

Ecological Applications, 12(3), 2002, pp. 641–647
© 2002 by the Ecological Society of America

ARE RECOVERY PLANS IMPROVING WITH PRACTICE?

CHERYL B. SCHULTZ^{1,2} AND LEAH R. GERBER^{1,3}

¹National Center for Ecological Analysis and Synthesis, University of California, 735 State Street, Suite 300, Santa Barbara, California 93101-3351 USA

Abstract. We asked two basic questions about endangered species recovery plans: (1) Have recovery plans improved over the last decade? (2) Are important features of recovery plans biased toward plants or animals? We answer these questions in the context of a large national study aimed at statistically summarizing key features of recovery plans and how those plans use science. In addition, we asked if the status of endangered species tends to be improving. Overall, the U.S. Fish and Wildlife Service (USFWS) is improving in its use of science in recovery plans. For example, based on the increased number of monitoring tasks included in more recent plans, the USFWS is becoming more concerned with the need to monitor changes in endangered species populations and their habitats. Similarly, specific recovery criteria, such as the number of years that a species needs to maintain a target population size, are more often being included in recovery plans. However, several features of recovery plans have not shown improvement, such as the tasks recommended to address major threats and the limited influence of focal species' biology on the selection of recovery criteria and monitoring protocols. Recovery plan features tend to be biased toward animals in several ways. Among animals, more tasks are recommended to address limitations in current biological information, to address major threats to the species, and to enhance public relations than is the case for plants. Finally, ~30% of species for which the current recovery plan is older than 1990 are increasing in abundance, a marked improvement over those species for which the recovery plan was only recently written. These data suggest that the process of listing species and writing recovery plans is working. In addition, animal populations are more often increasing in abundance than plant populations.

Key words: conservation biology; Endangered Species Act; extinction; recovery plan; USFWS.

INTRODUCTION

Scientists have repeatedly commented on the failures of recovery plans in the context of implementing the Endangered Species Act (Tear et al. 1993, Wilcove et al. 1993, National Research Council 1995, Easter-Pilcher 1996). Recovery plans provide an important mechanism for federal agencies to engage in conservation planning for threatened and endangered species. In 1988, Congress amended the Endangered Species Act to improve recovery efforts in several ways. The amendments include provisions to incorporate site-specific management actions, measurable recovery criteria, provisions for increased participation, and a bi-annual report to Congress on the status of listed species (16 U.S.C. § 1533 (f)). Implicit in these amendments was a call to replace vague, unenforceable recommendations with clear, measurable, and biologically based recommendations for recovery tasks. For example, the

Northern Rocky Mountain Wolf recovery plan (USFWS 1980) suggested that managers should “minimize direct, man-caused mortality.” The plan provided no guidance on how this recommendation should be implemented or how the effects of management actions should be measured.

The 1988 amendments direct the agencies to clearly articulate how recovery should be implemented and monitored. In particular, the 1988 amendments to the Endangered Species Act require recovery plans to include “objective, measurable” delisting criteria (16 U.S.C. § 1533 (f)(1)(B)(ii)). This policy was enacted to improve the tractability of recovery progress by encouraging planners to quantitatively define recovery goals. 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. In contrast, if a delisting criterion simply requires “more habitat,” with no further definition of the target amount necessary for the species to persist, success or failure of recovery efforts may be difficult to assess.

Another issue emerging from early recovery efforts was the lack of attention given to plants (GAO 1988, Wilcove et al. 1993, Tear et al. 1995). A Senate report

Manuscript received 30 January 2001; revised 23 April 2001; accepted 24 April 2001. For reprints of this Invited Feature, see footnote 1, p. 629.

² E-mail: schultz@nceas.ucsb.edu

³ Present address: Department of Biology, P.O. Box 871501, Arizona State University, Tempe, Arizona 85287-1501 USA.

accompanying the 1988 amendments noted that the USFWS strongly biased recovery efforts toward high-profile vertebrates (Rohlf 1989). Therefore, because the Endangered Species Act protects listed species across all taxonomic groups, Congress specified that recovery plans must be developed and implemented "without regard to taxonomic classification" (16 U.S.C. § 1533 (f)(1)(A)). Additionally, when plant recovery plans were developed, they lacked important biological details (Schemske et al. 1994). In their review of plant recovery plans, Schemske et al. (1994) observed that critical information for plant recovery was often unknown and that plans for these species often lacked research recommendations to redress this situation.

We examined recovery plans over the last 20 yr in light of these criticisms and 1988 changes in the law. In this paper, we summarize major features of recovery plans, focusing on how science is used and how recovery tasks are allocated. We ask the following questions. First, how scientifically defensible are recovery plans? Second, have the 1988 amendments and independent reviews of recovery efforts led to improvements in the recovery plan process? Third, to what extent do recovery plans vary across taxa? We focus on broad-brush patterns in recovery planning attributes with a particular focus on those attributes that are relatively easy for agencies to change, and conclude with a discussion of our findings and recommendations for future recovery efforts.

METHODS

Our analyses relied on a large database that includes reviews of 181 listed species in 135 recovery plans. The primary data and a key to those data are available at the project web site.⁴ In addition, Hoekstra et al. (2002) provide a detailed description of the database, methods, and potential biases in the database. In describing specific analyses, we refer to questions (e.g., Q9) or columns of questions (e.g., col. EE) from that database so that the reader can duplicate or build upon our analyses by consulting the original database.

We asked two questions about recovery plan features. (1) Are recovery plans improving over time? (2) Are recovery plans different across taxa? To investigate changes in recovery plan features over time, we compared recovery plans approved between 1980 and 1990 (recovery plans for 63 species) to those approved after 1990 (recovery plans for 118 species). We selected 1990 because this was the year when the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) revised recovery plan guidelines that incorporated the 1988 amendments. To investigate differences across taxa, we compared recovery plans written for 96 animal species to those written for 85 plant and lichen species (hereafter, "plant" species).

We do not differentiate between "threatened" and "endangered" species in this analysis. All references to "endangered" species refer to all listed species included in the database.

Eleven question areas were addressed within the context of these two focal questions (Table 1). These question areas address seven major aspects of recovery plans: biology of focal species, threats, management actions, monitoring activities, recovery criteria, public relations issues, and plan implementation. For all metrics for which we assessed responses based on the number of tasks, such as the number of tasks recommended to collect biological information, we reported median values for assessed responses and used Kruskal-Wallis one-way ANOVA to evaluate statistical significance. This approach was used because the numbers of tasks were not normally distributed. *G* tests were used to contrast if there were differences between recovery plans approved before and after 1990 and to investigate taxonomic differences within a question area.

Finally, we were interested in the extent to which temporal and taxonomic trends were associated with population status (e.g., improving, stable, declining). To investigate this question, we used species trend data from the 1996 Recovery Report (USFWS 1996) to Congress. Although USFWS trend data have been considered imprecise by some (National Research Council 1995), they are the only consistent index of population status for listed species. We first considered the entire data set for 181 species. Second, because populations will take time to respond to conservation initiatives, we considered only those species for which the *current* recovery plan was written in or before 1990. Finally, because we wanted to examine the extent to which recovery plans have influenced species trends overall, we considered all species for which the *original* recovery plan was completed by 1990.

RESULTS

Description of question areas

The number of tasks aimed at enhancing understanding of focal species' biology ranged from 2 to 148 for each species, with a median of 20 tasks per species (Table 2). The median number of tasks specified to address major threats was 15. The number of species for which recovery plans specified population-, habitat-, exotic species-, and incentive-based management were 159, 181, 90, and 63, respectively. Overall, recovery plans suggested 18 management tasks per species. Few species had monitoring programs that demonstrated a *very clear* relationship to biology. For 54% of species, biological information about the focal species clearly influenced what was to be monitored, and for 17% of species, biological information about the focal species clearly influenced chosen monitoring protocols. Overall, the median number of monitoring tasks for all recovery plans was 10 and the median number

⁴ URL: <http://www.nceas.ucsb.edu/recovery>

TABLE 1. Summary of recovery plan features analyzed in this study. For each feature, we asked two questions: (1) Have there been changes over time? (2) Are there differences across taxa?

Question area	Metric	Cells in questionnaire	Potential categories
Efforts to collect biological information	number of tasks	G	Potential categories to collect biological information included: habitat, population biology, life history, genetics, behavior, and general ecology.
Threats influencing focal species	percentage of species affected by threat	P	Potential threats included: construction, agriculture, resource use, water diversion, pollution, exotics, species interactions, and alteration in habitat dynamics.
Efforts to address major threats	number of tasks	X	
Recommended management actions	number of tasks	FF	Potential management actions included: population-based, habitat-based, exotic-species-based and incentive-based management actions.
Recommended monitoring actions	number of tasks	OO	Potential monitoring tasks included monitoring of focal species, of associated species, and of habitat.
Clarity in use of biological information to choose monitoring actions	percentage of species†	TT and UU‡	Analyzed responses included <i>very clear</i> use of biology and <i>unclear</i> use of biology to select monitoring strategy.
Recommended public relations actions	number of tasks	YY	Potential areas for public relations actions included: increasing public awareness, developing public support, encouraging public participation, and enforcing legal protections.
Is there a system to monitor plan implementation?	yes/no	Question 383	
Quantitative recovery criteria	number of years to maintain target population size§	Question 405 in column GGG	
Clarity in use of biological information to select recovery criteria	percentage of species	SSS and TTT¶	Analyzed responses included <i>very clear</i> use of biology and <i>unclear</i> use of biology to select recovery criteria.
Population status	population trend	Report to Congress#	Status could be improving, stable, or declining.

† In the questionnaire, the connection between biological information and recommended monitoring could be scored as *unclear*, *somewhat clear*, or *very clear*. For our analyses, if the use of biological information in selecting monitoring methods was specified as *very clear* for any monitoring task, the plan was scored as having *very clear* use of biological information in selecting monitoring methods. A plan was scored as *somewhat clear* in its use of biological information if the plan implied a biological basis for the monitoring method but did not make a specific connection. A plan was scored as having *unclear* use of biological information if the plan made no reference to biological information in the context of selecting monitoring methods. In our analyses, we omitted all plans with scorings of *somewhat clear* because of the ambiguity of the response.

‡ Question TT asked if biological information about the focal species clearly influenced what was to be monitored. Question UU asked if biological information about the focal species clearly influenced chosen monitoring protocols.

§ We chose one quantitative recovery criterion to investigate: the number of years a target population should be maintained. We reasoned that this is an essential criterion because any delisting should consider how much monitoring will be necessary to insure that recovery has been achieved.

|| In the questionnaire, the connection between biological information and selected recovery criteria could be scored as *unclear*, *somewhat clear*, or *very clear*. These analyses were similar to those for clarity in use of biological information to design monitoring strategies.

¶ Question SSS asked if focal species' biology clearly influenced the selection of recovery criteria. Question TTT asked if focal species' biology clearly influenced determination of target recovery values.

Population status data were from the 1996 USFWS Recovery Report to Congress.

of public relations tasks for all species' recovery plans was four. For ~23% of species, a system to monitor implementation of tasks was included in the recovery plans. About half of the recovery plans (100 of 181) in the data set specified the number years that a population needs to maintain a target value in order for the species to be considered "recovered." For those

plans that specify this criterion, the median number of years specified was five. In addition, a large percentage of recovery plans specified either five years (48%) or 10 yr (23%) as the number of years over which a population needs to maintain a target value. Only ~30% of species recovery plans were characterized as including a *very clear* use of biology to influence recov-

TABLE 2. Summary of features of recovery plans and relationship with various metrics of recovery plans.

Features	Overall trends†	Taxonomic differences	Time trends
Tasks to collect biological information	20 tasks	animals > plants	
Tasks to address major threats	15 tasks	animals > plants	
Recommended management tasks	18 tasks		before < after 1990
Recommended monitoring tasks	10 tasks		before < after 1990
Clear connection between focal species biology and monitored responses	54% of species		
Clear connection between focal species biology and monitoring protocols	17% of species		
Recommended public relations tasks	4 tasks	animals > plants	
Implementation monitoring	23% of species‡		
Number of years to maintain target population size	5 years§		
Clear connection between focal species biology and type of recovery criteria	35% of species		
Clear connection between focal species biology and target recovery values	29% of species		
Population status	27% improving	animals > plants	before > after 1990

Note: Blank cells indicate that there is no relationship between recovery plan features and various metrics.

† Tasks are reported as median number of tasks per species because distributions were not normal.

‡ Percentage of species' plans that establish a system by which to monitor recovery plan implementation.

§ Median number of years to maintain target population for 100 species' plans that specify this recovery criterion.

|| Statistic is based on 133 species in the data set for which status is known.

ery criteria and target values. Finally, 30 of 181 species had increasing population trends in 1996, the last year for which population trends for all species were reported (USFWS 1996).

Temporal trends

Recovery plans showed several signs of improvement in the 1990s. For tasks recommending collection of biological information, there was no change in the number of tasks specified before vs. after 1990 (Kruskal-Wallis ANOVA, $\chi^2 = 0.292$, $P = 0.59$, 20 = median number of tasks for both time periods). After 1990, however, there were twice as many tasks to collect genetic information (Fig. 1a). There were no significant differences in the distribution of threats over time, except for exotic species, which were characterized as posing a proportionally higher threat in later years (Fig. 2a). We did not detect temporal trends in the number of tasks specified to address major threats (Kruskal-Wallis ANOVA, $\chi^2 = 0.188$, $P = 0.67$). More management tasks were suggested in recovery plans written after 1990 (Kruskal-Wallis ANOVA, $\chi^2 = 3.664$, $P = 0.05$): 16 tasks per species before 1990 vs. 19 tasks per species after 1990. With regard to particular types of management actions, more population-based management tasks were suggested in more recent recovery plans than in earlier recovery plans (Fig. 3a). Exotic species-based management was also more common in later recovery plans. In addition, there were significantly more monitoring tasks recommended in recovery plans approved after 1990 than before (Kruskal-Wallis ANOVA, $\chi^2 = 9.37$, $P = 0.002$; median = 7 tasks before 1990, median = 12 tasks after 1990). Inclusion of public relations tasks did not change before

vs. after 1990 (Kruskal-Wallis ANOVA, $\chi^2 = 2.04$, $P = 0.15$). The number of species whose recovery plans included a system to monitor implementation of tasks did not differ before vs. after 1990. More recent recovery plans were more likely to specify the number years over which a population needs to maintain a target value for the species to be considered "recovered." ($G = 13.75$, $P = 0.0002$). For those plans that specify this criterion, there were no temporal differences in the median number of years specified (median = 5 yr, Kruskal-Wallis ANOVA, $\chi^2 = 2.73$, $P = 0.01$). In addition, there were no differences in the percentage of species for which there was a *very clear* use of biology to select recovery criteria (for selection of recovery criteria, $G = 0.15$, $P = 0.70$; for determination of target value for recovery, $G = 0.59$, $P = 0.44$). Finally, species for which the current recovery plan was older than 1990 were more likely to be increasing in abundance ($G = 5.33$, $P = 0.021$). Species for which the original recovery plan was older than 1990 were even more likely to be increasing in abundance ($G = 27.81$, $P < 0.00001$; 29 of 99 vs. 1 of 82 species).

Taxonomic differences

In three of five analyses, more tasks were specified in animal plans than plant plans (Table 2). For animals, tasks associated with collecting biological information were recommended more often for animals than for plants (Kruskal-Wallis ANOVA, $\chi^2 = 8.08$, $P = 0.004$, 22 tasks vs. 17 tasks). Specifically, animals had more tasks related to habitat, behavior, and life history (Fig. 1b). Animals were more often threatened by problems related to water diversion, pollution, and species interactions, whereas plants were more often threatened

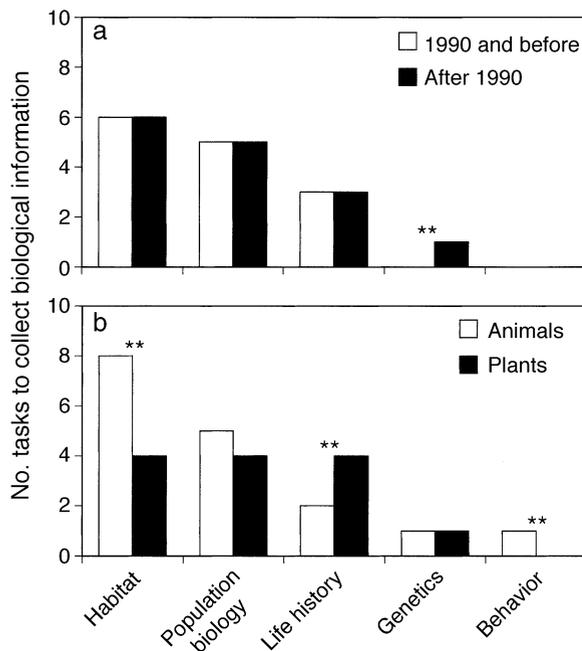


FIG. 1. (a) Tasks to collect biological information for recovery plans approved in 1990 or before vs. after 1990. From Kruskal-Wallis ANOVAs, there were no differences in tasks recommended to collect information related to habitat ($\chi^2 = 1.01$, $P = 0.32$), population biology ($\chi^2 = 0.13$, $P = 0.72$), life history ($\chi^2 = 0.526$, $P = 0.47$), or behavior ($\chi^2 = 2.16$, $P = 0.14$). Genetic-related information was more often recommended in more recent recovery plans ($\chi^2 = 8.37$, $P = 0.004$). (b) Tasks to collect biological information for animal vs. plant species plans. From Kruskal-Wallis ANOVAs, there were no differences in tasks recommended to collect information related to population biology ($\chi^2 = 0.60$, $P = 0.44$) or genetics ($\chi^2 = 0.02$, $P = 0.892$). Habitat and behavioral information were more often recommended for animals ($\chi^2 = 26.79$, $P < 0.001$ and $\chi^2 = 33.17$, $P < 0.001$, respectively), whereas life history information was more often recommended for plants ($\chi^2 = 5.11$, $P = 0.024$).

by exotic species. Threats identified for plants and animals did not differ significantly for threats related to construction, agriculture, resource use, and alteration in habitat dynamics (Fig. 2b). In general, animals had more tasks to address threats than did plants (Kruskal-Wallis ANOVA, $\chi^2 = 3.64$, $P = 0.05$, 19 tasks vs. 15 tasks). Similar numbers of management tasks were suggested for animals and plants (Kruskal-Wallis ANOVA, $\chi^2 = 0.153$, $P = 0.70$). In addition, for animals, more habitat- and population-based management tasks were suggested, but fewer exotics-based management tasks were suggested (Fig. 3b). Recovery plans for plants and animals did not differ significantly in the number of proposed monitoring tasks (Kruskal-Wallis ANOVA, $\chi^2 = 1.54$, $P = 0.21$). Overall, recovery plans for animals included more public relations tasks than did those for plants (Kruskal-Wallis ANOVA, $\chi^2 = 17.05$, $P < 0.0001$, five tasks vs. three tasks). Neither animal nor plant plans were more likely to specify a system

to monitor implementation of tasks. Animal and plant plans were equally likely to specify the number years a population needs to maintain a target value in order for the species to be considered "recovered" ($G = 1.92$, $P = 0.16$). For those plans that specify this criterion, there were no differences in the median number of years specified (median = 5 yr, Kruskal-Wallis ANOVA, $\chi^2 = 2.92$, $P = 0.09$). In addition, there were no differences in the percentage of species for which there was a *very clear* use of biology to select recovery criteria (for selection of recovery criteria, $G = 0.85$, $P = 0.35$; for determination of target value for recovery, $G = 0.32$, $P = 0.57$). Finally, animal species were characterized as improving in population status more than were plants, although this difference was not statistically significant ($G = 3.60$, $P = 0.06$).

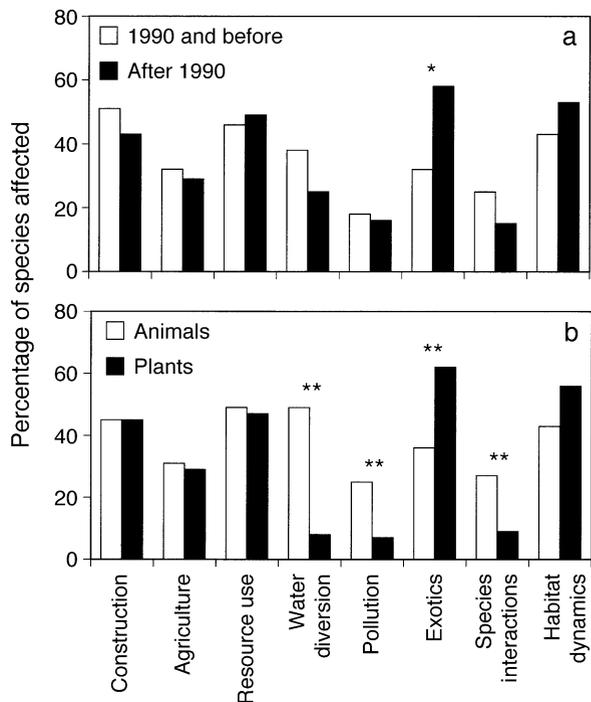


FIG. 2. (a) Percentage of endangered species affected by major threats identified in recovery plans approved in 1990 or before vs. after 1990. From G tests, there were no major differences between recent and older plans in threats stemming from construction ($G = 0.53$, $P = 0.47$), agriculture ($G = 0.12$, $P = 0.73$), resource use ($G = 0.08$, $P = 0.78$), water diversion ($G = 2.44$, $P = 0.118$), pollution ($G = 0.21$, $P = 0.64$), species interactions ($G = 1.77$, $P = 0.18$), or alteration in habitat dynamics ($G = 0.78$, $P = 0.37$). Exotic species threats were more often cited in recent plans ($G = 5.92$, $P = 0.015$). (b) Major threats affecting animal vs. plant species. From G tests, there were no major differences in threats related to construction ($G = 0.001$, $P = 0.99$), agriculture ($G = 0.05$, $P = 0.83$), resource use ($G = 0.03$, $P = 0.85$), or alteration in habitat dynamics ($G = 0.03$, $P = 0.85$). Animals were more often threatened by water diversion ($G = 28.5$, $P < 0.001$), pollution ($G = 9.49$, $P = 0.002$), and species interactions ($G = 7.97$, $P = 0.005$). Plants were more often threatened by exotic species ($G = 6.22$, $P = 0.012$).

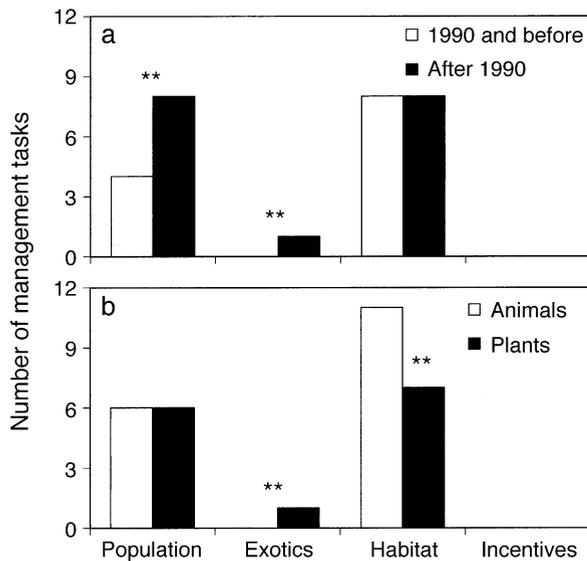


FIG. 3. (a) Recommended tasks to manage species for recovery in recovery plans approved in 1990 or before vs. after 1990. From Kruskal-Wallis ANOVAs, there were no major differences in tasks related to habitat- or incentive-based management ($\chi^2 = 0.14$, $P = 0.71$ and $\chi^2 = 0.17$, $P = 0.68$, respectively). Population- and exotic-based management tasks were more common in more recent plans ($\chi^2 = 12.21$, $P < 0.001$ and $\chi^2 = 7.28$, $P = 0.007$, respectively). (b) Recommended tasks to manage species for recovery for animal vs. plant species. From Kruskal-Wallis ANOVAs, there were no major differences for population- and incentive-based management ($\chi^2 = 1.45$, $P = 0.23$ and $\chi^2 = 1.62$, $P = 0.20$, respectively). Habitat-based management tasks were more often recommended for animals ($\chi^2 = 7.14$, $P = 0.08$), whereas exotic species-based management was more often recommended for plants ($\chi^2 = 11.02$, $P = 0.001$).

For the three analyses in which more tasks were recommended for animal species than plant species, further analyses were done to assess if there have been changes in these aspects of recovery plan in the 1990s. With regard to tasks recommending collection of biological information, the difference between these groups has grown in recent years (Kruskal-Wallis ANOVAs: before 1990, $\chi^2 = 0.94$, $P = 0.09$; after 1990, $\chi^2 = 10.6$, $P = 0.001$). In contrast, the difference between plants and animals in the numbers of recommended public relations tasks was less noticeable in the later years (before 1990, $\chi^2 = 11.64$, $P = 0.001$; after 1990, $\chi^2 = 3.32$, $P = 0.068$). There have been no relative changes in the number of tasks recommended to address major threats (before 1990, $\chi^2 = 2.79$, $P = 0.12$; after 1990, $\chi^2 = 2.44$, $P = 0.09$).

DISCUSSION

The USFWS has made modest improvements in the use of science in recovery plans. There were signs of improvement in both the recommended number of management tasks and the monitoring tasks (Table 2). An increase in the number of recommended tasks generally

reflects more detail in the recovery plans. This is important because, for example, the increased number of management tasks associated with species recovery is consistent with an increasing awareness of the need to actively manage endangered and threatened populations. The recognition that simply protecting habitat is not enough to ensure species recovery marks an important shift in planning efforts for endangered species recovery (also see Foin et al. 1998).

Our observed increase in the number of monitoring tasks suggests that the USFWS is also becoming more aware of the necessity to monitor changes in endangered species populations and their habitats. In addition, specific recovery criteria, such as the number of years a species needs to maintain a target population size, are more often being included in recovery plans. These improvements show signs that the USFWS positively responded to the 1988 amendments to the Endangered Species Act.

However, many features of recovery plans did not show signs of improvement. Among the most worrisome to us is that recent recovery plans do not show improvements in connecting focal species biology to important features of recovery planning efforts (Table 2). The lack of connection between focal species biology and monitoring protocols and recovery criteria will make it difficult to evaluate important aspects of recovery in the future.

Despite repeated criticism that the USFWS is biased in their treatment of animals vs. plants, there remains clear bias in many aspects of recent recovery efforts. Of note is that the difference between animal and plant plans in the number of tasks recommended to collect basic biological information has grown in recent years. This is particularly problematic because plant recovery plans from almost a decade ago did not recommend sufficient research tasks (Schemske et al. 1994). Our study suggests this problem has probably grown in magnitude.

Based on our analyses, we have a few specific recommendations for future recovery planning efforts. First, recovery plans should focus additional attention on addressing threats. The USFWS is clearly aware that threats need to be reduced, because their 1992 report to Congress defines recovery of a listed species as "the process by which the decline of a threatened or endangered species is arrested or reversed, and threats to its survival are neutralized" (USFWS 1992). No amount of population augmentation will result in permanent removal of a species from the endangered species list if its threats are not addressed. Second, recovery planning should draw more heavily on species-specific biology to select recovery criteria and monitoring protocols. Focused efforts are much more likely to result in efficient use of limited resources. Third, recovery efforts should be balanced between the needs of plants and animals. There is no scientific rationale

for the animal bias prevalent in current recovery planning efforts. These steps, along with the improvements that the USFWS has already begun, will enhance the use of science in recovery plans. Sound science will not, alone, lead to the success of the Endangered Species Act, but it lays an essential foundation on which to build, and recovery plans are the building blocks for endangered species recovery.

ACKNOWLEDGMENTS

This study 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 We thank Kate Benkert, Jon Hoekstra, Brian Hudgeons, Judy Jacobs, Peter Kareiva, and Joshua Lawler for helpful comments on earlier versions of this manuscript.

LITERATURE CITED

- Easter-Pilcher, A. 1996. Implementing the Endangered Species Act: assessing the listing of species as endangered or threatened. *BioScience* **46**:355–363.
- Foin, T. D., S. P. D. Riley, A. L. Pawley, D. R. Ayres, T. M. Carlsen, P. J. Hodum, and P. V. Switzer. 1998. Improving recovery planning for threatened and endangered species. *BioScience* **48**:177–184.
- GAO (General Accounting Office). 1988. Management improvements could enhance recovery Program. GAO/RCED: **89-5**. Washington, D.C., USA.
- Hoekstra, J. M., J. A. Clark, W. F. Fagan, and P. D. Boersma. 2002. A comprehensive review of Endangered Species Act recovery plans. *Ecological Applications* **12**:630–640.
- National Research Council. 1995. Science and the Endangered Species Act. National Academy Press, Washington, D.C., USA.
- Rohlf, D. J. 1989. The Endangered Species Act: a guide to its protections and implementations. Stanford Environmental Law Society, Stanford, California, USA.
- Schemske, D. W., B. C. Husband, M. H. Ruckelshaus, C. Goodwillie, I. M. Parker, and J. G. Bishop. 1994. Evaluating approaches to the conservation of rare and endangered plants. *Ecology* **75**:584–606.
- Tear, T. H., J. M. Scott, P. H. Hayward, and B. Griffith. 1993. Status and prospects for success of the Endangered Species Act: a look at recovery plans. *Science* **262**:976–977.
- Tear, T. H., J. M. Scott, P. H. Hayward, and B. Griffith. 1995. Recovery plans and the Endangered Species Act: are criticisms support by data? *Conservation Biology* **9**:182–195.
- USFWS (U.S. Fish and Wildlife Service). 1980. Northern Rocky Mountain Wolf recovery plan. U.S. Government Printing Office, Washington, D.C., USA.
- USFWS (U.S. Fish and Wildlife Service). 1992. Report to Congress, endangered and threatened species recovery program. U.S. Government Printing Office, Washington, D.C., USA.
- USFWS (U.S. Fish and Wildlife Service). 1996. Report to Congress on the recovery program for threatened and endangered species. U.S. Government Printing Office, Washington, D.C., USA.
- Wilcove, D. S., M. McMillan, and K. C. Winston. 1993. What exactly is an endangered species? An analysis of the Endangered Species List, 1985–1991. *Conservation Biology* **7**:87–93.

⁵ URL: (<http://www.nceas.ucsb.edu/recovery/acknowledgments>)