Ecological Applications, 12(3), 2002, pp. 668–673

ARE WE RECOVERING? AN EVALUATION OF RECOVERY CRITERIA UNDER THE U.S. ENDANGERED SPECIES ACT

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Abstract. In 1988, the Endangered Species Act was amended to require that recovery plans include objective criteria for delisting. In this paper, we characterized (1) temporal trends in the use of recovery criteria; (2) patterns of use for different categories of recovery criteria; (3) variability in the use of criteria by taxa and plan type; and (4) the relationship between categories of recovery criteria (population size, population trends, habitat fragmentation, demography, and legal/policy/other) and population status (i.e., declining, stable, improving). Of the 181 species (in 135 recovery plans) analyzed, 91% include at least one criterion, and 81% include at least one quantitative criterion. The total number of recovery criteria specified in plans increased significantly for species with plans approved after 1990. However, the number of recovery criteria characterized as having an unclear relationship to biological information also increased significantly for plans approved after 1990. Population size was the most quantitative and frequently used criterion, and there was a significant increase in the number of ''population size'' and ''population trend'' criteria with quantitative metrics after 1990. Species characterized as improving were more likely to include a very clear relationship to biological information. More recovery criteria are being developed for species in recent plans, and there is some evidence that species with improving status have a larger number of recovery criteria.

Key words: conservation biology; delisting; Endangered Species Act; extinction; population size; quantitative vs. qualitative; recovery criteria.

INTRODUCTION

The danger posed by human activities to the long-term survival of plant and animal species was the impetus for the enactment of the U.S. Endangered Species Act (ESA) in 1973. In light of the obvious impossibility of preventing all species everywhere from going extinct over indefinite time periods, it is not clear exactly what circumstances should trigger a species to be listed or delisted under the ESA. The ESA defines *endangered* as any species that is in danger of extinction throughout all or a significant portion of its range and *threatened* as any species that is likely to become an endangered species within the foreseeable future. With no clear definition for ESA categories of threat, it is up to recovery teams or responsible federal agencies to define listing and delisting criteria for each species in recovery plans.

In 1988, the ESA was amended to require that recovery plans include objective criteria for delisting species. Previous analyses of existing recovery plans have led some biologists to conclude that most plans do not include biologically defensible listing guidelines (Wilcove et al. 1993). Scott et al. (1995) argue that lack of distinction between biological and ''political'' recovery goals has resulted in the use of impractical and unachievable criteria on the one hand, and unsustainable criteria on the other. For example, one study has shown that 28% of threatened and endangered species for which population size data were available had recovery goals set at or below the existing population size (Tear et al. 1993). Without clearly defined metrics for recovery, responsible agencies may be unable to gauge the successes and failures of recovery efforts. Although recovery plans lack the legal clout to implement their recommendations, they do have one important regulatory attribute. Only in recovery plans is it specified what criteria would suffice to remove a species from the List of Threatened and Endangered Wildlife (Gerber and DeMaster 1999). Thus, recovery plans have the potential to function as important documents by defining formal delisting criteria.

In this paper, we examine the degree to which recovery criteria are used in recovery planning. In particular, we characterize (1) temporal trends in the use of recovery criteria and the metrics used to assess these

Manuscript received 30 January 2001; revised 20 April 2001; accepted 24 April 2001. For reprints of this Invited Feature, see footnote 1, p. 629.

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TABLE 1. Five categories of metrics used to define recovery criteria, and associated question number (in parentheses) for 16 possible metrics from the questionnaire.

Category	Metrics
Population size (405–407)	Total population size Number of subpopulations Number of individuals in each subpopulation
Population trend (408–410)	Trends in total population size Trends in number of subpopulations Trends in number of individuals in each subpopulation
Habitat fragmentation (411–413)	Total range Quantity of habitat Quality of habitat
Demography (415, 418)	Age structure of population Productivity/net recruitment rates
Legal, policy, or other (414, 416, 417, 419, 420)	Existence/significance of threat Implementation of post-delisting management programs Securement of water rights Securement of habitat (i.e., legal protection) Other metrics not captured

criteria; (2) patterns of use for different categories of recovery criteria; and (3) variability in use of criteria by taxa and plan type (single-species, multi-species, or ecosystem plans). For each of these analyses, we examine patterns of use in the number and type of criteria (e.g., quantitative or qualitative), and the clarity of the relationship between the selection of recovery criteria and biological information. Next, we investigate the relationship between the use of recovery criteria and species' status (i.e., declining, stable, improving). To conclude, we discuss the extent to which existing recovery plans comply with the ESA requirement that they include ''objective, measurable criteria which, when met, would result in a determination . . . that the species be removed from the List'' (16 U.S.C. § 1533(f)(1)(B)(ii)).

METHODS

The data

In September 1998, the Society of Conservation Biology, in cooperation with the U.S. Fish and Wildlife Service (USFWS), launched a national review of recovery plans for species listed under the Endangered Species Act (see Hoekstra et al. 2002). We sampled 134 plans that were approved between 1974 and 1998 and include recovery criteria for a total of 180 species (35 of the plans were written for more than one species). Definitions for the variables used in the analyses presented here were taken directly from the response categories provided in the questionnaire used to create the database, which is accessible to the public.[4] For example, question FFF asks whether the metric of the specified recovery criterion was qualitative or quantitative, and question SSS asks how biological information influenced the selection of the recovery criteria. The responses to the questions that we examined were either numerical (e.g., number of criteria) or categorical (e.g., taxon, species status, plan type, etc). Some of the data were reduced to presence/absence categories for simplification (Hoekstra et al. 2002). To analyze the data, we compared continuous data (e.g., the number of recovery criteria used in plans) among categories (e.g., plans approved 1974–1990 or 1991–1998, plant vs. animal plans, etc.) using nonparametric tests (Kruskal-Wallis and Mann-Whitney *U* tests) because the data are not normally distributed.

[4] URL: ⟨http://www.nceas.ucsb.edu⟩

Temporal trends in use of recovery criteria

The 1988 amendments to the ESA require recovery plans to include ''objective, measurable'' delisting criteria. This policy was enacted to improve the tractability of recovery progress by encouraging planners to clearly define recovery goals. In general, we believe that quantitative criteria are more likely to be clear than qualitative criteria. For example, citing that habitat must expand to incorporate ''at least two-thirds of the estimated historic range'' for a species to be considered for delisting provides a numeric goal. Progress can be measured by assessing expansions and/or collapses in the species' range over time. In contrast, if a delisting criterion simply requires ''more habitat,'' with no further definition of the target amount necessary for the species to persist, the success or failure of recovery efforts is difficult to assess. We hypothesized that the use of quantitative criteria might increase as a result of the 1988 amendments. To test this hypothesis, we evaluated the total number of recovery criteria and the average percentage of criteria per plan with quantitative vs. qualitative metrics for species with plans approved before and after 1990. The year 1990 was selected based on a predicted two-year time lag estimated for the amendments to affect the content of recovery plans. Also, 1990 was the year when the USFWS and NMFS (National Marine Fisheris Service) published revised recovery plan guidelines that incorporated the 1988 amendments.

We additionally hypothesized that the 1988 amendment might influence the use of biological information in selecting criteria for recovery. We considered responses to questions about the relationship between biological information and the selection of recovery criteria. In the questionnaire, the connection between biological information and recommended recovery criteria under each category was categorized as *unclear*, *somewhat clear*, or *very clear*. Criteria were scored as *very clear* if they explicitly linked specific biological information to selection of recovery metrics. *Somewhat clear* referred to criteria that alluded to a biological basis for the chosen metric, but did not make a specific connection. *Unclear* criteria made no reference to biological information in the context of selecting the chosen recovery metric. For example, a criterion requiring the ''successful reintroduction and breeding of conspecifics raised in captivity to replenish the genetic diversity of wild populations'' was scored as having a *very clear* biological basis. In contrast, a criterion requiring ''over 200 animals in the wild'' was considered *unclearly* linked to biology if no data were presented to support the choice of this particular number.

Variability in recovery criteria by taxa and plan type

We hypothesized that the use of recovery criteria might vary among taxonomic groups and types of plans (e.g., single-species, multi-species, or ecosystem plans). We categorized 85 of the 180 species as ''plants,'' which broadly included lichens, nonvascular plants, ferns, gymnosperms, angiosperms, and fungi. The remaining 96 species were categorized as ''animals,'' which included mammals, birds, reptiles, amphibians, fish, insects, crustaceans, mollusks, and other invertebrates. We then documented the mean number of recovery criteria and the number of criteria with quantitative metrics for plant and animal species plans, as well as the difference in the mean number of criteria for plant and animals with plans approved before and after 1990. We also considered the mean number of criteria specified as having an *unclear*, *somewhat clear*, or *very clear* relationship to biological information for plant and animal species.

To investigate patterns in the use of criteria among different types of plans, we documented the mean total number of criteria and the number of criteria with quantitative metrics specified for species in three types of plans: single-species, multi-species, and ecosystem plans (n = 100, 69, and 12 plans, respectively). Finally, we investigated the relationship between species whose recovery was reported by the USFWS in their 1996 Recovery Report to Congress (USFWS 1996) as involving ''conflict'' (n = 18) and the number of criteria specified in their recovery plans. In the 1996 report, each species was assigned a recovery priority according to the degree of threats, recovery potential, and taxonomic distinctiveness. This priority may also have been elevated if there was some degree of conflict between the species' conservation efforts and economic development associated with its recovery.

Recovery criteria and population status

We hypothesized that the inclusion of explicit recovery criteria might correlate with the status of listed species. To test this hypothesis, we used species trend data (i.e., declining, stable, improving) from the 1996 USFWS Recovery Report to Congress (for a discussion of these data, see Hoekstra et al. 2002). For this analysis, we considered only the species in our data set for which recovery plans were approved before 1990. Although the selection of this year was arbitrary, we thought that the status of more recently listed species was less likely to be reflective of recovery efforts. Thus, the total number of species available for our analyses regarding status was reduced from 181 to 63.

Results

The mean numbers of recovery criteria per species plan characterized as having *unclear*, *somewhat clear*, and *very clear* relationships to biological information were 2.9, 1.5, and 1.1 criteria, respectively. The mean percentage of recovery criteria characterized as having an *unclear* relationship to biological information increased significantly (Mann-Whitney $U = 2762$, $P = 0.0005$; Fig. 1a) for species with plans approved after 1990. Of the 181 species (in 135 recovery plans) analyzed, 91% included at least one criterion and 81% included at least one quantitative criterion for recovery. The total number of recovery criteria specified increased significantly for species with plans approved after 1990 (Mann-Whitney $U = 2925$, $P = 0.004$; Fig. 1b). This pattern is consistent with the increasing number of qualitative criteria used after 1990 (Mann-Whitney $U = 2986$, $P = 0.006$). However, the number of quantitative criteria did not change significantly for species with plans approved after 1990. This pattern indicates that while the use of recovery criteria has increased, the relative percentage of quantitative criteria has declined. A closer examination of these data revealed three interesting results. First, the number of quantitative metrics used to assess criteria in the population size (Mann-Whitney, $U = 2714$, $P = 0.004$) and population trend (Mann-Whitney $U = 2959$, $P = 0.02$) categories increased, significantly after 1990. Second, measures of population size are the most frequently used criteria with the highest percentage of quantitative metrics (Fig. 2). Third, less than one-half of the habitat, demographic, and legal/policy criteria have quantitative metrics.

For the 85 plant species (including lichens, nonvascular plants, ferns, gymnosperms, angiosperms, and fungi), the fraction including quantitative criteria was

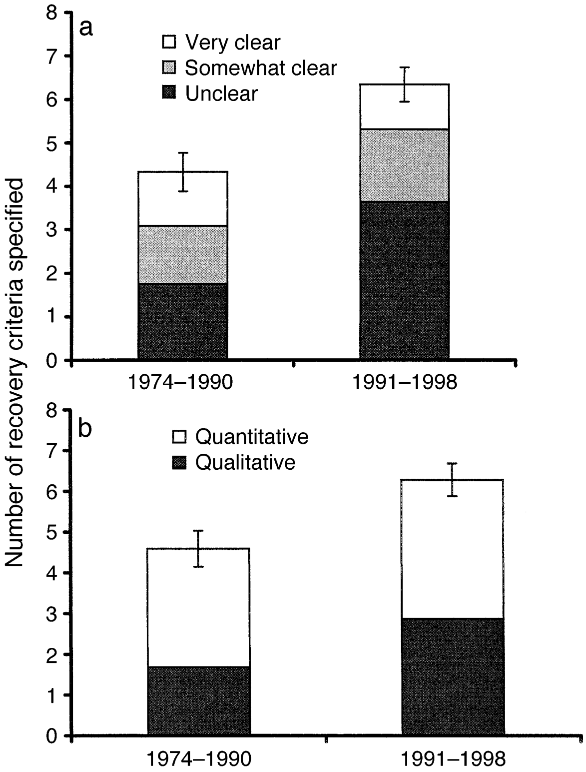

FIG. 1. (a) The mean (±1 SE) number of recovery criteria per plan for species with plans approved during 1974–1990 ($n = 73$) vs. 1991–1998 ($n = 107$) and the relative contribution of criteria whose selection was considered to be *unclearly*, *somewhat clearly,* and *very clearly* related to biological information. (b) The mean (±1 SE) number of qualitative and quantitative recovery criteria for species with plans approved during 1974–1990 ($n = 73$) vs. 1991–1998 ($n = 107$).

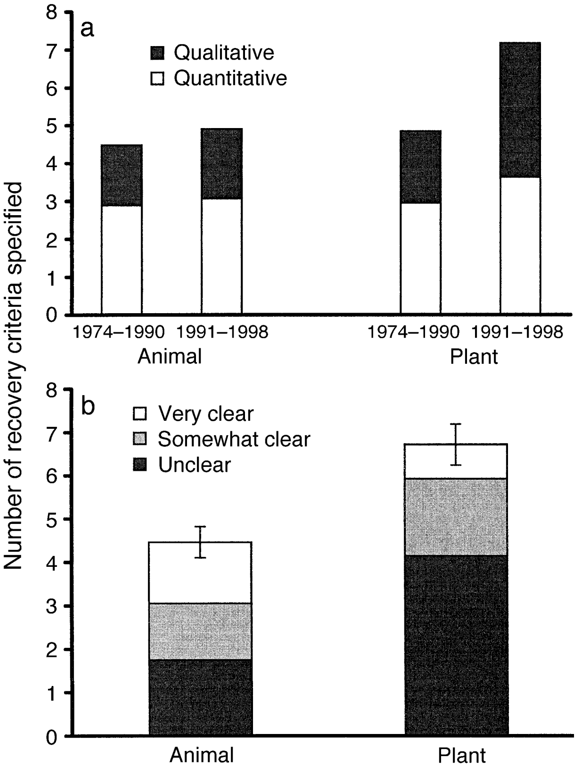

FIG. 2. (a) The relative contribution per plan of quantitative and qualitative recovery criteria for plants ($n = 23$) and animals ($n = 53$) with plans approved during 1974–1990 vs. plants ($n = 62$) and animals ($n = 43$) with plans approved during 1991–1998. (b) The mean (±1 SE) number of recovery criteria used for plants ($n = 85$) vs. animals ($n = 96$) and the relative contribution of criteria whose selection was considered to be *unclearly, somewhat clearly,* or *very clearly* related to biological information.

high (85%). The overall fraction of the 96 animal species whose plans included at least one quantitative criterion was slightly lower (79%). The mean number of criteria specified for plants increased significantly after 1990 (Mann-Whitney $U = 434$, $P = 0.015$), but this increase was driven by an increase in the number of recovery criteria with qualitative metrics for species with recent plans (Mann-Whitney $U = 4825$, $P = 0.003$; Fig. 2a). No trend in the overall use of criteria or the use of quantitative metrics was detected for animal species. The number of quantitative criteria used for plants and animals did not differ significantly. However, the mean number of recovery criteria per plan for plants was significantly greater than that for animals (Mann-Whitney $U = 3046$, $P = 0.003$), and the percentage of quantitative criteria specified for plants was significantly less than that for animals. These results indicate that, recently, more criteria have been specified for plants, but that relatively few of these criteria have had quantitative metrics. This observation was underscored by the additional finding that the percentage of recovery criteria used with an unclear relationship to biological information was significantly greater among plants (Mann-Whitney $U = 2819$, $P = 0.0002$; Fig. 2b).

Patterns in the overall number of recovery criteria or criteria with quantitative metrics were not correlated with type of plan (e.g., single- vs. multi-species). However, there is some evidence that species in ecosystem plans have fewer recovery criteria whose selection was *very clearly* related to biological information (Kruskal-Wallis, df = 2, $H = 6.6$, $P = 0.04$). The small number of species in ecosystem plans in our sample ($n = 12$), however, limits the strength of this finding. The designation of a species' recovery as involving conflict did not appear to be a strong determinant of the type or number of recovery criteria that were used. Species characterized as improving (40%) by the USFWS in 1996 were more likely to include recovery criteria with *very clear* relationships to biological information than were species characterized as declining (11%; Kruskal-Wallis, df = 2, $H = 7.16$, $P = 0.03$; Fig. 3a).

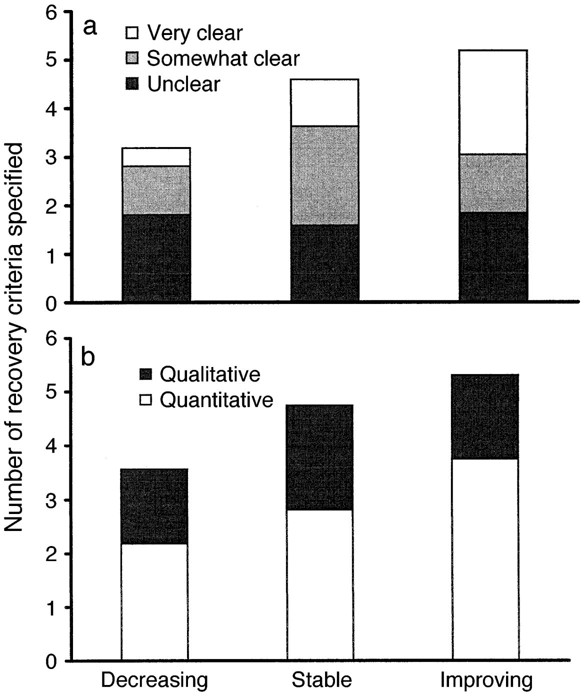

FIG. 3. (a) The relative contribution per plan of recovery criteria whose selection was considered to be *unclearly, somewhat clearly,* or *very clearly* related to biological information for species with plans approved between 1974 and 1990 and categorized according to the status of the species in 1996 (USFWS: declining, n = 16; stable, n = 27; and improving, n = 20). (b) The relative contribution of quantitative and qualitative recovery criteria for species with plans approved between 1974 and 1990 and categorized according to the status of the species in 1996 (USFWS: declining, n = 16; stable, n = 27; and improving, n = 20).

There was a strong trend for species with improving status to have more total and more quantitative criteria (Kruskal-Wallis, $n = 63$, df = 2, $H = 3.66$, $P = 0.1604$; Fig. 3b). Specifically, species with decreasing status ($n = 16$) had fewer quantitative recovery criteria than those characterized as improving in status ($n = 20$) (Mann-Whitney $U = 105$, $P = 0.0827$). When plants and animals were considered separately, the small sample size for plants with plans approved before 1990 and with known status ($n = 19$) prohibited statistically robust analysis. However, our data set includes a broader sampling of animal species with plans approved prior to 1990 and with known status ($n = 44$), and improving status was associated with specification of more quantitative recovery criteria for these species (Kruskal-Wallis, df = 2, $H = 5.454$, $P = 0.0654$). Specifically, animal species with improving status in 1996 ($n = 11$) have more quantitative recovery criteria than animal species with decreasing status in 1996 ($n = 13$; Mann-Whitney $U = 34$, $P = 0.0321$). These results suggest that specifying a large number of criteria and doing so quantitatively may enhance an animal species' likelihood of improving.

DISCUSSION

An important practical question in the conservation of endangered species concerns the extent to which recovery plans incorporate scientific knowledge in establishing guidelines for recovery efforts. The 1988 amendments to the ESA specifically addressed the need to encourage the use of objective, measurable criteria for measuring the success of recovery planning. Although the metrics and target values used in recovery planning will, and should, reflect biological differences among endangered species, broad categorization of criteria in this study allows us to document higher level patterns in the development of management goals under the ESA. In general, recovery plans for endangered and threatened species are improving with respect to the inclusion of recovery criteria. The number of recovery criteria specified in plans has increased significantly in recent years. Also, a large fraction of species' plans include quantitative criteria (81%).

The fact that improving species more frequently include a *very clear* relationship to biological information suggests that the use of biologically based recovery criteria may assist the recovery of listed species. Alternatively, it could be that if a species is recovering, there is a more direct motivation to develop clear listing criteria. For example, many of the large whales that were listed as endangered in the early 1970s have recently shown signs of increasing abundance. With recognition that certain populations be considered for delisting (e.g., Brownell et al. 1989), there has been a recent effort to develop quantitative recovery criteria for large whales (Gerber and DeMaster 1999, Gerber et al. 1999).

There were some important areas in which recovery plans can be improved. In contrast to previous authors' conclusions regarding ''taxonomic biases'' toward animals in recovery plans (Tear et al. 1993, Easter-Pilcher 1996), we found that recovery plans for animals include slightly fewer recovery criteria than plans for plants. On the other hand, recent increases in the use of more recovery criteria with qualitative metrics and less clear links to biological information were particularly underscored among plants, as plant species make up a disproportionate number of recently listed species. Our results show that although plants appear to be benefiting as a result of the 1988 initiative to improve the use of objective recovery criteria in recovery planning, more emphasis needs to be placed on using biological information in selecting recovery criteria and in developing quantitative metrics to monitor progress for plants.

Defining biological recovery criteria with quantitative metrics encourages recovery efforts to focus on salient short- and long-term conservation goals. If greater attention were paid to defining and monitoring recovery metrics, it might be possible to recognize management successes and failures. Determining when to stop managing species is understandably one of the most difficult decisions facing resource managers. Although recovery criteria have the potential to provide guidelines for determining when a species has evaded extinction, such criteria are only as reliable as the information on which they are based. More research is necessary to assess, on a case-by-case basis, how the metrics and target values specified in plans are chosen and how reflective they are of biological vs. nonbiological considerations. Monitoring based on well-designed recovery metrics should allow managers to reevaluate and adapt criteria for delisting, allowing the choice of criteria to play a more dynamic role in the recovery process.

Acknowledgments

This work was funded by Society for Conservation Biology, the U.S. Fish and Wildlife Service, and the National Center for Ecological Analysis and Synthesis, a center funded by the National Science Foundation (Grant DEB 94-21535), the University of California–Santa Barbara, the California Resources Agency, and the California Environmental Protection Agency. The Project director was Dee Boersma. Jeff Bradley, Debby Crouse, William Fagan, Jon Hoekstra, Peter Kareiva, Gordon Orians, and Jim Regetz all helped with parts of the project. A complete list of the more than 325 seminar and workshop participants can be found at the project web site.[5] The authors thank M. Schwartz and R. J. O'Connor for their contributions to initial ideas leading to this manuscript, and for participating in a number of helpful discussions. Dee Boersma, Deborah Crouse, Judy Jacobs, Peter Kareiva, Michael McCarthy, Loyal Mehroff, Cheryl Schultz, and several anonymous reviewers provided insightful comments on earlier drafts of this manuscript.

[5] URL: ⟨http://www.nceas.ucsb.edu/recovery⟩

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