Extinction and the U.S. Endangered Species Act

Noah Greenwald [Corresp., 1] , **Kieran F Suckling** [2] , **Brett Hartl** [3] , **Loyal Mehrhoff** [4]

[1] Center for Biological Diversity, Portland, Oregon, United States

[2] Center for Biological Diversity, Tucson, Arizona, United States

[3] Center for Biological Diversity, Washington DC, United States

[4] Center for Biological Diversity, Honolulu, Hawaii, United States

Corresponding Author: Noah Greenwald
Email address: ngreenwald@biologicaldiversity.org

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 four 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 291 species since passage in 1973, and has to date saved more than 99 percent of species under its protection.

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5   [1] Center for Biological Diversity, Portland, Oregon, USA

6   [2] Center for Biological Diversity, Tucson, Arizona, USA

7   [3] Center for Biological Diversity, Washington DC, USA

8   [4] Center for Biological Diversity, Honolulu, Hawaii, USA

10   **Corresponding Author:**

11   Noah Greenwald[1]

12   PO Box 11374, Portland, OR 97211, USA

13   Email address: ngreenwald@biologicaldiversity.org

23

24   **Abstract:**

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26   preventing species extinction, but quantifying the Act's effectiveness has proven difficult. To

27   provide one measure of effectiveness, we identified listed species that have gone extinct and

28   used previously developed methods to update an estimate of the number of species extinctions

29   prevented by the Act. To date, only five species have been confirmed extinct with another 22

30   possibly extinct following protection. Another 71 listed species are extinct or possibly extinct,

31   but were last seen before protections were enacted, meaning the Act's protections never had the

32   opportunity to save these species. In contrast, a total of 39 species have been fully recovered,

33   including 23 in the last 10 years. We estimate the Endangered Species Act has prevented the

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35   percent of species under its protection.

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47 **Introduction**

48 Passed in 1973, the U.S. Endangered Species Act (ESA) includes strong protections for listed

49 threatened and endangered species and has helped stabilize and recover hundreds of listed

50 species, such as the bald eagle and gray whale (Taylor et al., 2006; Schwartz, 2008; Suckling et

51 al., 2016). In part because of its strong protections, the ESA has engendered substantial

52 opposition from industry lobby groups, who perceive the law as threatening their profits and

53 have been effective in generating opposition to species protections among members of the U.S.

54 Congress. One common refrain from opponents of the ESA in Congress and elsewhere is that

55 the law is a failure because only two percent of listed species have been fully recovered and

56 delisted (Hastings et. al., 2014).

57

58 The number of delistings, however, is a poor measure of the success of the ESA because most

59 species have not been protected for sufficient time such that they would be expected to have

60 recovered. Suckling et al. (2016), for example, found that on average listed birds had been

61 protected just 36 years, but their federal recovery plans estimated an average of 63 years for

62 recovery. Short of recovery, a number of studies have found the ESA is effectively stabilizing or

63 improving the status of species, using both biennial status assessments produced by the U.S. Fish

64 and Wildlife Service for Congress and abundance trends (Male & Bean, 2005; Taylor et al.,

65 2006; Gibbs & Currie, 2012; Suckling et al., 2016).

66

67 In addition to recovering species, one of the primary purposes of the ESA is to prevent species

68 extinction. Previous studies indicate the ESA has been successful in this regard (McMillan &

69 Wilcove, 1994; Scott et al., 2006). As of 2008, the ESA was estimated to have prevented the

70 extinction of at least 227 species and the number of species delisted due to recovery

71 outnumbered the number of species delisted for extinction by 14 to 7 (Scott et al., 2006). In this

72 study, we identified all ESA listed species that are extinct or possibly extinct to quantify the

73 number of species for which ESA protections have failed and use these figures to update the

74 estimated number of species extinctions prevented. This is the first study in over 20 years to

75 compile data on extinction of ESA listed species, providing an important measure of one of the

76 world's strongest conservation laws (McMillan & Wilcove, 1994).

77

78 **Methods**

79 To identify extinct or possibly extinct ESA listed species, we examined the status of all 1,747

80 (species, subspecies and distinct population segments) U.S. listed or formerly listed species,

81 excluding species delisted based on a change in taxonomy or new information showing the

82 original listing to have been erroneous. We determined species to be extinct or possibly extinct

83 based on not being observed for at least ten years, the occurrence of adequate surveys of their

84 habitat, and presence of threats, such as destruction of habitat of the last known location or

85 presence of invasive species known to eliminate the species.

86

87 To differentiate extinct and possibly extinct species we relied on determinations by the U.S. Fish

88 and Wildlife Service, IUCN, species experts and other sources. In most cases, these

89 determinations were qualitative rather quantitative. Species were considered extinct if surveys

90 since the last observation were considered sufficient to conclude the species is highly likely to no

91 longer exist, and possibly extinct if surveys were conducted after the last observation, but were

92   not considered sufficient to conclude that extinction is highly likely (Butchart et al., 2006; Scott

93   et al., 2008).

94

95   Source information included five-year reviews, listing rules and critical habitat designations by

96   the U.S. Fish and Wildlife Service (for aquatic and terrestrial species) or NOAA Fisheries (for

97   marine species), published and grey literature, personal communication with species experts, and

98   classifications and accounts by NatureServe, IUCN and the Hawaiian Plant Extinction

99   Prevention program. For each species, we identified year of listing, year last seen, NatureServe

100   and IUCN ranking, taxonomic group, and U.S. Fish and Wildlife Service region. For species last

101   seen after listing, we also searched for abundance estimates at time of listing in order to give a

102   sense of likelihood of survival regardless of ESA protection.

103

104   Following previously developed methods, we estimated the number of species extinctions

105   prevented by the ESA by assuming that listed threatened and endangered species have a

106   comparable extinction risk to IUCN endangered species, which was estimated as an average of

107   67 percent over 100 years (Mace, 1995; Schwartz, 1999; Scott et al., 2006). We believe this

108   estimate of extinction risk is conservative based on similarity of IUCN criteria to factors

109   considered in ESA listings, observed low numbers for species at time of ESA listing and

110   observed correspondence between ESA listed species and species classified as endangered or

111   critically endangered by the IUCN (Wilcove et al., 1993; Wilcove and Master, 2005; Harris et

112   al., 2012). Presumed extinction risk was then multiplied by the number of extant listed species

113   and the proportion of a century in which species were protected by the ESA. Previous studies

114   used the length of time the ESA has been in existence (1973-present) for the proportion of a

115 century species have been protected (Schwartz, 1999; Scott et al., 2006), but because many

116 species have not been protected the entire 45 years the law has existed, we instead used the more

117 conservative average length species were protected (25 years). This corresponds to the following

118 formula:

119

120 *Expected extinctions = (Spp. X 100 year extinction risk X average proportion of a century with*

121 *protection)*.

122

123 **Results**

124 We identified a total of 97 ESA listed species that are extinct (23) or possibly extinct (74). Of

125 these, we found 71 extinct (19) or possibly extinct (52) species were last observed before they

126 were listed under the ESA and thus are not relevant to determining the Act's success in

127 preventing extinction (Supplemental information, Table 1). These species were last seen an

128 average of 24 years before protection was granted with a range of one to more than 80 years

129 prior.

130

131 A total of 26 species were last seen after listing, of which four are confirmed extinct and 21 are

132 possibly extinct (Supplementary information, Table 2). On average, these species were last seen

133 13 years after listing with a range of 2-23 years. We were able to find an abundance estimate at

134 the time of listing for 19 of these species, ranging from one individual to more than 2,000 with

135 an average of 272. In several cases, these estimates were based on extrapolations from very few

136 sightings.

137

138 The distribution of extinct and possibly extinct species was non-random with 64 of the 97

139 species from Hawaii and other Pacific Islands, followed by 18 from the southeast (Figure 1).

140 This was also the case for taxonomy. Forty of the 97 species were mollusks dominated by

141 Hawaiian tree snails and southeast mussels, followed by birds (18) and plants (17) (Figure 2).

142

143 We identified several other species that have been missing for more than 10 years, but for which

144 there has not been any effective surveys and thus classifying them as possibly extinct did not

145 seem appropriate, including two Hawaiian yellow-faced bees (*Hylaeus facilis* and *Hylaeus*

146 *hilaris*)(Magnacca personal communication, 2018) and Fosberg's love grass (*Eragrostis*

147 *fosbergii*)(USFWS, 2011). If indeed extinct, all three were lost prior to protection under the

148 ESA.

149

150 Including updated figures for number of listed species, time of protection and species

151 extinctions, we estimate the ESA has prevented the extinction of roughly 291 species in its 45

152 year history. Based on the number of confirmed extinctions following listing, we further

153 estimate that the ESA has to date prevented the extinction of more than 99 percent of species

154 under its protection. To date, a total of 39 species have been delisted for recovery compared to

155 five species that are extinct and 21 that are potentially extinct.

156

157 **Discussion**

158 The few number of listed species that have gone extinct following protection combined with an

159 estimated 291 species for which extinction was prevented demonstrate the ESA has achieved one

160 of its core purposes—halting the loss of species. We will not attempt to catalogue them here, but

161   numerous individual examples provide further support for this conclusion. Well known species

162   like the California condor (*Gymnogyps californianus*), black-footed ferret (*Mustela nigripes*) and

163   Hawaiian monk seal (*Neomonachus schauinslandi*), as well as lesser known species like the

164   yellowfin madtom (*Noturus flavipinnis*), are but a few of the species that likely would have been

165   lost were it not for the ESA.

166

167   The madtom is a case in point. Wrongly presumed extinct when described in1969, individual

168   madtom were found in the Powell and Copper Rivers of Tennessee and the species was protected

169   under the ESA in 1977 (USFWS, 1977). Following protection, federal and state officials worked

170   with a non-governmental organization, Conservation Fisheries Inc., to discover additional

171   populations and repatriate the species to rivers and streams in its historic range and there are now

172   populations of the yellowfin madtom in five different watersheds (USFWS, 2012a). The history

173   of the ESA is replete with similar such stories.

174

175   The distribution of extinct or possibly extinct listed species largely tracks those regions with the

176   highest rates of species endangerment, including Hawaii and the Northern Mariana Islands with

177   64 of the 97 extinctions or possible extinctions, and the Southeast with 18 of the extinctions or

178   possible extinctions, mostly freshwater species. The fragility of Hawaii's endemic fauna to

179   introduced species and habitat destruction and high degree of species imperilment is well

180   recognized (e.g. Duffy & Kraus, 2006). Similarly, the extinction and endangerment of

181   freshwater fauna in the southeast is well documented (Benz & Collins, 1997). To avoid further

182   extinctions, these areas should be priorities for increased funding and effort.

183

184   Protection under the ESA came too late for the 71 species last seen prior to listing. It's possible

185   that some of these species survived undetected following listing, but we find this unlikely for

186   most if not all of the species. It is very difficult to document extinction, but all of the species

187   were the subject of survey both before and after listing, which is described in the listing rules and

188   subsequent status surveys. In addition, the 71 species were last seen an average of 24 years prior

189   to listing, providing a long window for detection prior to listing. If some of these species did

190   survive after listing it was likely at very low numbers, such that recovery would have been

191   difficult at best.

192

193   That these 71 species were lost before protections were applied clearly highlights the need to

194   move quickly to protect species. Indeed, Suckling et al., (2004) identified 42 species that went

195   extinct while under consideration for protection. Since that analysis was completed, the U.S.

196   Fish and Wildlife Service has determined five additional species did not qualify for protection

197   because they were extinct, including the Tacoma pocket gopher (*Thomomys mazama*

198   *tacomensis*), Tatum Cave beetle (*Pseudanophthalmus parvus*), Stephan's riffle beetle

199   (*Heterelmis* stephani), beaverpond marstonia (*Marstonia castor*) and Ozark pyrg (*Marstonia*

200   *ozarkensis*), meaning there are now 47 species that have gone extinct waiting for protection

201   (USFWS, 2012b, 2016, 2017, 2018a).

202

203   The U.S. Fish and Wildlife Service currently faces a backlog of more than 500 species that have

204   been determined to potentially warrant protection, but which await a decision (USFWS, 2018b).

205   Under the ESA, decisions about protection for species are supposed to take two years, but on

206   average it has taken the Fish and Wildlife Service 12 years (Puckett et al. 2016). Such lengthy

207   wait times are certain to result in loss of further species and run counter to the purpose of the

208   statute. This problem can be addressed by streamlining the Service's process for listing species,

209   which has become increasingly cumbersome, and by increasing funding for the listing program.

210   For every species listed, the Service's process includes review by upwards of 20 people,

211   including numerous individuals who have no specific knowledge of the species and in a number

212   of cases are political appointees. We instead recommend that the Service adopt a process similar

213   to scientific peer review, involving review by 2-3 qualified individuals.

214

215   The loss of 26 species after they were protected is indicative of conservation failure. This

216   failure, however, in most cases cannot be wholly attributed to the Endangered Species Act

217   because most of these species were reduced to very low numbers by the time they were

218   protected, making recovery difficult to impossible. Of the nineteen species we could find an

219   abundance estimate for at the time of listing, 13 had an estimated population fewer than 100 with

220   eight having fewer than 10 individuals. Of the six other species, two Hawaiian birds,

221   Oahu creeper (*Paroreomyza maculate*) and 'O'u (*Psittirostra psittacea*) had estimated

222   populations in the hundreds, but this was based on sightings of single individuals. Given the lack

223   of further sightings and the presence of disease carrying mosquitoes throughout their habitat,

224   these estimates were likely optimistic. The other four species, the dusky seaside sparrow

225   (*Ammodramus maritimus nigrescens*), Morro Bay kangaroo rat (*Dipodomys heermanni*

226   *morroensis*), pamakani (*Tetramolopium capillare*) and Curtis' pearlymussel (*Epioblasma*

227   *florentina curtisii*), had populations at the time of listing ranging from 100-3,000 individuals, but

228   sufficient action was not taken to save them, making them true conservation failures.

229

230 At some level, all of the 97 ESA listed species that we identified as possibly extinct or extinct are

231 conservation failures. For 42 of these species, the law itself was too late because they were last

232 seen before the ESA was passed in 1973. But for others, there may have been time and we did

233 not act quickly enough or dedicate sufficient resources to saving them. There are many

234 examples of species both in the U.S. and internationally that have been successfully recovered

235 even after dropping to very small numbers, but this can only occur with fast, effective action,

236 resources and in many cases luck. The Mauritius kestrel (*Falco punctatus)*, for example, was

237 brought back from just two pairs (Cade & Jones, 1993) and the Hawaiian plant extinction

238 prevention program, which focuses on saving plants with fewer than 50 individuals, has

239 rediscovered many species believed extinct, brought 177 species into cultivation, constructed

240 fences to protect species from non-native predators and reintroduced many species into the wild

241 (Wood, 2012, http://www.pepphi.org/).

242

243 The failure to provide sufficient resources for conservation of listed species, however, continues

244 to the present. As many as 27 species of Oahu tree snail (*achatinella spp.*) are extinct or possibly

245 extinct, yet expenditures for the species that still survive are inadequate to support minimal

246 survey and captive propagation efforts. Likewise, the Hawaiian plant extinction prevention

247 program, which has been so effective in saving species on the brink of extinction, is facing a

248 budget cut of roughly 70 percent in 2019 (http://www.pepphi.org/), which very likely could

249 mean the extinction of dozens of plants that otherwise could be saved. Overall, Greenwald et al.

250 (2016) estimate current recovery funding is roughly three percent of estimated recovery costs

251 from federal recovery plans. We can save species from extinction, but it must be more of a

252 priority for federal spending.   Nevertheless, despite funding shortfalls and the tragedy of these

253 species having gone extinct, the ESA has succeeded in preventing the extinction of the vast

254 majority of listed species and in this regard is a success.

255

256 **Management Implications**

257 Of the 97 species we identified as extinct or potentially extinct, only 11 have been delisted for

258 extinction. Another 11 have been recommended for delisting due to extinction. The San Marcos

259 gambusia (*Gambusia georgei*) could also be delisted since there is very little hope it survives.

260 For the other 74 possibly extinct species, we recommend retaining protections in the hope that

261 some will be rediscovered and because there is little cost in retaining listing.

262

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Extinction and taxonomic group

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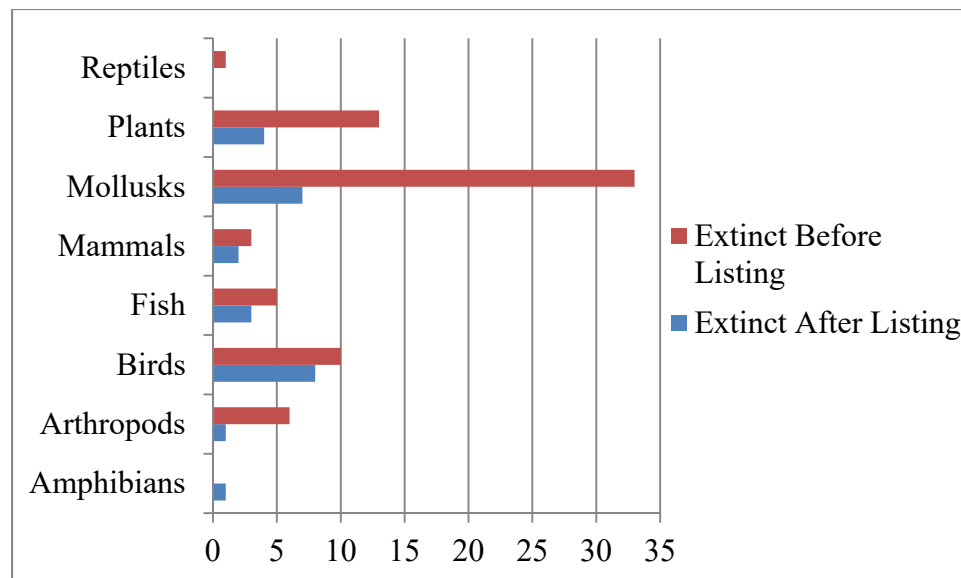
Figure 1. Extinct or possibly extinct listed species by taxonomic group.

Extinctions by region

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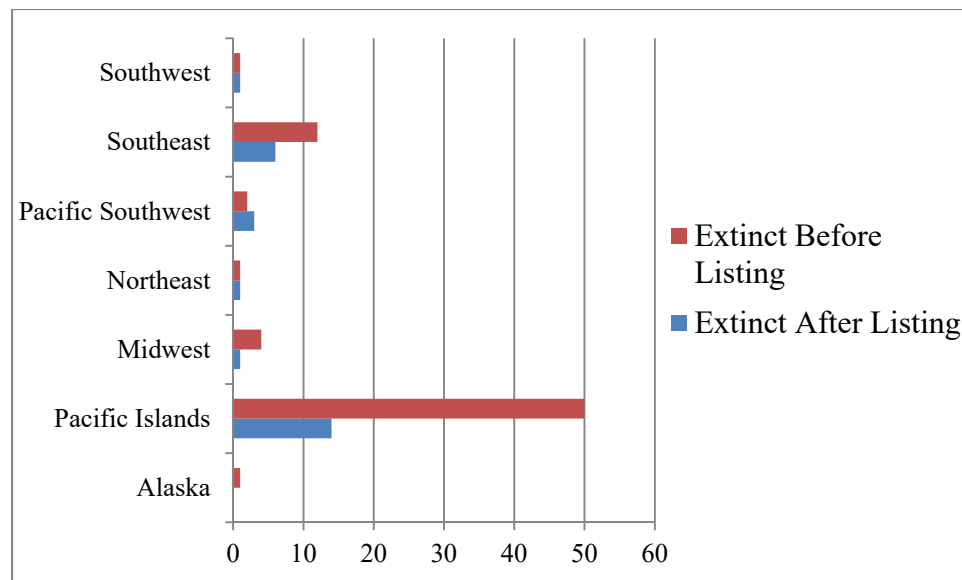
Figure 2. Extinct or possibly extinct listed species by U.S. Fish and Wildlife Service Region.

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