated conservationists that amphibians are a neglected vertebrate class and that the existing mechanisms to support species preservation are weighted in favor of other taxa (Stuart et al. 2004, Lannoo 2012). Although it is difficult to objectively test a hypothesis of biased taxon funding, annual reports by the US Fish and Wildlife Service (USFWS) to Congress on federal and state expenditures to preserve threatened and endangered species make it possible to evaluate the amounts of conservation funding to US species allocated under the Endangered Species Act (ESA). We evaluated listing bias by comparing the discrepancies in endangerment assessments of US species between the ESA (a legally recognized definition) and NatureServe (which is not legally recognized but indicates the potential for a formal listing; see the supplemental material, available online at *http://dx.doi.org/10.1525/bio.2012.62.2.13*). NatureServe is an independent organization working closely with the International Union for Conservation of Nature (IUCN) to make expert assessments of endangerment.

## Quantifying bias

We compiled reports related to ESA-related expenditures over the fiscal years 2004–2007 prepared by the USFWS for Congress (USFWS 2004, 2006, 2007). The spending totals (summed over all four years) included disbursements by all federal and state agencies, not only by the USFWS. Outlays in the reports to Congress included the broad categories of federal or state expenditures, and these were each subdivided into land acquisition or management actions. Following the principle that land acquisition is a specialized conservation

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action (Salafsky et al. 2008), we simply lumped all expenditures by year.

The USFWS reports expenditures by the lowest taxonomic unit, including subspecies and distinctive population segment level. To achieve standard taxonomic resolution for comparison among species, we aggregated the subspecies and distinctive-population segments to the species level. We recorded for each ESA-listed species the NatureServe rounded global conservation status (*critically imperiled*, *imperiled*, *vulnerable*, *apparently secure*, *secure*) (NatureServe 2011). Because of small sample sizes for the *presumed extinct* and *possibly extinct* status groups, these samples were merged and reported as a single category (*presumed extinct*). The independent group NatureServe has collaborated closely with the IUCN in its Global Amphibian Assessment, using a consistent, proven endangerment-assessment methodology (Master 1991). For each species, we recorded both the USFWS priority as either *endangered* or *threatened*. Unlike NatureServe, the ESA does not have a rounded global status for species-level comparisons, so where multiple subspecies or populations were encountered and aggregated, we recorded the conservation status for the species as the status of the least-threatened subspecies or population.

All of the data were analyzed in SPSS (IBM, Armonk, New York) and tested for normality using a Kolmogorov–Smirnov test and for homogeneity of variance using a Levene's test. The data were $\log_{10}$ transformed in order to normalize the data and to meet the analysis assumptions of normal distribution and homogeneity of variance. A one-way ANOVA (analysis of variance) was used to test the null hypotheses that there were no differences in funding allocations related to vertebrate class, USFWS priority, or NatureServe priority.

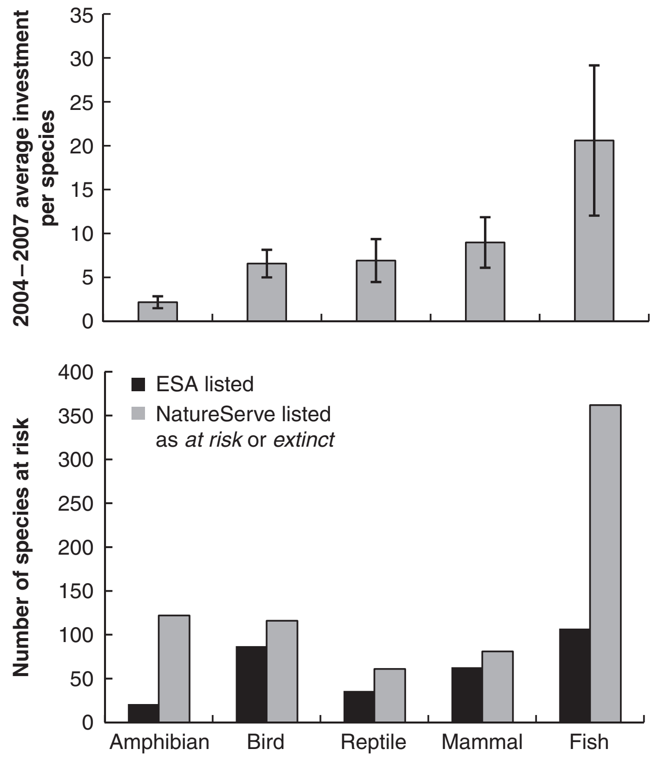


***Figure 1. On average, Endangered Species Act (ESA)–listed amphibian species received less funding (upper panel, in millions of US dollars) than did other vertebrate classes. The error bars represent the standard error of the mean. This pattern is compounded by a disproportionately smaller number of ESA-listed species that are considered at risk (*****endangered** ***and*** **threatened*****) than those in NatureServe's global assessment (bottom panel).***

### Magnitude of disparities

The average ESA-listed amphibian received only 25% of the funding from 2004 through 2007 allocated to the average mammal, bird, or reptile, and around 10% of that allocated to the average listed fish (figure 1). This apparent funding bias was not statistically significant ($F(4, 310) = 1.209$, $p = .31$), but we argue that a real funding bias exists when the figures are adjusted for listing bias (figure 1). Amphibians were the most underlisted taxon; NatureServe listed 122 amphibians as *at risk*, but only 21 species are listed as *threatened* or *endangered* under the ESA—a disparity of 82% (figure 1). A comparison with other vertebrate classes also indicated a major disparity for fish (with 70% of *apparently threatened* and *endangered* fish unlisted). The NatureServe–ESA discrepancies were modest for birds, reptiles, and mammals, at 25%, 40%, and 22%, respectively (figure 1).

Furthermore, funding allocations did not match the ESA assessments of extinction risk; the average *threatened* species (across all taxa) identified by the ESA received $5.9 million annually compared with only $1.3 million per year for their *endangered* counterparts ($F(1, 313) = 4.923$, $p = .03$). This was confirmed by the NatureServe threat assessments: ESA-listed species classified in NatureServe's *seriously imperiled* category received an average of 77% less funding than those characterized in the less-threatened *vulnerable* category (figure 2; $F(6, 308) = 15.140$, $p < .001$).

### The ESA should protect amphibians too

Despite being valuable research models (Burggren and Warburton 2007) and potential sources of medicines (Chivian and Bernstein 2008) and food (Gratwicke et al. 2010), as well as providing ecosystem services (Davic and Welsh 2004), amphibians are the most underlisted and underfunded vertebrate group in the United States, as was shown by the results above. The ESA specifically indicates that commercial or other nonbiodiversity value systems should not be considered in the designation process (Rohlf 1991, Brown and Shogren 1998). However, social, economic, and political trade-offs often influence funding and may explain the bias favoring nonamphibian vertebrate taxa (Restani and Marzluff 2002). Important swaying factors known to influence resource allocation are species charisma (Rohlf 1991, Czech et al. 1998) and the economic incentives from commercial or game species (Dawson and Shogren 2001).

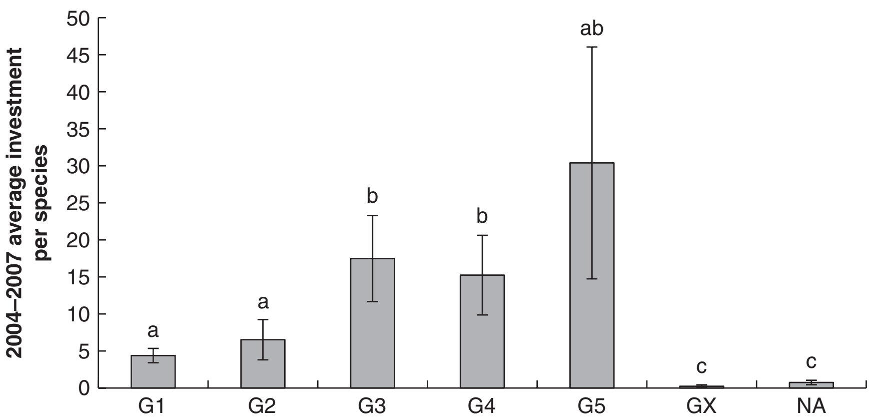


***Figure 2: Mean investments per species in millions of US dollars in each vertebrate class over a four-year period. US federal spending to meet the obligations of the ESA was not correlated positively with NatureServe's conservation-prioritization classification. More funding was provided to*** **globally secure** ***(or*** **apparently secure*****) species than to*** **imperiled** ***species. G1,*** **critically imperiled*****; G2,*** **imperiled*****; G3,*** **vulnerable*****; G4,*** **apparently secure*****; G5,*** **secure*****; GX,*** **extinct** ***and*** **presumed extinct*****; NA, ESA-listed species not evaluated by NatureServe. The letters indicate homogeneous subsets according to a post hoc Tukey's honestly significant difference test; the results are based on a one-way ANOVA (analysis of variance) on the $log_{10}$ transformed data (*****F*****(6, 308) = 15.140,*** **p** ***< .001). The error bars represent the standard error of the mean.***

Therefore, they are ineligible for ESA-related benefits. Amphibians are affected similarly. The tiger salamander is listed by NatureServe as *globally secure*; however, the ESA-listed Sonoran subspecies *Ambystoma tigrinum stebbinsi* received $331,000 from 2004 to 2007. By contrast, at least 100 other distinctly recognized amphibian species have received no funding, despite their being identified by experts as high priorities. The ESA could begin to address these issues by creating the equivalent of a global status category that considers the status of the species as a whole and that can be followed by subspecific identifications and comparisons in order to maintain perspective. We recognize that subspecific designations can be a prelude to complete species recognition. Nonetheless, our evaluation here has exposed the fact that *globally secure* species are consuming 50% of ESA funding.

It is conceivable, but unlikely, that amphibians may simply be less costly to conserve than are other vertebrates, which would explain the funding bias. This is plausible, given that many amphibians have small ranges (Ricketts et al. 2005). However, as a class of vertebrates, amphibians vary tremendously in life-history strategies and distribution, and they face a diverse range of complex threats, which makes generalization impossible. USFWS species recovery plans must now estimate recovery costs, but to date, this process has been too inconsistent to allow for meaningful comparisons (Tear et al. 1995). There are also few quantitative data on the relationship between the absolute amount of funding distributed and the effectiveness of threat mitigation. Therefore, it is reasonable to presume that fairly distributed amounts of funding are essential to building collective conservation capacity. Although it is now the highest priority for herpetologists (Lannoo 2012), there has been little financial support for enhancing amphibian conservation competency.

The rate at which new species are becoming threatened throughout the world has outstripped our ability to respond (Hoffmann et al. 2010). ESA funding cannot be apportioned to protect unlisted species, so clearing the widely recognized listing backlog is a high priority (USGAO 2002). Even so, our analyses and those of others (e.g., Restani and Marzluff 2001) have shown that a formal recognition of *endangered* status is a poor predictor of financial support. Currently, only 20% of the federal and state funding required to meet ESA directives is available, and the average amount of support per species has declined since the late 1970s (Scott et al. 2006). Almost three-quarters of USFWS field offices receive insufficient funds to complete ESA-related work (USGAO 2002). The critical lack of financial support to do the job is further confounded by the actual funding priorities' failing to reflect global conservation priorities. For example, 50% of ESA-related expenditures are apportioned to more than 50 species considered by NatureServe to be globally safe. Salmonids are a case in point, having benefited from funding through their controversial status as evolutionary significant units or distinctive-population segments (Pennock and Dimmick 1997, Cronin 2006). This has resulted in the Chinook salmon's (listed as *secure* by NatureServe) receipt of $714 million in ESA funding from 2004 through 2007, while commercial fisheries simultaneously harvested 84,000 pounds of this species (worth $194 million; NOAA 2010). Oddly, none of the whitefishes (subfamily Coregoninae), recognized by NatureServe as some of the most-endangered US salmonids, are listed by the ESA.

### Reactive and proactive solutions

Amphibians in the United States require immediate attention and their fair share of the limited amount of conservation dollars. We recognize two complementary approaches: identifying and assisting those species already in or approaching decline and preventing reductions in species numbers and populations before they become eligible for listing (under the ESA) or recognition (under NatureServe). A first step is recognizing that amphibians must benefit from the ESA mandate and related funding, especially given the rapidly increasing threats to species in the United States (Wake and Vredenburg 2008, Collins and Crump 2009, Hoffmann et al.

2010). On a broad scale, lawmakers must create legislative funding mechanisms that can grow at a rate commensurate with increasing threats in order to ensure that the ESA is implemented as was originally intended. This will take time, but emergency measures should be considered immediately in order to respond at a national level to the devastating consequences of mass mortalities caused by an ongoing *Batrachochytrium dendrobatidis* epidemic. This fungal pathogen has already caused the extinction of at least three US species (Burrowes et al. 2004) and has pushed several others to the brink of extinction (Odum and Corn 2005, Pilliod et al. 2010, Vredenburg et al. 2010). The effects of this disease have been even more dramatic on naive populations of amphibians elsewhere, where up to 50% of the species and 80% of the individuals at mountainous tropical sites have disappeared (Lips et al. 2006, 2008). Although it does not appear to be causing extinctions at this scale in the United States (Longcore et al. 2007, Rothermel et al. 2008), the influence of this fungus on many species remains unclear, and a proactive response plan designed to avert extinctions is needed. Other emerging diseases, including the amphibian ranaviruses (Gray et al. 2009), must be monitored for population-level effects, and we must be prepared to implement management prescriptions for these disease threats. Federal agencies have demonstrated an ability to respond to other emergency situations—for example, the insidious white nose syndrome, a disease that has caused the deaths of more than a million insect-devouring bats in Connecticut, Massachusetts, Vermont, New Jersey, Pennsylvania, Virginia, West Virginia, North Carolina, and Indiana (Blehert et al. 2009, USFWS 2011). The government responded by creating and providing the resources to implement a national management plan by the USFWS (2011). A similar coordinated effort should be initiated for critically endangered amphibians through a multiagency task force, including the hiring of at least one full-time staff member dedicated to conservation actions that mitigate amphibian extinction. There already exists a nascent community of external partners for such a task force, including a nongovernmental-organization community (i.e., the IUCN Amphibian Survival Alliance and Amphibian Ark, Partners in Amphibian and Reptile Conservation, Save The Frogs) with the needed expertise and ready-to-implement conservation plans (Mendelson et al. 2006).

## Building capacity

The ESA is a valuable tool for conservation but should be deployed more effectively in order to provide the necessary resources to save US amphibians. Besides the exploration of how existing legal and legislative mechanisms can build capacity in order to address the amphibian crisis, help will be needed from many stakeholders, especially nonfederal funders. Private foundations in particular have the flexibility and resources to implement capacity-building actions for amphibians. Within this crisis lies a significant opportunity to make measurable, global biodiversity impacts in a completely uncrowded field. Foundations also can take advantage of the incredible amount of scientific information from both NatureServe and the IUCN that has already led to the identification of species targets, many of which are not being supported by the ESA. Such partnerships could serve the dual function of steering some amphibian species away from the precipice while mobilizing resources and actions to prevent more ESA listings.

The traditional reactive model of initiating action only after the endangerment of a species will ultimately—and almost assuredly—be more costly in dollars and overall biodiversity than a proactive approach. Under the current model, the conservation community emphasizes the need for certainty in population numbers. However, in reality, the status of a species is generally in doubt until it can no longer be found, at which point it is too late to act (Wolfe 2005). For example, it took more than 30 years of a grassroots campaign to list the dusky gopher frog (*Lithobates sevosus*) under the ESA. This excruciatingly slow process no doubt helped contribute to its now dire status: It now includes only one remnant, naturally occurring population (Lannoo 2012). To help avoid this circumstance, we need to rely more on adaptive resource management, a proactive tool for coping with uncertainty that requires a commitment to both monitoring and management actions under clearly defined objectives (Williams 2002).

The Amphibian Research and Monitoring Initiative (ARMI) of the US Geological Survey has been working toward this goal since it was established in 2000. ARMI researchers monitor national parks, wildlife refuges, and other protected lands to assess species and population status and then use these objectively collected data to develop and advance conservation recommendations (Muths and Dreitz 2008). Likewise, there also is a national grassroots community of academic, state, and federal biologists operating under the Partners in Amphibian and Reptile Conservation banner that facilitates communication among public and private stakeholders to advance the conservation of these taxa.

These are examples of organizations and wildlife professionals that need adequate resources to understand little-studied amphibians, to objectively and continuously assess status and threats, and then to implement mitigation and management actions to prevent declines and extinctions (Lyons 2008). Our present analysis clearly indicates that amphibians are both underlisted and underfunded through the ESA. However, this federal act in coordination with fair amounts of funding could still prevent the extinction of significant numbers of amphibians. We are especially encouraged because of the existence of networks of professional specialists who have already identified the highest priorities and solutions for beginning to stabilize amphibian species and populations (Gascon et al. 2007). What are needed now are financial resources from a fair apportionment of the federal ESA obligation that, in turn, are leveraged with complementary support from the private sector.

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## References cited

Beauclerc KB, Johnson B, White BN. 2010. Genetic rescue of an inbred captive population of the critically endangered Puerto Rican crested toad (*Peltophryne lemur*) by mixing lineages. Conservation Genetics 11: 21–32.

Blehert DS, et al. 2009. Bat white-nose syndrome: An emerging fungal pathogen? Science 323: 227.

Brown GM Jr, Shogren JF. 1998. Economics of the Endangered Species Act. Journal of Economic Perspectives 12: 3–20.

Burggren WW, Warburton S. 2007. Amphibians as animal models for laboratory research in physiology. ILAR Journal 48: 260–269.

Burrowes PA, Joglar RL, Green DE. 2004. Potential causes of amphibian declines in Puerto Rico. Herpetologica 60: 141–154.

Chelgren ND, Pearl CA, Adams MJ, Bowerman J. 2008. Demography and movement in a relocated population of Oregon spotted frogs (*Rana pretiosa*): Influence of season and gender. Copeia 2008: 742–751.

Chivian E, Bernstein A, eds. 2008. Sustaining Life: How Human Health Depends on Biodiversity. Oxford University Press.

Collins JP, Crump ML. 2009. Extinction in Our Times: Global Amphibian Decline. Oxford University Press.

Cronin MA. 2006. A proposal to eliminate redundant terminology for intraspecies groups. Wildlife Society Bulletin 34: 237–241.

Czech B, Krausman PR, Borkhataria R. 1998. Social construction, political power, and the allocation of benefits to endangered species. Conservation Biology 12: 1103–1112.

Davic RD, Welsh HH Jr. 2004. On the ecological roles of salamanders. Annual Review of Ecology, Evolution, and Systematics 35: 405–434.

Dawson D, Shogren JF. 2001. An update on priorities and expenditures under the Endangered Species Act. Land Economics 77: 527–532.

Fellers GM, Bradford DF, Pratt D, Wood LL. 2007. Demise of repatriated populations of mountain yellow-legged frogs (*Rana muscosa*) in the Sierra Nevada of California. Herpetological Conservation and Biology 2: 5–21.

Gascon C, Collins JP, Moore RD, Church DR, McKay JE, Mendelson JR III, eds. 2007. Amphibian Conservation Action Plan. Proceedings: IUCN/SSC Amphibian Conservation Summit 2005. IUCN (International Union for Conservation of Nature) Species Survival Commission.

Gaston MA, Fuji A, Weckerly FW, Forstner MRJ. 2010. Potential component allee effects and their impact on wetland management in the conservation of endangered anurans. PLoS One 5: e10102.

Gratwicke B, Evans MJ, Jenkins PT, Kusrini MD, Moore RD, Sevin J, Wildt DE. 2010. Is the international frog legs trade a potential vector for deadly amphibian pathogens? Frontiers in Ecology and the Environment 8: 438–442.

Gray MJ, Miller DL, Hoverman JT. 2009. Ecology and pathology of amphibian ranaviruses. Diseases of Aquatic Organisms 87: 243–266.

Hoffmann M, et al. 2010. The impact of conservation on the status of the world's vertebrates. Science 330: 1503–1509.

[IUCN] International Union for Conservation of Nature. 2011. IUCN Red List of Threatened Species. Version 2011. (20 November 2011; *www.iucnredlist.org*)

Lannoo MJ, ed. 2005. Amphibian Declines: Conservation Status of United States Species. University of California Press.

———. 2012. A perspective on amphibian conservation in the United States. Alytes. Forthcoming.

Lips KR, Brem F, Brenes R, Reeve JD, Alford RA, Voyles J, Carey C, Livo L, Pessier AP, Collins JP. 2006. Emerging infectious disease and the loss of biodiversity in a Neotropical amphibian community. Proceedings of the National Academy of Sciences 103: 3165–3170.

Lips KR, Diffendorfer J, Mendelson JR III, Sears MW. 2008. Riding the wave: Reconciling the roles of disease and climate change in amphibian declines. PLoS Biology 6: e72.

Longcore JR, Longcore JE, Pessier AP, Halteman WA. 2007. Chytridiomycosis widespread in anurans of northeastern United States. Journal of Wildlife Management 71: 435–444.

Lyons JE, Runge MC, Laskowski HP, Kendall WL. 2008. Monitoring in the context of structured decision-making and adaptive management. Journal of Wildlife Management 72: 1683–1692.

Master LL. 1991. Assessing threats and setting priorities for conservation. Conservation Biology 5: 559–563.

Mendelson JR III, et al. 2006. Biodiversity: Confronting amphibian declines and extinctions. Science 313: 48.

Muths E, Dreitz V. 2008. Monitoring programs to assess reintroduction efforts: A critical component in recovery. Animal Biodiversity and Conservation 31: 47–56.

Muths E, Johnson TL, Corn PS. 2001. Experimental repatriation of boreal toad (*Bufo boreas*) eggs, metamorphs, and adults in Rocky Mountain National Park. Southwestern Naturalist 46: 106–113.

NatureServe. 2011. NatureServe Explorer: An Online Encyclopedia of Life, version 7.1. NatureServe. (20 January 2011; *http://www.natureserve.org/explorer*)

[NOAA] National Oceanic and Atmospheric Administration. 2010. Annual Commercial Landing Statistics. NOAA. (19 November 2011; *www.st.nmfs.noaa.gov/st1/commercial/landings/annual_landings.html*)

Odum RA, Corn PS. 2005. *Bufo baxteri* Porter, 1968: Wyoming toad. Pages 390–392 in Lannoo M, ed. Amphibian Declines: The Conservation Status of United States Species. University of California Press.

Pennock DS, Dimmick WW. 1997. Critique of the evolutionarily significant unit as a definition for "distinct population segments" under the U.S. Endangered Species Act. Conservation Biology 11: 611–619.

Pilliod DS, Muths E, Scherer RD, Bartelt PE, Corn PS, Hossack BR, Lambert BA, McCaffery R, Gaughan C. 2010. Effects of amphibian chytrid fungus on individual survival probability in wild boreal toads. Conservation Biology 24: 1259–1267.

Restani M, Marzluff JM. 2001. Avian conservation under the Endangered Species Act: Expenditures versus recovery priorities. Conservation Biology 15: 1292–1299.

———. 2002. Funding extinction? Biological needs and political realities in the allocation of resources to endangered species recovery. BioScience 52: 169–177.

Richter SC, Crother BI, Broughton RE. 2009. Genetic consequences of population reduction and geographic isolation in the critically endangered frog, *Rana sevosa*. Copeia 2009: 799–806.

Ricketts TH, et al. 2005. Pinpointing and preventing imminent extinctions. Proceedings of the National Academy of Sciences 102: 18497–18501.

Rohlf DJ. 1991. Six biological reasons why the Endangered Species Act doesn't work—And what to do about it. Conservation Biology 5: 273–282.

Rothermel BB, Walls SC, Mitchell JC, Dodd CK Jr, Irwin LK, Green DE, Vasquez VM, Petranka JW, Stephenson DJ. 2008. Widespread occurrence of the amphibian chytrid fungus *Batrachochytrium dendrobatidis* in the southeastern USA. Diseases of Aquatic Organisms 82: 3–18.

Salafsky N, et al. 2008. A standard lexicon for biodiversity conservation: Unified classifications of threats and actions. Conservation Biology 22: 897–911.

Scott JM, Goble DD, Svancara LK, Pidgorna A. 2006. By the numbers. Pages 16–35 in Goble DD, Scott JM, Davis FW, eds. The Endangered Species Act at Thirty, vol. 1: Renewing the Conservation Promise. Island Press.

Stuart SN, Chanson JS, Cox NA, Young BE, Rodrigues ASL, Fischman DL, Waller RW. 2004. Status and trends of amphibian declines and extinctions worldwide. Science 306: 1783–1786.

Tear TH, Scott JM, Hayward PH, Griffith B. 1995. Recovery plans and the Endangered Species Act: Are criticisms supported by data? Conservation Biology 9: 182–195.

[USFWS] US Fish and Wildlife Service. 2004. Federal and State Endangered and Threatened Species Expenditures: Fiscal Year 2004. USFWS.

———. 2006. Federal and State Endangered and Threatened Species Expenditures: Fiscal Years 2005–2006. USFWS.

———. 2007. Federal and State Endangered and Threatened Species Expenditures: Fiscal Years 2007–2008. USFWS.

———. 2011. White-nose syndrome: A devastating disease of North American bats. USFWS. (19 November 2011; *www.fws.gov/whitenose syndrome*)

[USGAO] US Government Accountability Office. 2002. Endangered Species Program: Information on How Funds Are Allocated and What Activities Are Emphasized. USGAO. Report no. GAO-02-581.

Vredenburg VT, Knapp RA, Tunstall TS, Briggs CJ. 2010. Dynamics of an emerging disease drive large-scale amphibian population extinctions. Proceedings of the National Academy of Sciences 107: 9689–9694.

Wake DB, Vredenburg VT. 2008. Are we in the midst of the sixth mass extinction? A view from the world of amphibians. Proceedings of the National Academy of Sciences 105: 11466–11473.

Williams BK, Nichols JD, Conroy MJ. 2002. Analysis and Management of Animal Populations: Modeling, Estimation, and Decision Making. Academic Press.

Wolfe JM, Horowitz TS, Kenner NM. 2005. Rare items often missed in visual searches. Nature 435: 439–440.

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