Authorship and the Use of Biological Information in Endangered Species Recovery Plans

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Abstract: We examined the relationship between authorship and the use of biological information in recovery plans under the U.S. Endangered Species Act. Approximately one-third of recovery plans were written solely by federal government employees, and one-third of plans included authors with university affiliations. The number of plans written strictly by federal staff increased significantly over time, whereas the percentage of plans that included authors with university affiliation remained unchanged. We tested three hypotheses posed by Clark et al. (1994) regarding authorship and endangered species recovery and found that (1) groups of authors from diverse affiliations are likely to strengthen the recovery planning process, (2) recovery plans lacking nonfederal participation suffer from inadequate attention to species biology, and (3) academic affiliation is strongly associated with the use of focal-species biology in recovery plans. Our results suggest that modifying the choice of participants in the recovery planning process may increase the use of biological information in recovery measures recommended in recovery plans and thus influence the eventual success of recovery efforts.

Introduction

Scientists have repeatedly commented on the failure of species recovery plans in implementing the U.S. Endangered Species Act (ESA; Tear et al. 1993; Wilcove et al. 1993; Easter-Pilcher 1996; National Research Council 1995). The success or failure of recovery plans is determined in part by who writes these plans (Clark et al. 1994). The choice of authorship is in the hands of responsible federal agencies. Scientists can assist in implementation of the ESA by helping responsible agencies choose appropriate groups of professionals to write...
recovery plans and by serving on recovery teams. We examined authorship of 133 recovery plans and asked whether authorship influences the way science is used in plans. Understanding the relationship between authorship and recovery planning is important, because selecting appropriate groups of people to write recovery plans is one of the few facets of recovery planning that is within the control of responsible agencies.

The ESA of 1973 (as in U.S. Code 1988) was established to prevent the extinction of plant and animal species. The ESA protects plant and animal species listed as endangered or threatened and provides for designation of critical habitat and a recovery plan for listed species. Numerous obligations are imposed on federal agencies, not only in requirements that federal actions not jeopardize the continued existence of listed species, but also in requirements that agencies use their authority to undertake programs to conserve and recover listed species (Yaffee 1982). Recovery plans provide a key mechanism for federal agencies to engage in conservation planning for listed species. The U.S. Fish and Wildlife Service (USFWS; responsible for all terrestrial species and a few marine species) and the National Marine Fisheries Service (NMFS; responsible for most marine species) are required to develop a recovery plan if these agencies determine that a such plan will promote the recovery of a listed species (16 U.S.Code §1531, §4(f)). It is important to note that recovery plans are not legally required in cases where agencies determine that such a plan will not promote recovery. As of December 1999, 1763 species were listed as threatened or endangered under the ESA; either draft or final recovery plans were in place for 924 of these species (USFWS 2000).

To evaluate the use of biological information in ESA recovery planning, the USFWS recently supported the Society for Conservation Biology (SCB) in conducting a national study aimed at statistically summarizing key features of recovery plans. We used this database to examine three ideas related to recovery-plan authorship that have been suggested by Clark et al. (1994:422, 419–420): (1) “endangered species conservation is a multifaceted task of interacting biological, professional, sociological, organizational, economic, political and policy dimensions,” (2) “government agencies must be made more effective in dealing with endangered species recovery,” and (3) “there is no substitute for sound professional training well grounded in state-of-the-art theories and techniques.” To examine these arguments quantitatively, we propose three hypotheses: (1) participation by authors with diverse affiliations enhances the use of biological information in recovery plans, (2) recovery plans written exclusively by federal government employees are less well grounded in biological information than those that include nonfederal participation, and (3) participation by individuals with university appointments may improve the use of biological information in recovery plans. We consider academic affiliation to be a surrogate for state-of-the-art professional training, because recovery-plan documents do not include the educational credentials of the plan’s authors. Academic affiliation indicates that the author was affiliated with a university at the time the recovery plan was written, but it does not necessarily imply that a doctoral degree was earned by the author. Many government agencies and nonprofit organizations are staffed with highly trained professionals. But because academia rewards those who stay abreast of current ideas and techniques, whereas many agency structures make such learning prohibitive, we suggest that academic affiliation may be a reasonable, although imperfect, surrogate for state-of-the-art professional training.

Methods

The Database

In September 1998, the SCB in cooperation with the USFWS, launched a national review of recovery plans for species listed under the Endangered Species Act (Boersma et al., unpublished data). Our analysis relied on the database resulting from this study, which included 181 species listed in 135 recovery plans. This database resulted from efforts of over 300 participants at 19 universities, who analyzed recovery plans in the context of a questionnaire of over 2000 questions relating to recovery-plan content, construction, and potential implementation. Detailed descriptions of the SCB project, the methods used to review recovery plans, and the data collected are presented by Hoekstra et al. (2001). The primary data and a key to those data are now available at http://www.nceas.ucsb.edu/recovery.

As a roadmap to our analyses, throughout this paper we refer to particular response categories from the database (e.g., question 547 or question 4F) so that the reader could duplicate or build on our analyses by consulting the original database. The responses to the questions we examined were either numerical (e.g., number of tasks) or categorical (e.g., USFWS employee, academic scientist, etc). In plans for which several species were sampled by the SCB project, we randomly selected one species per plan. In addition, there were two plans for which no authorship data were available. Thus our analyses are based on one species in each of 133 recovery plans.

Influence of a Large Group of Authors or Diverse Affiliations

To test the hypothesis that a large or diverse group of authors influences the use of biological information in recovery plans, we calculated an authorship diversity index for each recovery plan as the sum of the different af-
filiations represented by a recovery plan’s authors. Authors could be associated with 1 of 11 affiliations: USFWS or NMFS, other federal agencies, state resource agencies, other state agencies, local government agencies, tribal groups, business or industry, environmental or conservation organizations, consultants, academia, or the general public. We examined the influence of the size and diversity of groups of authors for three recovery-plan features: (1) type of management actions proposed, (2) biological information used to select recovery criteria, and (3) biological information used to design monitoring strategies. We also examined patterns in authorship size and diversity in recovery plans for plants versus those for animals and in plans written for one species versus those written for many species.

MANAGEMENT TASKS

To examine the contribution of number and diversity of authors on the management actions proposed in recovery plans, we considered whether a task was recommended for recovery in each of four major categories of tasks: habitat management, population management, exotic species management, and the use of incentive programs (question FF). In the SCB questionnaire, “habitat management” included restoration or enhancement of habitat quality, securing habitat, maintaining natural disturbance regimes, and reducing human disturbance of habitat; “population management” included augmenting food supplies, reintroducing populations into previously occupied habitats, introducing populations into new habitats, translocating individuals, breeding individuals in captivity, regulating hunt or harvest, controlling predators or disease, and reducing competition with other species; “exotic species management” included controlling invasion of other species that affect the focal species; and “use of incentive programs” included using incentive programs of the U.S. Department of Agriculture (USDA) Conservation Reserve Programs, USDA Wetlands Reserve Programs, USDA Stewardship Incentive Programs, USDA Forest Legacy Programs, USDA Environmental Quality Improvement Programs, USFWS Habitat Conservation Plans, USFWS National Wildlife Refuge designations, state management and incentive programs, mitigation banks and Safe Harbor programs. For these data on whether the recovery plan called for a particular type of task, we scored a plan as recommending a task category if any task in a given category was recommended.

RECOVERY CRITERIA

To investigate the influence of number and diversity of recovery plan authors on the use of biological information in selecting criteria for recovery, we considered responses to questions about metrics used to define recovery criteria (question SSSS). These metrics included population size, population trends, and habitat quality. In the questionnaire, the connection between biological information and recommended recovery criteria under each category could be categorized as “unclear,” “some-what clear,” or “very clear.” A plan that explicitly linked specific biological information to selection of recovery metrics was scored as very clear. A plan was scored as somewhat clear in its use of biological information if it alluded to a biological basis for the metric but did not make a specific connection. A plan was scored as unclear in its use of biological information if it made no reference to biological information in the context of selecting recovery criteria. We omitted the somewhat-clear category in our analyses because of the ambiguity of the response.

For our analyses, if the use of biological information in selecting recovery criteria was specified as very clear for any of the three metrics, the plan was scored as very clear in its use of biological information for selecting recovery criteria. For example, the recovery plan for *Ziziphus celata*, an extremely rare Florida shrub limited in range to two pastures, specified that 20 distinct populations be protected at five or more properties but that “definitive recovery goals await estimates of minimum viable population on a species-specific basis” (USFWS 1989:5). Because habitat-related recovery criteria did not include any biological justification, and because population size and trend criteria were not included in the plan, it was characterized as unclear for all metrics in its use of biological information for selecting recovery criteria. Conversely, the recovery plan for the Okaloosa darter (*Etheostoma okaloosae*), which persists in six Florida stream systems, included detailed recovery criteria regarding population size, trends, and habitat restoration (USFWS 1998). For one recovery criterion regarding population trends, the plan stated that delisting may be considered when monitoring shows that the population in all six stream systems had remained stable or had increased for a 20-year hydrologic cycle. This criterion was based on the goal of maintaining self-sustaining populations of the species. Because variability in population indices may obscure true population trends, the plan suggested use of standard-deviation metrics to quantify population trends for each stream (USFWS 1998). Therefore, this plan was characterized as very clear in its use of biological information for selecting recovery criteria.

MONITORING

To assess the influence of the number and diversity of authors on the use of biological information in designing monitoring strategies, we evaluated the degree to which biological information influenced what was to be monitored (question TT). Two categories of monitoring were considered: population trends, which included monitoring population size and trends in population size, and demographic attributes, which included monitoring re-
productive rates, mortality rates, and age or stage structure. As above, if the use of biological information in the selection of monitoring strategies was specified as very clear within either of the monitoring categories, the plan was scored as very clear in its use of biological information for that attribute. In addition, we omitted all plans that included a somewhat clear use of biological information in monitoring.

Characteristics of Plans Written Exclusively by Federal Government Employees

To investigate the hypothesis that recovery plans include a stronger biological basis when individuals from outside federal agencies contribute to them, we divided the recovery plans into two groups: those that included authors who were exclusively federal employees (n = 42) and those that included at least one author who was not a federal employee (n = 91). We assessed the influence of federal affiliation on the three recovery-plan features described above and examined whether the USFWS was more likely to include an individual from outside government on recovery plans written for plants versus those for animals, and the same for those written for one species versus those written for many species.

Influence of Authors with an Academic Affiliation

To test the hypothesis that adding an author with an academic affiliation influences the use of biological information in recovery plans, we divided the 133 recovery plans into two groups: those that included at least one author with an academic appointment (n = 42) and those that did not (n = 91). To assess the influence of an author with an academic affiliation, we compared these two groups of recovery plans in the context of the three features described above: the type of management actions proposed, the biological information used to select recovery criteria, and the biological information used to design monitoring strategies. In addition, we investigated the influence of taxonomic associations and of single versus multiple species in recovery plans.

Results

On average, 4.4 people from 2.4 types of institutions contributed to the development of each recovery plan. The number of authors and the diversity of their affiliations have not dramatically changed over the last two decades (linear regression 1977–1998, r² = 0.004, p = 0.473, and r² = 0.004, p = 0.475, respectively). Groups with federal government authors only were significantly smaller than groups that included nonfederal authors (average number of authors, 1.2 vs. 5.6, t = 9.52, p < 0.001). Groups including academic scientists were larger than groups without academic scientists (average number of authors, 6.6 vs. 3.3, t = 4.30, p < 0.001) and more diverse (average authorship diversity, 3.7 vs. 1.7, t = 6.16, p < 0.001). The number of recovery plans written solely by federal personnel has increased since 1977 (plans with and without nonfederal personnel, logistic regression, χ² = 5.08, p = 0.024). The percentage of groups with academic scientists has not changed significantly over the time period of the study, however, (1977–1998, plans with and without academic-affiliated authors, logistic regression, χ² = 0.64, p = 0.415).

Authorship significantly influenced some aspects of biological information used in recovery plans. Increasing the number of authors was not significantly related to improved use of science in recovery plans, although authorship diversity was somewhat significantly related to improved science (Table 1). The number of authors had no significant influence on the tasks selected for recovery, the use of biology in selecting recovery criteria, or the use of biology in designing monitoring strategies. Low diversity of authorship was significantly associated with selection of incentive programs to manage species recovery (Table 1). Compared to those for plants, recovery plans for animals had both significantly more authors (average = 5.3 vs. 2.7, t = 3.7, p < 0.001) and significantly more diverse groups of authors (average = 2.7 vs. 1.6, t = 4.3, p < 0.001). Recovery plans written for one species had similar numbers of authors as those written for multiple species (average = 4.4 for both, t = 0.008, p = 0.99) but significantly more diverse groups of authors (average = 2.4 vs. 1.6, t = 2.7, p = 0.009).

Including individuals with nonfederal affiliations had marked effects on the use of biological information in recovery plans. Those plans whose authors included at least one person from outside federal agencies were less likely to include incentive programs as a method to manage species recovery and were more clear in their use of biology to select recovery criteria and design monitoring strategies in some cases (Table 1; Fig. 1). Recovery plans for animals were significantly more likely to have nonfederal authors than those for plants (χ² = 5.15, p = 0.023), and recovery plans written for one species were significantly more likely to have nonfederal authors than those written for multiple species (χ² = 6.4, p = 0.012).

Finally, including at least one author with an academic affiliation resulted in a somewhat lower likelihood of a recovery plan recommending tasks to control invasive species (χ² = 3.26, p = 0.07), a somewhat more clear use of biological information in selection of recovery criteria (χ² = 2.75, p = 0.09), and a much clearer use of biological information in design of monitoring strategies (for population monitoring, χ² = 5.97, p = 0.02; for demographic monitoring, χ² = 4.68, p = 0.03) (Table 1; Fig. 1). Recovery plans for animals and plants were equally likely to have an author with academic affiliation (χ² = 1.51, p = 0.22), and those plans for single species were just as likely...
as those for multiple species to have an author with academic affiliation ($\chi^2 = 0.76, p = 0.39$).

### Discussion

The regulatory and biological ambiguities surrounding ESA recovery planning have created a demand for more stakeholder involvement in planning and a more explicit use of biological information in the recovery planning process (Tear et al. 1993; Schemske et al. 1994; Foin et al. 1998; Gerber & DeMaster 1999). We present the first empirical data to provide evidence for the importance of stakeholder involvement. Clearly, science alone cannot solve conflicts among economic and political interests and the well-being of endangered species, but scientists

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**Table 1. Influence of authorship attributes on features of endangered-species recovery plans.**

<table>
<thead>
<tr>
<th>Authors</th>
<th>Number of authors</th>
<th>Nonfederal participation</th>
<th>Participation by authors with academic affiliation</th>
</tr>
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<tr>
<td>$\chi^2$</td>
<td>$p$</td>
<td>$\chi^2$</td>
<td>$p$</td>
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<tr>
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<td>0.46</td>
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<td>na$^c$</td>
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<tr>
<td>exotic-species tasks</td>
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<td>0.99</td>
<td>1.75</td>
</tr>
<tr>
<td>incentive programs</td>
<td>5.65</td>
<td>0.02</td>
<td>0.32</td>
</tr>
<tr>
<td>Use of biological information in selecting recovery criteria</td>
<td>0.84</td>
<td>0.36</td>
<td>0.06</td>
</tr>
<tr>
<td>Use of biological information in designing monitoring programs</td>
<td></td>
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<td>0.21</td>
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<tr>
<td>demographic monitoring</td>
<td>0.02</td>
<td>0.90</td>
<td>0.90</td>
</tr>
</tbody>
</table>

$^a$Influence of authorship diversity and number of authors was analyzed by logistic regression, with authorship diversity and number of authors as continuous variables. Binary response variables were whether or not types of management tasks were selected, whether or not there was a clear link between recovery criteria and species biology, and whether or not there was a clear link between monitoring strategy and species biology.

$^b$Influence of nonfederal authors and authors with academic affiliation was analyzed by chi-square test. Binary response variable was as in footnote a.

$^c$All recovery plans relied on habitat-management tasks for species recovery, so there were no differences between authorship groups.

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**Figure 1. Influence of biological information on selection of recovery criteria and strategies to monitor recovery. Influence of authorship in plans (a) with strictly federal participation and with nonfederal participation and (b) with and without academic scientists (asterisk indicates $p < 0.05$ in chi-square tests).**
can help define the research and management required to conserve these species. We tested three hypotheses posed by Clark et al. (1994) regarding endangered-species recovery and found that groups of authors with diverse affiliations are likely to strengthen the recovery planning process, that recovery plans lacking nonfederal participation suffer from inadequate attention to species biology, and that academic affiliation is strongly associated with the use of biology in recovery plans (Table 1). Our results suggest that modifying the choice of participants in the recovery planning process may improve the use of biological information in recovery plans and thus influence the eventual success of efforts to recover endangered species.

Our analyses of recovery plans suggest that the problems Clark et al. (1994) observed with implementing endangered species recovery in general also plague the selection of recovery-plan authors. The three hypotheses we tested complement one another. That is, if an author with an academic affiliation contributed to a recovery plan, then the recovery plan was not written exclusively by federal employees, and adding an academic perspective increased the overall diversity of authors contributing to a recovery plan. But the key is not simply to add a nonfederal perspective, but to add an academic scientist. This result was surprising because many federal scientists are well-grounded in current scientific ideas and techniques. It is possible that the academic reward system and peer-review process may allow those in academia to maintain more familiarity with current ideas and techniques, which translates to an improved link between species biology and recovery planning applications. In our view, the cost of including this additional individual in the recovery planning process is low in light of the benefits of increasing the scientific rigor of the recovery plans. Thus, we recommend that academic scientists be included more frequently in the preparation of recovery plans. This suggestion is not to be taken as criticism of past recovery efforts, but merely to indicate what might be done in the future to improve the recovery process.

Similar to previous authors’ conclusions regarding a bias toward animals in recovery plans, we found that recovery plans for animals generally had more contributors and that the groups were more diverse than recovery plans for plants. In addition, our finding that the inclusion of authors with nonfederal affiliation was significantly associated with the use of biological information in recovery plans suggests that animals may be given preferential treatment over plants, given the fact that plans for animals generally had more diverse groups of authors. One reason for this may be that endangered animals create more controversy than endangered plants, causing the USFWS to establish diverse stakeholder recovery teams more frequently for animals.

A few unanticipated results emerged from our analyses. It was surprising to find that, despite recent efforts of the USFWS to include diverse stakeholders in the recovery planning process, we found no apparent change in author diversity over the last two decades. It was also surprising to find that incentive programs were more likely to be included in plans with low authorship diversity and in plans with exclusively federal authors. This suggests that academics may be less familiar with incentive programs than federal scientists and that incentive programs may be preferred when federal scientists are given little outside input.

Our results suggest three practical considerations in formulating groups for recovery planning. First, the USFWS should provide specific guidance on the incorporation of biological information into recovery plans; the relatively low proportion (30–40%) of recovery criteria that are based on very clear use of biological information should be of concern to the USFWS (Fig. 1). Second, more diversity in authorship, particularly the inclusion of academic scientists, might lead to a more explicit use of biological information in recovery plans. Third, because there were few differences in the use of biological information in recovery plans among author groups of different sizes, dollars spent on large recovery-planning groups may be better spent on other recovery efforts, such as increasing the diversity of the groups rather than the size of groups.

Acknowledgments

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