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Extinction and the U.S. Endangered Species Act

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The United States Endangered Species Act is one of the strongest laws of any nation for preventing species extinction, but quantifying the Act's effectiveness has proven difficult. To provide one measure of effectiveness, we identified listed species that have gone extinct and used previously developed methods to update an estimate of the number of species extinctions prevented by the Act. To date, only five species have been confirmed extinct with another 22 possibly extinct following protection. Another 71 listed species are extinct or possibly extinct, but were last seen before protections were enacted, meaning the Act's protections never had the opportunity to save these species. In contrast, a total of 39 species have been fully recovered, including 23 in the last 10 years. We estimate the Endangered Species Act has prevented the extinction of roughly 465 species since passage in 1973, and has to date saved more than 99 percent of species under its protection.

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Abstract:

The United States Endangered Species Act is one of the strongest laws of any nation for preventing species extinction, but quantifying the Act's effectiveness has proven difficult. To provide one measure of effectiveness, we identified listed species that have gone extinct and used previously developed methods to update an estimate of the number of species extinctions prevented by the Act. To date, only five species have been confirmed extinct with another 22 possibly extinct following protection. Another 71 listed species are extinct or possibly extinct, but were last seen before protections were enacted, meaning the Act's protections never had the opportunity to save these species. In contrast, a total of 39 species have been fully recovered, including 23 in the last 10 years. We estimate the Endangered Species Act has prevented the extinction of roughly 465 species since passage in 1973, and has to date saved more than 99 percent of species under its protection.

Introduction

Passed in 1973, the U.S. Endangered Species Act (ESA) includes strong protections for listed threatened and endangered species and has helped stabilize and recover hundreds of listed species, such as the bald eagle and gray whale (Taylor, Suckling, & Rachlinski 2006; Schwartz, 2008; Suckling, Mehrhoff, Beam, & Hartl, 2016). In part because of its strong protections, the ESA has engendered substantial opposition from industry lobby groups, who perceive the law as threatening their profits and have been effective in generating opposition to species protections among members of the U.S. Congress. One common refrain from opponents of the ESA in Congress and elsewhere is that the law is a failure because only two percent of listed species have been fully recovered and delisted (Hastings et. al., 2014).

The number of delistings, however, is a poor measure of the success of the ESA because most species have not been protected for sufficient time such that they would be expected to have recovered (Suckling et al., 2016). Short of recovery, a number of studies have found the ESA is effectively stabilizing or improving the status of species, using both biennial status assessments produced by the U.S. Fish and Wildlife Service for Congress and abundance trends (Male & Bean, 2005; Taylor, Suckling, & Rachlinski 2006; Gibbs & Currie, 2012; Suckling et al., 2016).

In addition to recovering species, one of the primary purposes of the ESA is to prevent species extinction. Previous studies indicate the ESA has been successful in this regard. As of 2008, the ESA was estimated to have prevented the extinction of at least 227 species and the number of species delisted due to recovery outnumbered the number of species delisted for extinction by 14 to 7 (Scott et al., 2006). In this study, we identified all ESA listed species that are extinct or

70 possibly extinct to quantify the number of species for which ESA protections have failed and use
71 these figures to update the estimated number of species extinctions prevented. This is the first
72 study to compile data on extinction of ESA listed species and provides an important measure of
73 one of the world's strongest conservation laws.
74
75 **Methods**
76 To identify extinct or possibly extinct ESA listed species, we examined the status of all 1,755
77 (species, subspecies and distinct population segments) U.S. listed or formerly listed species,
78 excluding species delisted based on a change in taxonomy or new information showing the
79 original listing to have been erroneous. We determined species to be extinct or possibly extinct
80 based on not being observed for at least ten years, the occurrence of adequate surveys of their
81 habitat, and presence of threats, such as destruction of habitat of the last known location or
82 presence of invasive species known to eliminate the species.
83
84 To differentiate extinct and possibly extinct species we relied on determinations by the U.S. Fish
85 and Wildlife Service, IUCN, species experts and other sources. In most cases, these
86 determinations were qualitative rather quantitative. Species were considered extinct if surveys
87 since the last observation were considered sufficient to conclude the species is highly likely to no
88 longer exist, and possibly extinct if surveys were conducted after the last observation, but were
89 not considered sufficient to conclude that extinction is highly likely (Butchart, Stattersfield, &
90 Brooks, 2006; Scott et al., 2008).
91

Source information included five-year reviews, listing rules and critical habitat designations by the U.S. Fish and Wildlife Service (for aquatic and terrestrial species) or NOAA Fisheries (for marine species), published and grey literature, personal communication with species experts, and classifications and accounts by NatureServe, IUCN and the Hawaiian Plant Extinction Prevention program. For each species, we identified year of listing, year last seen, NatureServe and IUCN ranking, taxonomic group, and U.S. Fish and Wildlife Service region. For species last seen after listing, we also searched for abundance estimates at time of listing in order to give a sense of likelihood of survival regardless of ESA protection.

Following previously developed methods, we estimated the number of species extinctions prevented by the ESA by assuming that listed threatened and endangered species have a comparable extinction risk to IUCN endangered species, which was estimated as an average of 67 percent over 100 years (Mace, 1995; Schwartz, 1999; Scott et al., 2006). This figure was then multiplied by the number of listed species and the proportion of a century in which species were protected by the ESA, which was assumed to be 45 years (1973-2018) based on the year the law was passed. This corresponds to the following formula:

Expected extinctions = (Spp. X 100 year Extinction Risk X Portion of a century with protection)

Results

We identified a total of 97 ESA listed species that are extinct (22) or possibly extinct (75). Of these, we found 71 extinct or possibly extinct species were last observed before they were listed under the ESA and thus are not relevant to determining the Act's success in preventing

extinction (Supplemental information, Table 1). These species were last seen an average of 24 years before protection was granted with a range of one to more than 80 years prior.

A total of 26 species were last seen after listing, of which five are confirmed extinct and 21 are possibly extinct (Supplementary information, Table 2). On average, these species were last seen 13 years after listing with a range of 2-23 years. We were able to find an abundance estimate at the time of listing for 19 of these species, ranging from one individual to more than 2,000 with an average of 272. For those with a higher abundance, this was generally an estimate in some cases based on very few sightings.

The distribution of extinct and possibly extinct species was non-random with 64 of the 97 species from Hawaii alone, followed by 18 from the southeast (Figure 1). This was also the case for taxonomy. Forty of the 97 species were mollusks dominated by Hawaiian tree snails and southeast mussels, followed by birds (18) and plants (17) (Figure 2).

We identified several other species that have been missing for more than 10 years, but for which there has not been any effective surveys and thus classifying them as possibly extinct did not seem appropriate, including two Hawaiian yellow-faced bees (*Hylaeus facilis* and *Hylaeus hilaris*)(Magnacca personal communication, 2018) and Fosberg's love grass (*Eragrostis fosbergii*)(USFWS, 2011). If indeed extinct, all three were lost prior to protection under the ESA.

Including updated figures for number of listed species, time of protection and species extinctions, we estimate the ESA has prevented the extinction of roughly 465 species in its 45 year history. Based on the number of confirmed extinctions following listing, we further estimate that the ESA has to date prevented the extinction of more than 99 percent of species under its protection. To date, a total of 39 species have been delisted for recovery compared to five species that are extinct and 21 that are potentially extinct.

Discussion

The few number of listed species that have gone extinct following protection combined with an estimated 465 species for which extinction was prevented demonstrate the ESA has achieved one of its core purposes—halting the loss of species. We will not attempt to catalogue them here, but numerous individual examples provide further support for this conclusion. Well known species like the California condor (*Gymnogyps californianus*), black-footed ferret (*Mustela nigripes*) and Hawaiian monk seal (*Neomonachus schauinslandi*), as well as lesser known species like the yellowfin madtom (*Noturus flavipinnis*), are but a few of the species that likely would have been lost were it not for the ESA.

The madtom is a case in point. Wrongly presumed extinct when described in1969, individual madtom were found in the Powell and Copper Rivers of Tennessee and the species was protected under the ESA in 1977 (USFWS, 1977). Following protection, federal and state officials worked with a non-governmental organization, Conservation Fisheries Inc., to discover additional populations and repatriate the species to rivers and streams in its historic range and there are now

populations of the yellowfin madtom in five different watersheds (USFWS, 2012a). The history of the ESA is replete with similar such stories.

The distribution of extinct or possibly extinct species largely tracks those regions with the highest rates of species endangerment, including Hawaii and the Northern Marianas with 64 of the 97 extinctions or possible extinctions, and the Southeast with 18 of the extinctions or possible extinctions, mostly freshwater species. The fragility of Hawaii's endemic fauna to introduced species and habitat destruction and high degree of species imperilment is well recognized (e.g. Duffy & Kraus, 2006). Similarly, the extinction and endangerment of freshwater fauna in the southeast is well documented (Benz & Collins, 1997). To avoid further extinctions, these areas should be priorities for increased funding and effort.

Protection under the ESA came too late for the 71 species last seen prior to listing. This highlights the need to move quickly to protect species. Indeed, Suckling, Slack & Nowicki (2004) identified 42 species that went extinct while under consideration for protection. Since that analysis was completed, the U.S. Fish and Wildlife Service has determined five additional species did not qualify for protection because they were extinct, including the Tacoma pocket gopher (*Thomomys mazama tacomensis*), Tatum Cave beetle (*Pseudanophthalmus parvus*), Stephan's riffle beetle (*Heterelmis* stephani), beaverpond marstonia (*Marstonia castor*) and Ozark pyrg (*Marstonia ozarkensis*), meaning there are now 47 species that have gone extinct waiting for protection (USFWS, 2012b, 2016, 2017, 2018a).

181 The U.S. Fish and Wildlife Service currently faces a backlog of more than 500 species that have
182 been determined to potentially warrant protection, but which await a decision (USFWS, 2018b).
183 Under the ESA, decisions about protection for species are supposed to take two years, but on
184 average it has taken the Fish and Wildlife Service 12 years (Puckett, Kessler & Greenwald,
185 2016). Such lengthy wait times are certain to result in loss of further species and run counter to
186 the purpose of the statute. This problem can be addressed by streamlining the Service's process
187 for listing species, which has become increasingly cumbersome, and by increasing funding for
188 the listing program.
189
190 The loss of as many as 26 species after they were protected further highlights the need for
191 accelerating the rate of species listings, as most of these species were reduced to very low
192 numbers by the time they were protected, including at least eight that had dropped to fewer than
193 10 individuals. It also highlights the need to move quickly to save species when they have
194 dropped to such low levels. There are many examples of species both in the U.S. and
195 internationally that have been successfully recovered after dropping to very small numbers, but
196 this can only occur with fast, effective action, resources and in many cases luck. The Mauritius
197 kestrel (*Falco punctatus)*, for example, was brought back from just two pairs (Cade & Jones,
198 1993) and the Hawaiian plant extinction prevention program, which focuses on saving plants
199 with fewer than 50 individuals, has rediscovered many species believed extinct, brought 177
200 species into cultivation, constructed fences to protect species from non-native predators and
201 reintroduced many species into the wild (Wood, 2012, http://www.pepphi.org/).
202

In this sense, all of the 97 ESA listed species that we identified as possibly extinct or extinct are conservation failures. For 42 of these species, the law itself was too late because they were last seen before the ESA was passed in 1973. But for others, there may have been time and we did not act quickly enough. The dusky seaside sparrow is a case in point. Despite the species listing in 1967 and noted population declines, birds were not brought into captivity until 1979, by which time there were too few individuals for success and the species was lost (USFWS, 1990).

Our failure to provide sufficient resources for conservation continues to the present. As many as 27 species of Oahu tree snail (*achatinella spp.*) are extinct or possibly extinct, yet expenditures for the species that still survive are inadequate to support minimal survey and captive propagation efforts. Likewise, the Hawaiian plant extinction prevention program, which has been so effective in saving species on the brink of extinction, is facing a budget cut of roughly 70 percent in 2019 (http://www.pepphi.org/), which very likely could mean the extinction of dozens of plants that otherwise could be saved. Overall, Greenwald et al. (2016) estimate current recovery funding is roughly three percent of estimated recovery costs from federal recovery plans. We can save species from extinction, but it must be more of a priority for federal spending. Nevertheless, despite funding shortfalls and the tragedy of these species having gone extinct, the ESA has succeeded in preventing the extinction of the vast majority of listed species and in this regard is a success.

Literature Cited

Benz, G.W., & Collins D.E., (Eds.) (1997). *Aquatic Fauna in Peril: The Southeastern Perspective*. Southeast Aquatic Research Institute Special Publication 1, Lenz Design and Communications, Decatur, GA. 553 pp.

Butchart, S.H.M., Stattersfield, A.J., & Brooks, T.M., (2006). Going or gone: defining 'Possibly Extinct' species to give a truer picture of recent extinctions. *Bulletin of the British Ornithologists' Club, 126A*, 7-24.

Cade, T.J., & Jones, C.G., (1993). Progress in Restoration of the Mauritius Kestrel. *Conservation Biology, 7*, 169-175. doi/abs/10.1046/j.1523-1739.1993.07010169.x

Duffy, D. C., & Kraus, F., (2006). Science and the Art of the Solvable in Hawai`i's Extinction Crisis. *Environment Hawaii 16 (11)*, 3-6. Retrieved from http://www.environment-hawaii.org/?p=1451

Gibbs, K.E. & Currie D.J., (2012). Protecting Endangered Species: Do the Main Legislative Tools Work? *PLoS ONE 7(5), 1-7*. e35730. doi:10.1371/journal.pone.0035730

Greenwald, N., Hartl, B., Mehrhoff, L. & Pang J., (2016). Shortchanged, funding needed to save America's endangered species. Retrieved from https://www.biologicaldiversity.org/programs/biodiversity/pdfs/Shortchanged.pdf

Hastings, D., Lummis C., Amodei, M., Bishop, R., Collins, D., Harris, A., … Valadao, D., (2014). Endangered Species Act Working Group Report, Findings and Recommendations. February 4, 2014. Retrieved from https://valadao.house.gov/uploadedfiles/esaworkinggroupreportandrecommendations.pdf

Mace, G.M., (1995). Classification of threatened species and its role in conservation planning. In Lawton, J.H. & May, R.M. (Eds.), *Extinction Rates* (pp. 197–213). Oxford, UK: Oxford Univ. Press.

Male, T. D. & Bean, M. J., (2005). Measuring progress in US endangered species conservation. *Ecological Letters*, *8*, 986–92. doi/abs/10.1111/j.1461-0248.2005.00806.x

Schwartz, M. W., (1999). Choosing the appropriate scale of reserves for conservation. *Annual Review of Ecology, Evolution and Systematics, 30*, 83-108. doi/abs/10.1146/annurev.ecolsys.30.1.83

Scott J.M., Goble D.D., Scvancara L., & Pidgorna A. (2006). By the numbers. In Goble, D.D., Scott, J.M., Davis, F.W., (Eds.), *The Endangered Species Act at Thirty: Renewing the Conservation Promise* (pp 16–35). Island Press, Washington, DC.

Scott, J. M., Ramsey F. L., Lammertink, M., Rosenberg K. V., Rohrbaugh R., Wiens J. A., & Reed, J. M., (2008). When is an “extinct” species really extinct? Gauging the search efforts for

Hawaiian forest birds and the Ivory-billed Woodpecker. *Avian Conservation and Ecology 3(2)*, 3. http://www.ace-eco.org/vol3/iss2/art3/

Suckling, K.F., Slack, R., & Nowicki B., (2004). Extinction and the Endangered Species Act. Center for Biological Diversity. Retrieved from http://www.biologicaldiversity.org/publications/papers/ExtinctAndESA.pdf

Suckling, K.F., Mehrhoff, L.A., Beam, R., & Hartl, B., (2016). A wild success, a systematic review of bird recovery under the Endangered Species Act. Retrieved from http://www.esasuccess.org/pdfs/WildSuccess.pdf

Taylor, M., Suckling, K., & Rachlinski, J., (2005). The effectiveness of the Endangered Species Act: a quantitative analysis. *BioScience 55*, 360-367

U.S. Fish and Wildlife Service., (1977). Final Threatened Status and Critical Habitat for Five species of Southeastern Fishes. *Federal Register, 42* (175), 45526-45530.

U.S. Fish and Wildlife Service., (1990). Final Rule to Delist the Dusky Seaside Sparrow and Remove its Critical Habitat Designation. *Federal Register, 55*, (239), 51112-51114.

U.S. Fish and Wildlife Service, (2011). Eragrostis fosbergii (Fosberg's love grass) 5-Year Review Summary and Evaluation. Retrieved from https://ecos.fws.gov/docs/five_year_review/doc3814.pdf

U.S. Fish and Wildlife Service, (2012a). Yellowfin Madtom (noturus flavipinnis), Smoky Madtom (Noturus baileyi) 5-Year Review Summary and Evaluation. Retrieved from https://ecos.fws.gov/docs/five_year_review/doc4146.pdf

U.S. Fish and Wildlife Service, (2012b). Listing Four Subspecies of Mazama Pocket Gopher and Designation of Critical Habitat, Proposed Rule. *Federal Register, 77*, 73769-73825.

U.S. Fish and Wildlife Service, (2016). Endangered and threatened wildlife and plants; 12-Month findings on petitions to list 10 species as endangered or threatened species. *Federal Register, 81,* 69425-69422.

U.S. Fish and Wildlife Service, (2017). Endangered and threatened wildlife and plants; 12-month findings on petitions to list a species and remove a species from the federal lists of endangered and threatened wildlife and plants. *Federal Register, 82,* 61725-61727.

U.S. Fish and Wildlife Service, (2018a). Endangered and threatened wildlife and plants; 12-month findings on petitions to list 13 species as endangered or threatened species. *Federal Register, 83,* 65127-65134.

U.S. Fish and Wildlife Service, (2018b). Listing and Critical Habitat Workplan. Retrieved from https://www.fws.gov/endangered/what-we-do/listing-workplan.html.

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Wood, K.R., (2012). Possible Extinctions, Rediscoveries, and New Plant Records within the Hawaiian Islands, Records of the Hawaii Biological Survey for 2011. In Evenhuis, N.L., & Eldredge, L.G., (Eds.). *Bishop Museum Occasional Papers 113*, 91–102.

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Figure 1(on next page)

Extinction and taxonomic group

Figure 1. Extinct or possibly extinct listed species by taxonomic group.

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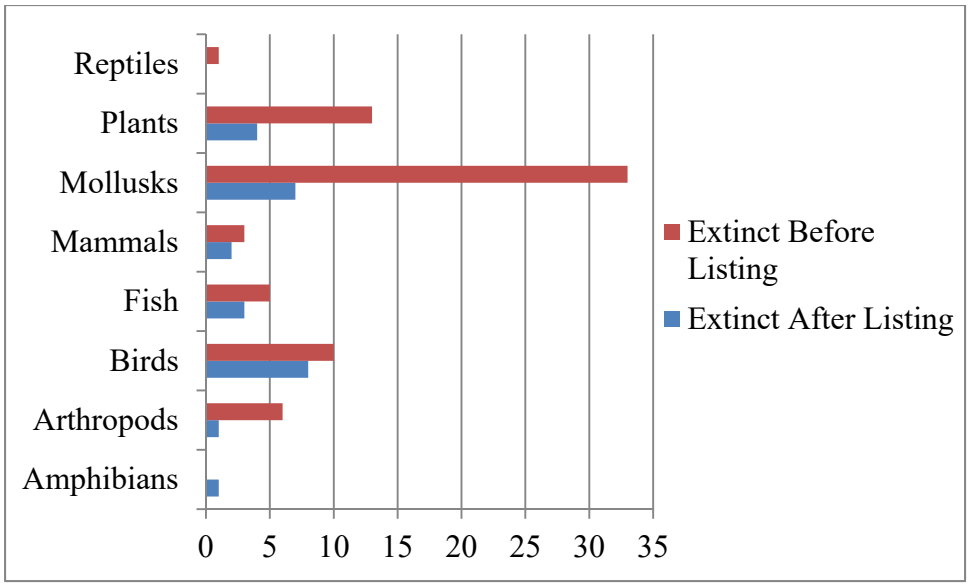

Figure 1. Extinct or possibly extinct listed species by taxonomic group.

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Figure 2(on next page)

Extinctions by region

Extinct or possibly extinct listed species by U.S. Fish and Wildlife Service Region.

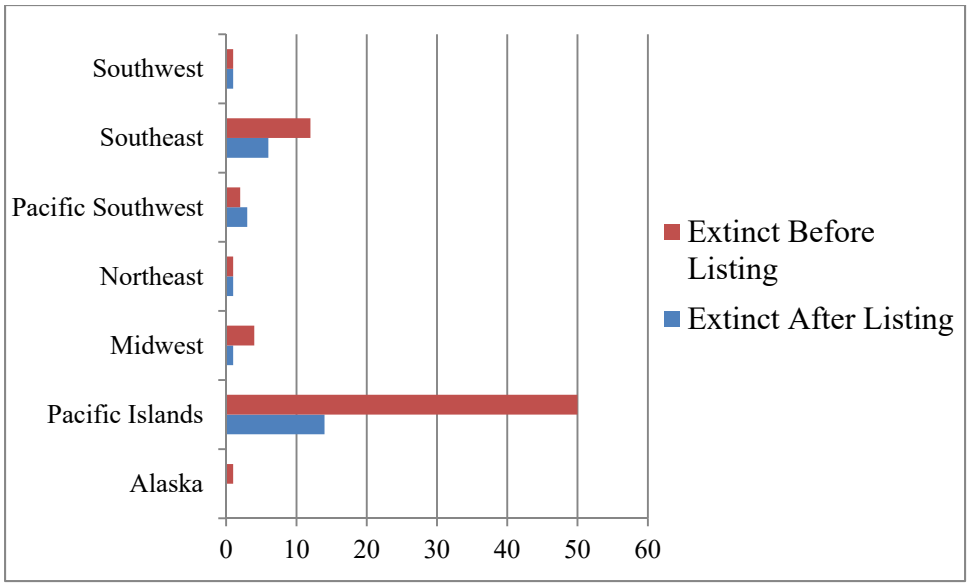

Figure 2. Extinct or possibly extinct listed species by U.S. Fish and Wildlife Service Region.

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