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JURISDICTION OVER ENDANGERED SPECIES' HABITAT: THE IMPACTS OF PEOPLE AND PROPERTY ON RECOVERY PLANNING

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Abstract. Coordinating management among multiple landowners and jurisdictional agencies is one of the greatest challenges confronting conservation planning. In this study, we assessed the impacts on recovery progress of the people and property involved in recovery plan development and implementation. We compared indices of recovery progress among endangered species whose primary habitat falls into one of four federal jurisdiction categories: nonfederal land only, <50% federal land, >50% but not all federal land, and all federal land. Species found exclusively on federal land are more likely to be improving in status. This may result from the fact that overall implementation of recovery tasks is lower among species occurring exclusively on nonfederal lands. Revision status, the existence of a centralized database, the designation of a person or committee to coordinate plan implementation, the parties involved in drafting the plan, and those designated as responsible for implementing recovery tasks are also significant factors in determining recovery plan implementation. Specifically, diversity of recovery team membership and the average number of participants increase with increasing federal jurisdiction, and tasks are more likely to be completed when more parties are involved in developing recovery plans. However, fewer recovery tasks are completed as the number of parties involved in implementation increases, suggesting that species on federal lands may benefit from less division of labor among agencies. Differences in drafting plans and administering their implementation appear to be stronger determinants of the observed variation in recovery success than differences in the kinds of threats facing species and their habitats.

Key words: conservation biology; endangered species; Endangered Species Act; federal land; habitat management; private land; recovery planning.

INTRODUCTION

The U.S. Endangered Species Act (ESA) requires that recovery plans for listed species include detailed implementation schedules prioritizing recovery tasks and suggesting agencies responsible for completing them (U.S. ESA 1988). Critics of species-based recovery efforts have argued that recovery resources could be used more effectively by addressing ecosystem- or landscape-level habitat management (Scott et al. 1991, Shaffer 1992). One concern with this approach is that increasing the scale of habitat conservation may further accentuate the difficult nature of managing land across complicated boundaries of ownership and jurisdiction (Bullock and Wall 1995).

Coordinating conservation efforts throughout species' ranges can present major legal and political hurdles to recovery efforts (Schemske et al. 1994). Although the ESA gives the U.S. Fish and Wildlife Service (USFWS) sole jurisdiction over the majority of listed species, protection for plants from take and habitat alteration is limited to species on federal land (U.S. ESA 1988). For animal species, protection of habitat and protection from take are linked only when habitat modification or degradation can be shown to ''actually kill or injure fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering'' (U.S. Department of Commerce 1999). Thus, although the ESA can provide strong protection for some habitat under some conditions, its legal hold over the majority of endangered species' habitat has proven tenuous. Most commonly, jurisdiction over species' habitat is shared among several stakeholders including federal, state, and local governmental agencies and private landowners. In addition, populations of an endangered species, even if found exclusively on federal land, could fall under the management of a number of federal agencies. The federal government administers nearly 30% of the total land area of the United States through five major agencies: the National Park Service, the U.S. Fish and Wildlife Service, the Forest Service, the Bu-

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reau of Land Management, and the Department of Defense (Groves et al. 2000). Coordinating management and monitoring activities among these agencies can be a challenge (Schemske et al. 1994). Many states also have systems of public parks, forests, and wildlife management areas, some of significant size and distribution. Even if coordination were seamless, managing populations on local, state, and federal public lands alone will not protect sufficient habitat for the majority of endangered species. For example, in regions such as the southern United States, private ownership comprises up to 90% of the land base (O'Connell 1996), and it has been estimated that >50% of the species federally listed as threatened or endangered occur exclusively on private land (Groves et al. 2000).

It is clear that ownership and jurisdiction over habitat influence the recovery of endangered species; those occurring entirely on private land fare worse than those found exclusively on federal lands (USFWS 1994, USGAO [U.S. General Accounting Office] 1994). However, it is unclear why this pattern emerges. In this study, we assessed the impact that habitat jurisdiction has on endangered species recovery, using a database created from a national review of 135 recovery plans written for 181 listed species (see Hoekstra et al. 2002). We compared several indices of recovery progress among species whose primary habitat falls into one of the following four jurisdiction categories: species whose primary habitat is (1) entirely on nonfederal lands, (2) less than half on federal lands, (3) more than half but not entirely on federal land, and (4) entirely on federal land. First, we asked whether the factors threatening endangered species differ among the four jurisdiction categories. Second, we analyzed whether the inclusion and completion of management and monitoring tasks varies with the degree of federal jurisdiction. Finally, we assessed whether the number and affiliations of parties involved in plan development and implementation and the inclusion of tasks to coordinate and administer the implementation of recovery plans vary according to the percentage of species' habitat falling under federal jurisdiction. The relationship between the people and property involved in recovery planning and implementation provides insight into how the social and organizational context surrounding endangered species impacts our efforts to protect their habitat.

Methods

Data collection

In September 1998, the Society of Conservation Biology, in cooperation with the U.S. Fish and Wildlife Service, launched a national review of recovery plans for species listed under the ESA. The review was carried out by >300 researchers at 19 universities, using a detailed questionnaire to compile a database and conduct exploratory analysis of the information contained in 135 recovery plans written for 181 species. Details regarding the general design and methodology of the recovery plan review project are presented in Hoekstra et al. (2002). For each analysis described, we reference the unique alphanumeric codes that identify the columns of data extracted from the project database. The entire database can be accessed online at the project web site.[4]

Data analysis

Species were placed in one of four categories, according to the degree of federal jurisdiction over their primary habitat (form 2, question 80). Decisions as to what percentages of species' habitats were on federal vs. nonfederal land were based solely on information provided in their recovery plans. Finer discrimination among state and private land ownership or among federal land systems (i.e., National Parks, National Wildlife Refuges, National Forests, Bureau of Land Management, or Department of Defense) was not possible in this study because of limited sample sizes within each category. Likewise, small sample sizes also precluded regional analyses. Of the sampled species, 66 are found only on nonfederal land; 10 species occur exclusively on federal land; 47 species occur on lands under federal and nonfederal jurisdiction, but with <50% of their habitat on federal land; and 30 of the species are under mixed jurisdiction, but with >50% of their habitat on federal land. Recovery plans for 28 species did not contain sufficient information to classify them in any jurisdiction category; thus, they were dropped from our analysis.

We also used recovery trend data published by the USFWS (1996) to assess the effect of selected predictor variables on species' recovery (form 2, question Q82). Possible recovery trend categories were: unknown, decreasing, stable, and improving. Data on the degree of implementation for various tasks in the recovery plan were provided by the USFWS. From these data, we derived an overall index for the degree of task completion for each recovery plan. Our goal was to create a consistent measure of overall implementation that would allow comparison among plans with different numbers of tasks. The overall index is constructed from five categories of implementation data: (1) tasks calling for the acquisition of biological information (form 4, col. J), (2) tasks addressing factors threatening the species (form 6, col. AA), (3) management tasks (form 7, col. KK), (4) monitoring tasks (form 8, col. WW), and (5) tasks calling for public relations actions (form 9, col. CCC). The overall index of implementation is an average of the proportion of tasks completed in each category weighted by the total number of tasks called for within each category. Thus, the overall index of implementation takes on a value between zero and one.

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

TABLE 1. Specific questions about recovery plan implementation and habitat jurisdiction addressed in this study.

Questions posed in this study	Response variable	Statistical test†
1) Overall patterns of jurisdiction, recovery status, and implementation of recovery plans		
Does species status vary with habitat jurisdiction?	USFWS (1996) species status (categorical)	χ^2 contingency
Does recovery plan implementation vary with habitat jurisdiction?	index of overall task implementation (continuous)	ANOVA
Which factors are the strongest predictors of recovery plan implementation?	index of overall task implementation (continuous)	all-subsets regression
2) Factors threatening species		
Do the numbers of tasks addressing different kinds (categories) of threats vary with habitat jurisdiction?	no. tasks in different categories of threats (continuous)	Kruskal-Wallis
Within each threat category, do the numbers of tasks addressing specific threats vary with habitat jurisdiction?	no. tasks addressing threats within categories (categorical: binned no.)	χ^2 contingency
3) Management and monitoring recovery tasks		
Do the numbers of different kinds (categories) of management tasks vary with habitat jurisdiction?	no. tasks in management categories (continuous)	Kruskal-Wallis
Does the implementation of different kinds (categories) of management tasks vary with habitat jurisdiction?	proportion of management tasks implemented (continuous)	Kruskal-Wallis
Which factors are the strongest predictors of management task implementation?	index of management task implementation (continuous)	all-subsets regression
Do the numbers of different kinds (categories) of monitoring tasks vary with habitat jurisdiction?	no. tasks in monitoring categories (continuous)	Kruskal-Wallis
Does the implementation of different kinds (categories) of monitoring tasks vary with habitat jurisdiction?	proportion of monitoring tasks implemented (continuous)	Kruskal-Wallis
Which factors are the strongest predictors of monitoring task implementation	index of monitoring task implementation (continuous)	all-subsets regression
4) Recovery plan development and coordination		
Parties involved in drafting and implementing recovery plans		
Does the number of recovery team members vary with habitat jurisdiction?	no. recovery team members (continuous)	ANOVA
Does the diversity of recovery team membership vary with habitat jurisdiction?	no. organizations represented in recovery team (continuous)	ANOVA
Does the number of people/organizations responsible for plan implementation vary with habitat jurisdiction?	no. people/organizations responsible for implementation (continuous)	ANOVA
Recovery plan administration and coordination		
Does the designation of an individual or a committee to coordinate plan implementation vary with habitat jurisdiction?	coordinator: yes/no (categorical)	χ^2 contingency
Does the creation of a centralized database for information on species' status vary with habitat jurisdiction?	centralized database: yes/no (categorical)	χ^2 contingency
Does the establishment of a system to monitor plan implementation vary with habitat jurisdiction?	monitoring system: yes/no (categorical)	χ^2 contingency

† Each statistical analysis tested the effect of percentage of federal habitat (categorical variable) on the response variable listed. All-subsets regression analyses tested for the joint effect of various categorical and continuous variables on overall implementation indices.

Tasks within each category were interpreted as ''implemented'' even if they were only partially completed; therefore, our measure of implementation is a lenient one. When it was unknown whether or not a task had been completed or partially completed, we conservatively interpreted the task as not started. The USFWS categorical trend data and our implementation index are probably an oversimplification of the true status of species' recovery. Nonetheless, we chose to confine our analyses to data gathered and published by the USFWS, data that they use themselves to track the success of recovery efforts. We reasoned that independent data sources on recovery (such as those published by heritage programs or environmental organizations), although perhaps more detailed, could possibly be biased depending on the reporting agency, and very likely would not be comparable across the large numbers of plans that we examined. Our analyses, therefore, assess the USFWS's internally reported progress in recovering listed species.

In this study, we addressed hypotheses concerning: (1) overall patterns of jurisdiction, recovery status, and implementation of recovery plans; (2) the factors threatening species; (3) management and monitoring recovery tasks; and (4) recovery plan administration and coordination (Table 1). Analyses used multivariate all-subsets regression and univariate nonparametric tests for both count and categorical data. Standard ANOVA and χ^2 contingency tests were used only when transformed data satisfied assumptions of normality.

Significant relationships among coarsely binned variables were investigated at finer scales using raw data (sample size permitting). Each statistically tested data set was unique; thus, probability values were not corrected for multiple comparisons. In general, relationships whose probability values were less than the standard error level of $\alpha = 0.05$ were judged to be significant. However, values <0.1 were reported as indicating strong trends or consistent contribution to the fit of selected regression models.

Results

The results of all analyses are summarized in Table 2, including the direction of the response to increasing federal habitat jurisdiction and the associated *P* value.

Overall patterns of jurisdiction, recovery status, and implementation of recovery plans

The status of species varied according to the category of jurisdiction over their habitat (Fig. 1A; χ^2, df = 9, $P = 0.0350$). In particular, species restricted entirely to federal lands were more likely to be improving, and species found entirely or mostly on nonfederal land had a disproportionately higher ''unknown'' status. In addition, we found that overall implementation of recovery plan tasks was lower in species occurring exclusively on nonfederal lands (Fig. 1B; ANOVA, $F = 4.02$, df = 1, 114, $P = 0.047$).

We used an all-subsets regression model to address the joint effects of several variables on the implementation of tasks called for in recovery plans. We included in the model all variables that could potentially relate to jurisdiction, but because of missing data, we minimized the number of variables to retain a sufficiently large sample size. The following factors were included as potential predictors of the degree of task implementation in recovery plans: (a) the year that the species was listed (form 2, Q55); (b) whether or not critical habitat was designated at the time of listing (form 2, Q58); (c) whether or not measures were included to administer plan implementation (i.e., designation of an individual or committee to coordinate plan implementation [form 10, Q381], creation of a centralized database for information on the status of the species [form 10, Q382], or establishment of a system to monitor plan implementation [form 10, Q383]); (d) who was suggested as responsible for plan implementation (form 10, Q384–394); (e) who participated in plan development (form 1, Q20–30); (f) the species' taxon (form 2, Q66), (g) whether or not the species occurred in more than one state (form 2, Q78); (h) whether or not the plan was revised (form 1, Q12); (i) whether the species was listed as endangered or threatened (form 2, Q54); and (j) what percentage of the species' primary habitat was on federal land (form 2, Q80), and (k) the interaction between federal jurisdiction and the designation of critical habitat. In addition, the following interactions were included to address taxonomic differences in the ESA's protection for species on nonfederal land: (l) the interaction between federal jurisdiction and species' taxon; (m) between who participated in planning and species' taxon; (n) between who is responsible for plan implementation and species' taxon; and (o) between the inclusion of measures to administrate plan implementation and species' taxon. These factors encompassed a total of 56 separate categorical and continuous variables and yielded a data set of 116 species (species with missing data are omitted). Overall implementation data were arcsine-transformed and were fit to a linear model with all 56 variables, using SAS Version 8.0 (SAS Institute 1999). Variable selection was performed to identify those factors that together best predict the degree of task implementation. This selection was carried out using SAS all-subsets regression, based on Mallow's C_p; a penalized log-likelihood measure in which the penalty is an increasing function of the number of parameters (SAS Institute 1999). The final model was selected from a pool of candidate models with low C_p values by evaluating the collinearity of predictors, diagnostics as to the fit of the model, and possible violations of assumptions. The selected model indicated that revision status, the existence of a centralized database, the designation of a person or committee to coordinate plan implementation, the establishment of a system to monitor plan implementation, the numbers and affiliations of the parties involved in drafting the plan, and the numbers and affiliations of those responsible for implementing the tasks in the plan are good predictors of overall implementation (Table 3). In addition, one interaction, that between vertebrates and species with $>50\%$ of their primary habitat on federal land, was also a significant predictor. Overall, the model accounts for 42% percent of the variation in the implementation of recovery plans (Table 3). Jurisdiction of primary habitat did not itself add significantly to the explanatory capability of the model; thus, overall implementation is better explained by factors associated with jurisdiction than by jurisdiction directly. Likewise, species' taxon did not directly account for a significant amount of the observed variation in our task implementation, despite the fact that the ESA provides stronger protection for animals than it does for plants on nonfederal land. However, coarse binnings of jurisdiction and species' taxon were retained in the selected model because of the interaction between vertebrates and species with $>50\%$ of their habitat on federal land. This interaction contributed to the fit of the final and all candidate models, indicating that overall implementation of recovery tasks is heightened for vertebrate species whose habitat is predominantly federal. Small sample sizes often precluded analyzing plants and animals separately in this study. However, the lack of additional significant interactions between species' tax-

TABLE 2. Summary of results in tests of the effect of habitat jurisdiction on implementation of recovery plans.

Questions posed in this study	Relationship(s)	Response†	*P*
1) Overall patterns of jurisdiction, recovery status, and implementation of recovery plans			
Does species status vary with habitat jurisdiction?	yes (Fig. 1A)	+	0.035
Does recovery plan implementation vary with habitat jurisdiction?	yes (Fig. 1B)	+	0.047
Which factors are the strongest predictors of recovery plan implementation?	see Table 3		
2) Factors threatening species			
Do the numbers of tasks addressing different kinds (categories) of threats vary with habitat jurisdiction?	construction	−	0.07
	resource use	~	0.07
Within each threat category, do the numbers of tasks addressing specific threats vary with habitat jurisdiction?	commercial construction	−	0.1
	urban construction	−	0.02
	hunting/fishing (resource use)	~	0.00001
3) Management and monitoring recovery tasks			
Do the number of different kinds (categories) of management tasks vary with habitat jurisdiction?	habitat management (Fig. 2A)	+	0.0015
Does the implementation of different kinds (categories) of management tasks vary with habitat jurisdiction?	habitat management (Fig. 2B)	+	0.020
Which factors are the strongest predictors of management task implementation?	see Table 4A		
Do the numbers of different kinds (categories) of monitoring tasks vary with habitat jurisdiction?	focal species monitoring (Fig. 3)	−	0.080
Does the implementation of different kinds (categories) of monitoring tasks vary with habitat jurisdiction?	habitat monitoring	+	0.010
Which factors are the strongest predictors of monitoring tasks implementation?	see Table 4B		
4) Recovery plan development and coordination			
Parties involved in drafting/implementing plans			
Does the number of recovery team members vary with habitat jurisdiction?	yes (Fig. 4A)	+	0.090
Does the diversity of recovery team membership vary with habitat jurisdiction?	yes (Fig. 4B)	+	0.028
Does the number of people/organizations responsible for plan implementation vary with habitat jurisdiction?	yes	−	0.031
Recovery plan administration/coordination			
Does the designation of an individual/committee to coordinate implementation vary with habitat jurisdiction?	yes	+	0.008
Does the creation of a centralized database on species' status vary with habitat jurisdiction?	no		0.320
Does the establishment of a system to monitor plan implementation vary with habitat jurisdiction?	no		0.784

† Direction of response and its statistical significance: +, increasing with increasing federal habitat jurisdiction; −, decreasing with increasing federal jurisdiction; and ~, nonlinear relationship with increasing federal jurisdiction.

on and other predictor variables in the model supports the use of a combined data set in subsequent analyses.

Factors threatening species

The types of threats affecting species could vary among jurisdiction categories and contribute to differences in the inclusion and completion of tasks in recovery plans. Before interpreting the pattern of implementation, we asked whether differences in the factors threatening species on federal, mixed jurisdiction, and nonfederal land were driving our initial results.

We examined six broadly defined categories of threats to endangered species: construction, agriculture, resource use, water diversion, pollution, and presence of exotic or alien species (form 6, col. X). There were surprisingly few differences among jurisdictional categories in the types of threats impacting species (as judged by the tasks included in their recovery plans). However, plans for species that occur exclusively on federal land included marginally fewer tasks addressing threats from construction (commercial, urban, road, and public utility activities) (Kruskal-Wallis $H = 7.04$, df = 3, $P = 0.07$). This pattern was specifically due to fewer tasks addressing commercial and urban development on all federal land (commercial construction, $\chi^2 = 6.25$, df = 3, $P = 0.1$; urban construction,

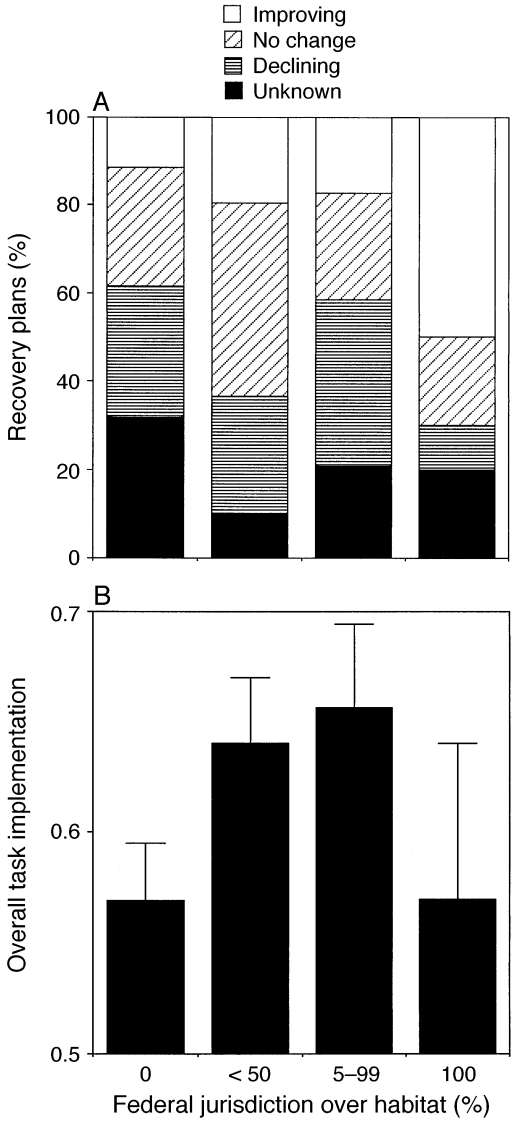

FIG. 1. (A) Recovery status and (B) overall implementation of tasks in recovery plans for sampled species with primary habitat falling under four levels of federal jurisdiction. Error bars indicate + 1 SE.

$\chi^2 = 9.41$, df = 3, $P = 0.02$). In addition, species with primary habitat on all federal or all nonfederal land had fewer tasks to address threats from resource use (timber, ore, oil and gas extraction, grazing, fishing, and hunting) than did cases of mixed jurisdiction (Kruskal-Wallis $H = 7.18$, df = 3, $P = 0.07$). This resulted from less hunting and fishing activity in the 100% federal land and 100% nonfederal land categories ($\chi^2 = 14.84$, df = 3, $P = 0.00001$).

Management and monitoring recovery tasks

We asked whether there were differences in the kinds of management and monitoring policies that are used to guide recovery efforts on federal vs. nonfederal lands. Management and monitoring tasks outlined in recovery plans can focus on very distinct biological scales, ranging from individual populations to management of habitats occupied by the endangered species. In our analysis, we grouped management tasks into three groups according to their goals and focus: (1) those that call for actions taken at the level of populations (e.g., translocation of individuals, regulation of harvest or hunting, augmentation of food supply, control of invading species); (2) those that call for management of habitat (e.g., restoration or enhancement of habitat, reduction of disturbance, maintenance of dispersal habitat); and, (3) those that call for incentive programs that, in turn, would increase the chances of species' survival (e.g., federal or state incentive programs, mitigation banks, safe harbor programs) (form 7, col. FF). Likewise, monitoring tasks were grouped into three biologically relevant categories: (1) those directly monitoring the focal species; (2) those monitoring species associated with the focal species (such as invasive species, predatory, or prey species); and

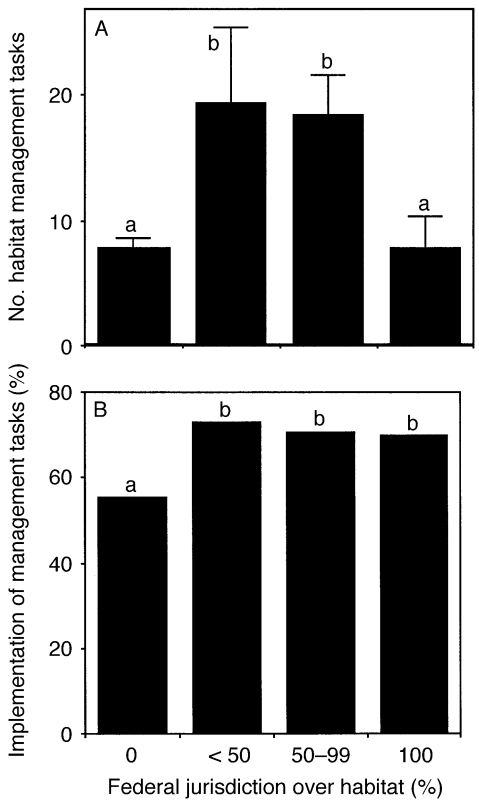

FIG. 2. Variation in habitat management for species in different federal jurisdiction categories. (A) Mean numbers (+ 1 SE) of habitat management tasks called for, and (B) mean proportions of these tasks at least partially completed for species with primary habitat falling under four federal jurisdiction categories. Different letters in each panel indicate that the means are significantly different at $\alpha = 0.05$.

TABLE 3. Results of all-subsets regression for variables affecting the overall implementation index in sampled recovery plans.

Variable	Value	1 SE	Response†	*P*	*t*
Intercept	62.61	4.80		0	13.04
Recovery plan revised	12.71	3.28	+	0.0002	3.86
Centralized database proposed for recovery information	11.11	4.61	+	0.017	2.41
System proposed to monitor implementation	−5.47	3.88	+	0.161	−1.41
Individual proposed to coordinate recovery	−11.32	8.23	+	0.172	−1.38
Committee proposed to coordinate recovery	6.03	4.50	+	0.183	1.34
Interaction between species' taxon (vertebrate) and >50% federal jurisdiction over habitat	11.13	7.01	+	0.115	1.59
Primary habitat more/less than 50% federal	−2.76	4.92		0.575	−0.56
Species' taxon (vertebrate/invertebrate/plant)	−5.76	6.33		0.364	−0.91
More federal government employees involved in plan drafting	−2.33	0.66	−	0.0007	−3.49
More local government employees involved in plan drafting	4.44	1.25	+	0.0006	3.53
More environment organizations involved in plan drafting	−9.63	5.70	−	0.0943	−1.69
More other individuals involved in plan drafting	−1.35	0.81	+	0.0983	1.67
More local government employees involved in implementation	−0.15	0.05	−	0.0116	−2.57

Notes: The Mallow's C_p-based all-subsets regression suggests that the 13 variables in the table best predict the degree of overall implementation of recovery tasks. The model accounts for 42.25% of the variance ($F_{13, 102} = 5.87$, $P < 0.0001$).

† The direction of each variable's influence within the model: +, positive; −, negative.

(3) those monitoring some aspect of the habitat of the focal species (form 8, col. OO).

Management of habitat varied significantly among jurisdiction categories. Specifically, the number of habitat management tasks called for was significantly lower among species under primarily nonfederal jurisdiction (Fig. 2A; Kruskal-Wallis $H = 15.628$, df = 3, $P = 0.0015$). The degree of habitat management task implementation was also significantly lower among species under nonfederal jurisdiction compared to species on at least some federal land (Fig. 2B; Kruskal-Wallis $H = 9.425$, df = 3, $P = 0.02$). We used an all-subsets regression including 23 possible predictors to determine which factors specifically influence the overall completion of management tasks, regardless of category. Nine factors explained 35% of the variation in management implementation (Table 4A). As was the case for overall plan completion (Table 3), revision status, the existence of a centralized database, designating a person or committee to coordinate plan im-

TABLE 4. Results of all-subsets regression for variables affecting implementation of (A) management and (B) monitoring tasks in recovery plans.

Variable	Value	Response†	*P*
A) Management tasks			
Intercept	63.02		0
Recovery plan revised	−9.87	+	0
Species listed as endangered (vs. threatened)	−5.001	+	0.045
Individual proposed to coordinate recovery	−6.06	+	0.19
Committee proposed to coordinate recovery	5.12	+	0.026
More local government employees involved in drafting plan	2.76	+	0.048
More other parties involved in drafting plan	2.16	+	0.03
More environmental organizations involved in drafting plan	−13.62	−	0.0002
More other parties responsible for implementation	−0.32	−	0.0151
More academics responsible for implementation	4.54	+	0.0615
B) Monitoring tasks			
Intercept	80.41		0
Primary habitat >50% federal	−4.47	−	0.052
Individual proposed to coordinate recovery	−7.1	+	0.13
Committee proposed to coordinate recovery	4.96	+	0.027
Centralized database for recovery information	7.73	+	0.0086
More federal employees involved in drafting plan	−3.66	−	0
More local government employees involved in drafting plan	3.96	+	0.0156
More other parties involved in drafting plan	2.56	+	0.008
More local government responsible for plan implementation	−0.2	−	0.0068

Notes: A combination of eight and nine variables best predict implementation of management and monitoring tasks, respectively. The Mallow's C_p-based all-subsets regressions account for 35.2% of the variance in management task completion ($F_{9,98} = 5.913$, $P < 0.0001$) and 32.5% of the variance in monitoring task completion ($F_{8,94} = 5.659$, $P < 0.0001$).

† Direction of each variable's influence within the models: +, positive; −, negative.

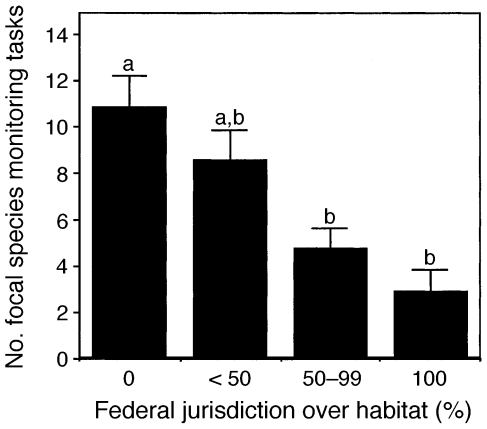

FIG. 3. Mean numbers (+ 1 SE) of tasks associated with focal species monitoring for species with primary habitat falling under four federal jurisdiction categories. Different letters indicate that the means are significantly different at $\alpha = 0.05$.

plementation, the number and affiliations of the parties involved in drafting the plan, and the number and affiliations of those suggested as responsible for implementing the tasks called for in the plan were good predictors of management implementation. Additionally, the status of the species as endangered vs. threatened, and the listing of academics as responsible for implementation also improved completion of management actions. As in the overall implementation analysis, species' taxon and jurisdiction did not appear in the selected model. Small sample size precluded the inclusion of taxon interactions as potential predictors of specifically management or monitoring task completion.

Plans written for species whose habitats are primarily under nonfederal jurisdiction included marginally *more* tasks to monitor the focal species (Fig. 3; Kruskal-Wallis $H = 6.654$, df = 3, $P = 0.08$). All other comparisons between the numbers of tasks that focused on any aspects of monitoring for endangered species did not vary significantly with jurisdiction. The pattern for monitoring implementation was more complicated. The all-subsets regression model, using 23 possible predictors, indicated that eight factors explained 33% of the variation in the completion of monitoring tasks (Table 4B). Seven of these predictors were shared with the overall and management task models (Tables 3 and 4A). Interestingly, the percentage of species' habitat on federal land was also a significant factor, with species on predominantly federal land showing less overall monitoring implementation than those on mostly nonfederal land. Analyses of particular categories of monitoring actions, however, indicated that the implementation of habitat monitoring tasks was lower among species on entirely nonfederal land than those under at least some federal jurisdiction (Kruskal-Wallis $H = 11.159$, df = 3, $P = 0.01$).

Recovery plan development and coordination

Parties involved in drafting and implementing recovery plans.—Some recovery plans are drafted solely by representatives from the USFWS or private contractors, but, most plans are prepared by several individuals with some level of expertise on the species. In this study, parties listed as actively participating in plan development were considered members of a recovery team (see form 1, Q20–30 for more details). Given the important role of the recovery teams in plan design, the number and affiliation of its members could be an important determinant of recovery progress if team membership elicits collaboration from a larger group of interested parties.

We asked whether the number and affiliation of recovery team members varied according to jurisdiction categories. The average number of participants (ANOVA, $F = 2.21$, df = 3, 97, $P = 0.09$) and the diversity of recovery teams (ANOVA, $F = 5.02$. df = 3, 97, $P = 0.028$) tended to increase with increasing federal land jurisdiction (Fig. 4A, B). Recovery teams were smallest and least diverse for species with habitat falling entirely outside of federal jurisdiction. In addition,

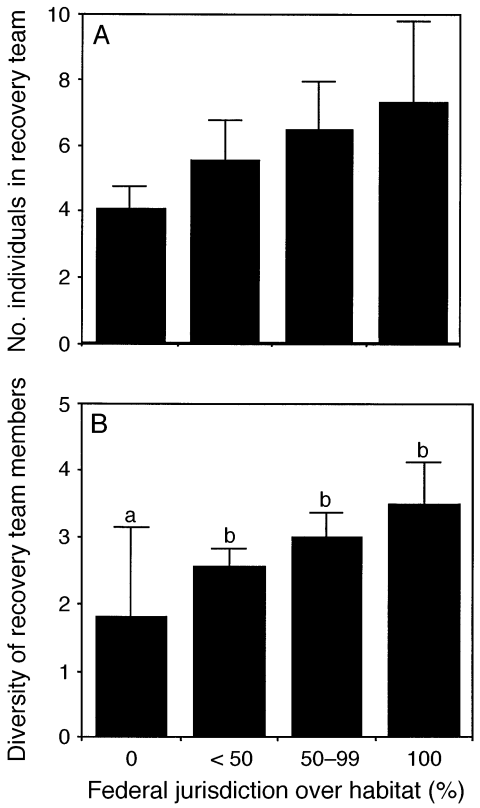

FIG. 4. Variation in composition of recovery teams for sampled species. Mean numbers (+ 1 SE) of individuals participating in (A) plan development and (B) their diversity for species with primary habitat falling under four federal jurisdiction categories. Different letters in each panel indicate that the means are significantly different at $\alpha = 0.05$.

our overall analysis suggested that the composition of recovery teams can influence task completion. Degree of implementation increased when more representatives from state and local governmental agencies and from most nongovernmental agencies (see list form 1, Q20–30, with the exception of environmental organizations) were involved in plan development (Tables 3 and 4A, B). However, implementation decreased with increasing representation from federal agencies and environmental organizations during the drafting process (Tables 3 and 4A, B). These results suggest that recovery teams become more inclusive when the habitat to be managed is primarily under federal jurisdiction, and that tasks are more likely to be completed when more parties are involved in planning. The involvement of regional governmental agencies and most nongovernmental interests in plan development also seems to enhance implementation.

Recovery plan developers are also charged with devising a time schedule for task completion and suggesting those parties responsible for task implementation (form 10, Q384–394). The USFWS is always listed as responsible for implementation in recovery plans. Other parties involved in recovery plan development can be responsible for task implementation; however, responsibility for implementation is likely to shift from those with knowledge of the species to those with some jurisdiction over the populations and habitats. Indeed, we found significant differences among the four jurisdiction categories in the number of parties responsible for task implementation. Diversity in implementation parties was lowest for species exclusively under federal jurisdiction (ANOVA, $F = 3.06$, df = 3, 97, $P = 0.031$); the average number of parties ranged from five for species in the nonfederal land category to 3.2 for those in the 100% federal land category. This result is not surprising, given the higher number of stakeholders in mixed land ownership categories. However, the results of the all-subsets regression analysis suggest that the completion of tasks decreases as the number of representatives from state and local governmental agencies and from nongovernmental agencies (see previous list, with the exception of environmental organizations) responsible for implementation increases (Tables 2A, B and 3).

Recovery plan administration and coordination.—Three administrative measures sometimes included in recovery plans are (1) the designation of an individual or committee to coordinate implementation of recovery tasks (form 10, Q381); (2) the creation of a centralized database for information on the status of the species (form 10, Q382); (3) the establishment of a system to monitor plan implementation (form 10, Q383). Our overall analysis of recovery plan implementation suggests that task completion is higher when the recovery plan specifically establishes a centralized database (Table 3). The designation of a committee to coordinate plan implementation and the establishment of a system to monitor implementation also had positive effects on overall implementation (Table 3), suggesting that these administrative measures are successful for coordination among all parties involved.

We asked whether the degree of centralized coordination varied with jurisdiction over habitat. Sharing information and monitoring and coordinating plan implementation are particularly important when the number of parties involved in implementation is high (Clark et al. 1994). Such a situation is more common for species with primary habitat falling under mixed jurisdiction. Despite the presumed benefits of these measures, we found that species with no primary habitat under federal jurisdiction are less likely to have designated implementation coordinators ($\chi^2 = 11.83$, df = 3, $P = 0.008$; proportions of plans with a designated coordinator: no federal land = 0.06, <50% federal land = 0.28, >50% federal land = 0.25, all federal land = 0.42). Creation of a centralized database and establishment of a system to monitor implementation did not differ with the degree of federal jurisdiction (centralized database, $\chi^2 = 3.525$, df = 3, $P = 0.32$; monitoring system, $\chi^2 = 1.070$, df = 3, $P = 0.78$).

Discussion

Our results support data collected in 1994 by the USFWS and the USGAO indicating that endangered species with habitat on federal land are faring better than those with little federal jurisdiction (USFWS 1994, USGAO 1994). The largest barrier to management of listed species on nonfederal lands is limited access, particularly on private land (Bean 1999). We found that species' status on entirely nonfederal lands (which include state and regional public lands as well as private property) was more often unknown, suggesting that access difficulties might also hinder efforts on certain types of public lands. In addition, lack of federal jurisdiction may limit the ability of recovery teams to implement recovery tasks. For example, when proposed, tasks calling for management and monitoring of habitat were less likely to be implemented on nonfederal lands. We also found that plans for species partially or completely on nonfederal lands proposed fewer tasks to manage and monitor habitat. These differences between recovery planning for species on predominantly federal lands vs. those under mixed jurisdiction probably reflect challenges posed by private property rights and coordination among stakeholders.

To better understand why implementation of recovery plans was lower for species on nonfederal land, we quantified the relative effects of several factors related to jurisdiction on task completion. We found that 42% of the observed variation in implementation can be explained by seven factors directly related to the people and property involved in recovery efforts. However,

although land ownership may be the basis for jurisdictional distinctions in the recovery process, it does not appear to influence implementation directly. Instead, jurisdiction becomes an important descriptor of recovery progress through the relationship between the composition of landowners throughout a species' range and the number and diversity of parties involved in drafting and implementing its recovery plan.

Diversity in recovery teams generally improves recovery progress. Specifically, teams involving more local government interest groups and members from most nongovernmental organizations are correlated with higher implementation. More inclusive recovery teams may reflect a better effort on the part of the USFWS to identify the appropriate parties and to develop partnerships with them, which then has a positive impact on the utility of the drafted plan (U.S. Department of the Interior and U.S. Department of Commerce 1994). These partnerships are expected to be far more critical to recovery efforts on nonfederal land. Unfortunately, recovery teams for species whose habitats occur at least partially under nonfederal jurisdiction were found to be smaller and less diverse. This pattern does not bode well for species under mixed and entirely nonfederal jurisdiction.

In contrast to the benefits of diversity in the recovery plan drafting team, division of labor among parties implementing tasks has a negative impact on progress. On federal land, implementation of recovery tasks is higher, but the demand for several agencies to be actively involved in management, and therefore the need to coordinate their activities, is low. Thus, the most productive situation appears to be one in which collaboration and cooperation among interested parties is encouraged during plan development, but responsibility for implementation of the plans is restricted to fewer parties.

The discrepancy between the benefits of team diversity in the design vs. implementation phases of recovery may also reflect the difficulties of coordination at these different stages. Greater representation on recovery teams may broaden and strengthen the content of recovery plans. However, putting recovery tasks into action is more complex and requires prioritizing efforts, allocating resources, and organizing parties responsible for implementation. Several experienced resource managers have agreed that coordinating plan implementation is equally or more important to recovery than efforts to increase population sizes or protect habitat (Bullock and Wall 1995, Clark 1997). Reduced access and use of recovery data, faulty decision making through lack of information, confused authority relationships, and many other implementation problems have plagued recovery programs (Clark et al. 1994). Our results corroborate these claims that organizational factors are a major constraint hindering endangered species management. Unfortunately, we found that these organizational measures are lacking where they are needed most; in recovery plans for species with habitat outside of federal land, where several parties must work together to implement management actions.

Many concerned parties have emphasized the need for creativity and partnership to address increasing threats due to loss and degradation of habitat, especially on private land (Bullock and Wall 1995, USFWS 1996, Wilcove et al. 1996, Bean and Wilcove 1997). Our results show that improving the diversity of initial involvement in recovery planning for endangered species may improve progress toward short-term recovery goals. However, without incentives to support and guide their involvement, division of labor among resource managers appears to hinder short-term recovery progress. Despite the apparent importance of a centralized database, monitoring, and coordination, $<30\%$ of the plans we examined specifically included calls for these administrative measures. Greater investment in centralized databases and coordinators represents a straightforward and practical means of improving conservation activities and ought to be universally adopted in endangered species recovery programs.

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