

FACTORS AFFECTING IMPLEMENTATION OF RECOVERY PLANS

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Abstract. Recovery plans for endangered and threatened species will not benefit conservation efforts unless prescribed tasks are actually implemented. We analyzed data collected on task implementation in early 1999 and found that an average of 70.3% of recovery tasks were either partially or completely implemented, although they ranged from 0% to 100% implemented. Plans approved in 1990 or earlier had relatively uniform task implementation, whereas implementation of more recent plans varied with plan and species attributes. Among plans approved after 1990, multi-species plans had lower task implementation than single-species plans. Recovery plans for plants, terrestrial species, and insular species had a lower degree of task implementation than those for animals, aquatic species, and continental species, respectively. Analyses further indicated that species with: (1) critical habitat designation, (2) conflict designation, (3) revised recovery plans, (4) a recovery coordinator, and (5) a dedicated database had greater task implementation than species lacking these management features. These results suggest that multi-species plans are implemented more slowly than single-species plans, and that recovery plans for species with greater public or agency profiles (as evidenced by critical habitat designation, conflict designation, and plan revision) are implemented at a higher rate. The effect of administrative strategies on higher rates of task implementation indicate that recovery efforts should include a recovery coordinator and database whenever possible. When developing recovery plans, responsible agencies should explicitly consider attributes of species and plans that influence task implementation.

Key words: *Endangered Species Act; multi-species vs. single-species; recovery plans; task implementation.*

INTRODUCTION

Several investigators have criticized the recovery planning process for endangered and threatened species based on extensive time lags between listing and plan approval, taxonomic biases, poorly justified recovery criteria, and infrequent recovery success (Tear et al. 1993, 1995, Angermeier and Williams 1994, Carroll et al. 1996). Recovery plans delineate management actions necessary to recover listed species, but even the best management strategies are worthless unless prescribed tasks are actually implemented. Given the critical role of task implementation in recovery efforts and the complete lack of previous studies on the subject, analysis of factors affecting recovery task implementation is overdue.

Clearly the amount of time elapsed between plan approval and the present can affect the percentage of implemented tasks. Implementation may also be influ-

enced by particular features of recovery planning, or by characteristics of their constituent species. Although the former can be established during plan development and modified with revision, the latter cannot be altered by recovery planners. Species from different taxa, habitat types, or geographical regions may require different kinds of recovery tasks. Alternatively, similar tasks may be more difficult to implement for different species. Both sources of variation can produce differential task implementation, potentially enhancing differences among species generated during the process of plan development (e.g., Tear et al. 1995, Foin et al. 1998). Recovery plans for more charismatic or controversial species also tend to be developed more frequently and quickly (e.g., Rohlf 1991), and rates of task implementation may be greater for such species if they garner more agency resources or attention from researchers. Finally, certain administrative and organizational practices, including the formation of a recovery coordinator position and dedicated database for a species, could facilitate the recovery process and lead to higher implementation rates.

METHODS

We used data extracted from a database compiled during a comprehensive review of 135 recovery plans

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covering 181 listed species under the jurisdiction of the U.S. Fish and Wildlife Service (USFWS). Details regarding the design and methodology of the review project are presented in Hoekstra et al. (2002), and the database can be accessed at the project web site.⁴ Descriptions of each analysis include unique alphanumeric codes corresponding to specific questions from the database (e.g., row 24). These data were used as independent variables (i.e., species and plan characteristics) for our analyses. The dependent variable for all analyses was derived from data provided by the USFWS on task implementation status as of 1999 (not implemented, underway, completed), which were available for 176 of the 181 species. Precise dates of implementation for each task were unavailable. For each species, the percentage of implemented recovery tasks was calculated by dividing the number of tasks that were underway or completed by the total number of tasks for which implementation status was known. Although considering partially and fully completed tasks as "implemented" biased our results toward higher rates, we included both levels so that tasks with long or indefinite time frames (e.g., sustained monitoring) would be commensurate with shorter term tasks. For recovery plans that included multiple species, we analyzed implementation by species rather than by plan, as preliminary analyses showed no differences in results.

Because date of plan approval ranged from 1980 to 1999, we divided the data set temporally into plans approved before or during 1990 (older plans) and those approved after 1990 (newer plans). The rationale for this categorization was twofold: (1) plans approved before 1991 had nearly a decade or more for tasks to be implemented, and (2) Congress amended the ESA in 1988, prompting the USFWS to subsequently publish recovery plan guidelines (USFWS 1990).

To investigate whether recovery plan design and structure affected implementation, we compared implementation percentages among species according to five plan attributes: (1) plan type (single-species, multi-species, or ecosystem; row 6); (2) number of times the plan had been revised (row 12); (3) whether critical habitat had been designated (row 58); (4) whether a recovery coordinator had been assigned (row 381); and (5) whether a recovery plan database existed (row 382). We compared task implementation with respect to four species attributes: (1) taxonomic group (vertebrate, invertebrate, or plant; row 66); (2) taxonomic subdivision (species, subspecies, or population; row 53); (3) ecotype (terrestrial or aquatic; row 73); and (4) geographic category (insular or continental; row 76). We also compared task implementation with respect to four aspects of USFWS recovery planning: (1) listing category (threatened or endangered, row 54); (2) USFWS as-

signed recovery priority number (binned as high, medium, or low priority; row 62); (3) whether a conflict between recovery management and human activities had been designated (row 62, USFWS 1994); and (4) USFWS reported trend status (increasing, decreasing, stable, unknown; row 82, USFWS 1996). The USFWS recovery priority numbers range from 1 (highest) to 18 (lowest) and are based on degree of threat, recovery potential, and taxonomic distinctness. In accordance with USFWS priority comparison standards (D. Crouse, *personal communication*), we binned the priority numbers in three groups of six for analysis.

Nonparametric methods (Mann-Whitney tests or Kruskal-Wallis tests) were used because data violated the assumption of normality required for parametric analyses (Conover 1999); distributions of implementation percentages were positively skewed. Because analyses of proportional data are sensitive to differences in the denominator, and because the number of tasks per plan differed (see Results), we also calculated *P* values using randomization tests with 5000 replicates (Manly 1997) for all analyses. We adjusted the probability of committing a Type I error (α) with a Bonferroni correction for multiple comparisons (Sokal and Rohlf 1995), which reduced the level of significance for all tests (adjusted $\alpha = 0.05/13 = 0.0038$).

RESULTS

The total number of recovery tasks for which status was reported varied considerably among plans (30 ± 18.5 tasks, mean ± 1 SD; minimum = 4 tasks, maximum = 132 tasks). The percentage of tasks implemented for older plans ($82.5 \pm 17.9\%$, $n = 62$) was significantly greater than for newer plans ($63.4 \pm 28.6\%$, $n = 114$; $U = 2176.5$, $P < 0.0001$). Although percentages ranged from 0% to 100% implementation, most plans from both temporal categories had a high degree of tasks implemented; approximately half had task implementations $>90\%$ (Fig. 1a). All plans had a low percentage of completed recovery tasks; the temporal trend was similar to that for tasks that were completed and underway (Fig. 1b). Older plans showed no significant differences in implementation levels across any of the independent variables ($P > 0.0038$). Significant differences in implementation among newer plans were detected for nearly all independent variables, and the randomization tests produced the same qualitative results as standard nonparametric tests (Table 1).

Several aspects of recovery plan structure and design affected implementation of newer plans. We found that the percentage of tasks implemented was significantly higher in single-species and ecosystem plans as compared to multi-species plans (Table 1a, Fig. 2a). The mean percentage of implemented tasks in single species plans was 30 percentage points higher than the mean for multi-species plans. The level of task implemen-

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

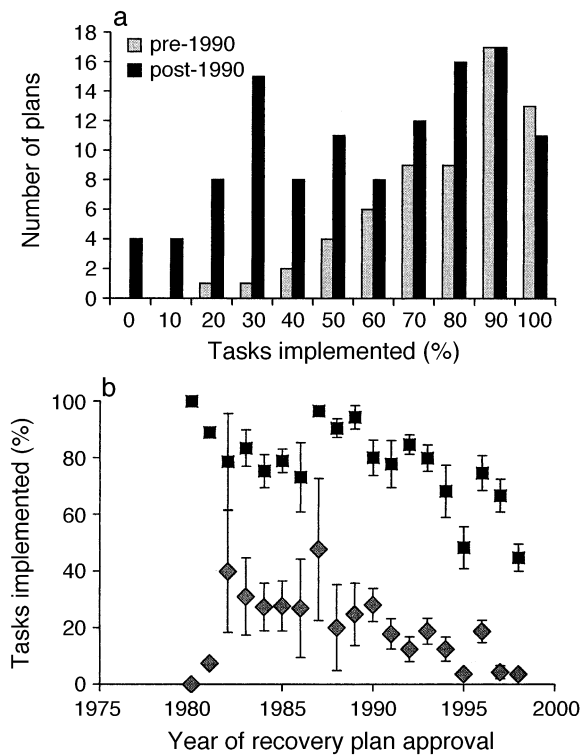


FIG. 1. (a) Distribution of the percentage of tasks implemented for 176 recovery plans using raw USFWS data, for plans in 1990 or earlier vs. plans after 1990. Bins represent intervals of 10 percentage points, from 0 to 10, including the lower bound. Plans with 100% of tasks implemented are included in a separate bin. (b) Mean percentage of tasks implemented for each year in which recovery plans were approved. Squares represent task implementation percentages based on both partially and completely implemented tasks. Diamonds represent percentage implementation of completed tasks only. Error bars represent ± 1 SE.

tation increased when a plan was revised once, but further revisions did not significantly increase implementation levels (Table 1a, Fig. 2b). The mean percentage of tasks implemented was significantly higher for plans with critical habitat designated, a recovery coordinator, and a recovery database (Table 1a).

Task implementation was unevenly distributed for species with different attributes. Plants had significantly lower implementation percentages than did vertebrates. The mean implementation percentage of tasks for aquatic species was slightly greater than 15 percentage points higher than that for terrestrial species (Table 1b). The average percentage of implementation of tasks for island species was slightly more than half that of continental species (Table 1b). The island category includes primarily Hawaiian species, which had a low average implementation of 39.0% ($n = 42$). Taxonomic subdivision (species, subspecies, population) did not appear to affect task implementation (Table 1b).

Although the difference was not statistically significant, recovery plans for threatened species had a mean

task implementation rate 20 percentage points higher than plans for endangered species (Table 1c). USFWS (1996) species recovery priority numbers (binned numerical data) had no influence on task implementation. Species with conflict designations (reflecting actual or imminent conflict between species' conservation and human activities) had an additional 15% of tasks implemented compared to those without a conflict designation (Table 1c, Fig. 3a). Mean implementation percentages of species with 1996 USFWS species population trend data (improving, I; stable, S; decreasing, D; unknown, U) indicated that species whose population trend was unknown had the lowest percentage of tasks implemented and species whose population trend was improving had the highest percentage of tasks implemented (Table 1c, Fig. 3b).

DISCUSSION

Species with older plans had consistently high recovery task implementation and little variation with species and plan attributes, yet species with newer plans had significantly different implementation of tasks with respect to nearly all of the independent variables that we investigated. Perhaps greater amounts of time available for management actions allowed equilibration of task implementation across different types of plans and species. In other words, differences currently associated with newer plans may have existed for older plans in the past, but these differences may have diminished over time as the percentage of tasks implemented or underway approached 100%. Alternatively, recovery planning and implementation practices may have changed fundamentally over time, possibly prompted by the initial publication of explicit recovery planning guidelines (USFWS 1990). Without data indicating when specific recovery tasks were implemented, these alternative hypotheses cannot be evaluated. We recommend more frequent analysis of the implementation status of tasks, which would provide for a better understanding of causes of differential implementation.

Certain species attributes were associated with higher task implementation for newer plans, including taxonomic group, ecotype, and geographical category. The observed patterns of differential implementation could either reinforce or offset biases documented in previous studies of the listing and recovery planning processes. Tear et al. (1995) found that a higher percentage of listed animals (especially vertebrates), relative to other species, have approved recovery plans, and our results indicate that vertebrate recovery plans similarly are disproportionately implemented. Although previous studies have shown biases in the listing process against aquatic species (Angermeier and Williams 1994, Hughes and Noss 1992), we found that task implementation was actually higher for aquatic species than terrestrial species. We also found that continental spe-

TABLE 1. Percentage of tasks completely and partially implemented for different plans, species, and USFWS attributes for recovery plans approved after 1990.

Attributes	Tasks implemented (%)			Test statistic		P_{\ddagger}	P_{rand}^{\S}
	Mean [†]	1 SE	n	H	U		
a) Plan attributes							
Plan type				33.46		<0.0001	0.0002
Single-species	76.1 ^a	3.3	51				
Multi-species	48.0 ^b	3.5	54				
Ecosystem	86.6 ^a	5.7	9				
Number of revisions				31.76		<0.0001	0.0002
0	53.6 ^c	3.1	76				
1	82.3 ^d	3.1	27				
2	92.5 ^d	2.3	6				
3	95.8 ^d	3.0	3				
Critical habitat designation					294	0.0007	0.0002
Yes	86.6	4.6	14				
No	60.4	2.9	96				
Recovery coordinator					478	0.0004	0.0006
Yes	82.1	4.4	21				
No	58.8	3.0	90				
Recovery database					303	<0.0001	0.0002
Yes	89.5	2.8	20				
No	58.3	2.9	92				
b) Species attributes							
Taxonomic group				21.66		<0.0001	0.0002
Vertebrate	80.7 ^e	3.7	33				
Invertebrate	71.7 ^{ef}	7.6	12				
Plant	54.1 ^f	3.4	69				
Ecotype					789.5	0.0013	0.0008
Terrestrial	58.3	3.4	65				
Aquatic	75.5	4.3	39				
Geographic category					547.5	<0.0001	0.0002
Insular	43.9	3.6	43				
Continental	75.6	3.9	71				
Taxonomic subdivision				2.07		0.3558	0.3697
Species	62.8	3.1	85				
Subspecies	70.2	5.3	24				
Population	50.7	18.8	4				
c) USFWS data							
Listing status					511	0.0079	0.0094
Threatened	80.9	4.0	18				
Endangered	60.8	3.0	94				
USFWS recovery priority number				0.5089		0.7753	0.7808
High (1–6)	67.0	3.3	76				
Medium (7–12)	68.1	5.9	20				
Low (13–18)	58.8	13.9	5				
USFWS conflict designation					549.5	0.0016	0.0014
Conflict	80.9	4.8	25				
No conflict	62.2	3.3	76				
USFWS trend status				17.22		0.0006	0.0004
Decreasing	71.0 ^{gh}	4.2	38				
Stable	68.6 ^{gh}	5.7	24				
Improving	68.7 ^g	3.2	13				
Unknown	47.04 ^h	5.8	25				

Note: Values in boldface indicate the significance of test statistics H and U at $P = 0.0038$.

[†] Different superscript letters (a–h) indicate significant differences between mean values at $P = 0.0038$ for Bonferroni/Dunn (nonparametric) post hoc comparison tests.

[‡] P values from nonparametric tests.

[§] P values from randomization tests with 5000 permutations.

cies had higher task implementation than insular species, a result driven by the fact that listed insular species are largely Hawaiian species with low task implementation (42 of 51 species). A better understanding of what causes differences in species-specific implementation would be invaluable to conservation efforts, and a detailed study of specific tasks prescribed in re-

covery plans among different types of species may begin to provide answers to this question.

Unlike characteristics of species, some factors associated with higher task implementation for newer plans can be directly influenced by recovery planners. These include plan type, critical habitat and conflict designation, plan revision, and presence of a recovery

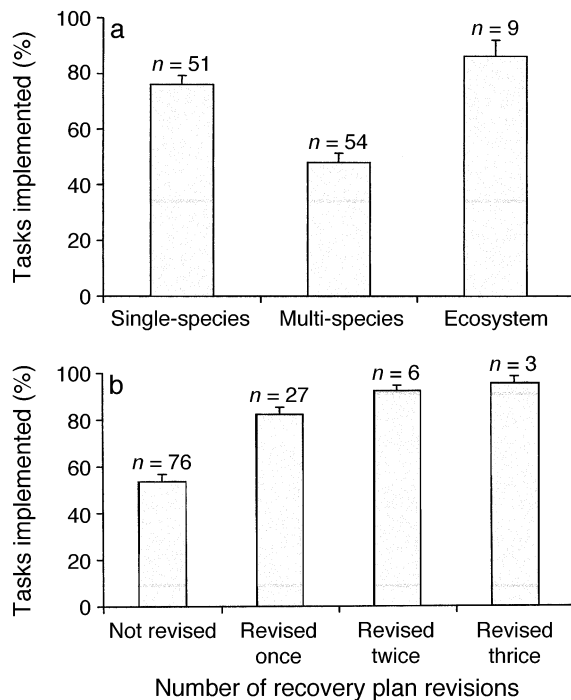


FIG. 2. Percentage of tasks implemented for post-1990 plans with differing plan attributes. (a) Single species vs. multi-species vs. ecosystem plans. (b) Number of revisions. Error bars represent +1 SE.

coordinator and database. Several authors have advocated a multi-species or ecosystem approach to recovery planning (e.g., Angermeier and Williams 1994, Carroll et al. 1996, Rohlf 1991), yet we found that multi-species plans had lower levels of task implementation than single-species plans. This result is consistent with that of other studies suggesting that multi-species plans are actually less effective management tools than single-species plans (Boersma et al. 2001, Clark and Harvey 2002). However, as multi-species plans are biased toward certain types of species (Clark and Harvey 2002), differences in effectiveness among plan types may stem partially from correlations with these factors rather than plan type per se. Although critical habitat designation has been criticized based on the assertion that it negatively affects public opinion (Sidle 1987), our results indicated that critical habitat designation was positively associated with task implementation. Species considered by the USFWS to conflict with human activities also had higher levels of implementation. Increased political and legal pressure associated with critical habitat and conflict designation may generate greater agency attention, resulting in greater task implementation for species with such designations.

Plan revision, assignment of a recovery coordinator, and establishment of a recovery database were associated with higher task implementation. These results

may be partly a consequence of a positive relationship between the extent of biological understanding and implementation success. Revised plans tend to present more scientific information than corresponding original versions (Harvey et al. 2002), and a recovery coordinator and database might be more likely to be included in a recovery plan if more information is available. However, it is also likely that these factors directly influence task implementation. Revised plans probably describe tasks and management actions more clearly than original plans, and administrative strategies that include a coordinator and database probably make recovery efforts more effective and efficient. Hence, we recommend that plans periodically be revised and that recovery coordinators and databases be established whenever possible.

Because recovery priorities are assigned to allocate agency resources, it is surprising that USFWS recovery priorities did not influence implementation. Other studies have reported a similar lack of influence of priority designation on recovery plan revisions (Harvey et al. 2002). These results may reflect a problem with recovery priority assignments (e.g., Rohlf 1991) rather than the recovery planning process itself.

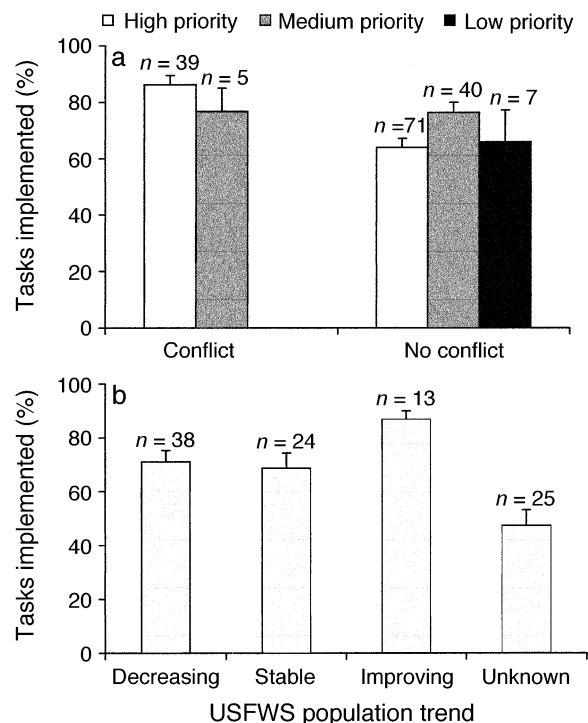


FIG. 3. Percentage of tasks implemented for all plans with differing USFWS prioritization criteria. (a) USFWS 1996 Species Recovery Priority Number (1-18, highest through lowest, binned into categories of 1-6, 7-12, and 13-18) with or without conflict designation. (b) Percentage of tasks implemented for post-1990 plans, by USFWS 1996 species trend data (increasing, stable, decreasing, or unknown). Error bars represent +1 SE.

Our results indicate the percentage of implemented recovery tasks is consistently high and equitable among species with older plans, but this is not the case for species with newer plans. Although differential implementation equilibrates over time, many listed species may go extinct before recommended tasks are implemented. For recovery of threatened and endangered species to be successful and equitable, responsible agencies must seek to understand how intrinsic attributes of species influence recovery task implementation, and must make prudent use of management strategies that yield higher implementation rates.

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