Improving U.S. Endangered Species Act Recovery Plans: Key Findings and Recommendations of the SCB Recovery Plan Project

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Abstract: *To promote more effective recovery planning for species listed under the U.S. Endangered Species Act (ESA), the Society for Conservation Biology sponsored a systematic review of a large sample of ESA recovery plans. The review was conducted in collaboration with the U.S. Fish and Wildlife Service, the National Center for Ecological Analysis and Synthesis, and 19 universities. We describe the genesis of the project and the development of the resulting database of information on ESA recovery plans. The project's primary goals were to characterize the content and attributes of recovery plans; to identify important differences, patterns, and trends among plans; and to use these results to develop recommendations for the U.S. Fish and Wildlife Service for improving recovery plans. We review key findings from published analyses of the project database and offer prioritized recommendations for improving recovery-plan development and implementation. First, the use of science in recovery-plan development and implementation could be improved by making threats a primary focus of plans, specifying adequate monitoring tasks for species status and recovery tasks, and ensuring that species trend data are current, quantitative, and documented. Second, recovery-plan structure and development could be enhanced by keeping authorship teams small yet diverse, making existing administrative designations more biologically relevant, improving and standardizing the revision process, and reevaluating the use of multispecies plans. Third, agency resources and personnel could be better utilized by developing new recovery plan guidelines, assigning personnel explicit responsibility for overseeing plan implementation, expanding personnel training, and tracking expenditures in recovery programs. And fourth, several generic failings in the field of conservation biology could be addressed by reducing taxonomic bias and by collecting and fully integrating key biological information into recovery plans. The recovery-plan project offers a model of how professional societies, universities, and government agencies can work together beneficially to address key issues in conservation biology.*

Mejorando los Planes de Recuperación del Acta de Especies en Peligro de E. U. A.: Hallazgos Clave y Recomendaciones del Proyecto Plan de Recuperación de la SBC

Resumen: *Para promover una planeación más efectiva de la recuperación de especies incluidas en la lista de Especies en Peligro (AEP), la Sociedad de Biología de la Conservación financió una revisión sistemática de una amplia muestra de planes de recuperación de AEP. Esta revisión se llevó a cabo en colaboración con el Servicio de Pesca y Vida Silvestre de E.U.A., el Centro Nacional de Análisis y Síntesis Ecológica y 19 universidades. Describimos la génesis del proyecto y el desarrollo de la base de datos de información de los planes de recuperación de AEP. Las metas primarias del proyecto fueron la caracterización del contenido y atributos de los planes de recuperación; la identificación de diferencias importantes, patrones y tendencias entre*

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Paper submitted August 6, 2001; revised manuscript accepted May 16, 2002.

planes y la utilización de estos resultados para desarrollar recomendaciones al Servicio de Pesca y Vida Silvestre de E.U.A. para mejorar el desarrollo e implementación de planes de recuperación. Revisamos hallazgos clave de análisis publicados de la base de datos del proyecto y ofrecemos recomendaciones priorizadas para mejorar el desarrollo y la implementación de planes de recuperación. Primero, el uso de la ciencia en el desarrollo y la implementación de planes de recuperación podría mejorar si el enfoque primario de los planes son las amenazas; especificando actividades de monitoreo adecuadas para el status de la especie y actividades de recuperación; asegurando que los datos de la tendencia de las especies sean actuales, cuantitativos y documentados. Segundo, la estructura y el desarrollo del plan de recuperación podría reforzarse manteniendo equipos pequeños pero diversos de autores; haciendo designaciones administrativas más relevantes biológicamente; mejorando y estandarizando el proceso de revisión; reevaluando el uso de planes multiespecies. Tercero, los recursos y el personal de las agencias podría ser utilizados mejor con el desarrollo de nuevos lineamientos para planes de recuperación; asignando responsabilidades explícitas al personal para supervisar la implementación de los planes; aumentando la capacitación del personal y dando seguimiento al gasto de los fondos de los planes de recuperación. Y cuarto, se podrían atender varias fallas genéricas en el campo de la biología de la conservación reduciendo el sesgo taxonómico y recolectando e integrando de lleno la información biológica clave en los planes de recuperación. El proyecto de planes de recuperación ofrece un modelo de cómo las asociaciones profesionales, universidades y agencias del gobierno pueden trabajar en conjunto para beneficiar temas clave en la biología de la conservación.

Recovery Plans and the Endangered Species Act

The U.S. Endangered Species Act of 1973 (ESA; U.S. Code 2001*a*) is the most important piece of U.S. legislation providing protection for species at risk of extinction. In addition to protection of listed species, a fundamental goal of the ESA is to "recover" listed species to the point that they are no longer threatened with extinction (National Research Council 1995). The ESA requires that a recovery plan be developed for every listed species, unless such a plan would not help recover the species (U.S. Code 2001*b*). Recovery plans are intended to provide the foundation for efforts to recover species listed under the ESA.

Since December 1988, the ESA has required that all recovery plans include three key elements: a description of specific management actions necessary to achieve recovery, objective criteria by which recovery will be measured, and time and cost estimates for plan implementation (U.S. Code 2001*b*). In addition to these statutory requirements, recovery plans typically include summaries of current knowledge about species' biology and threats. Together, these components make recovery plans a singular resource for information about the threats facing listed species and actions needed for recovery.

Improving the quality and effectiveness of recovery plans is an important goal for the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS), the two agencies responsible for administration of the ESA. Increased attention to the development and implementation of ESA recovery plans should significantly benefit threatened and endangered species. As the central documents guiding management and recovery actions for ESA–listed species, recovery plans can help decision-makers and resource managers promote consistency in decision-making, reduce susceptibility to political pressures, and avoid the appearance of arbitrariness. If implemented well, high-quality recovery plans can help shift the focus of recovery efforts beyond stopgap measures meant to prevent extinction, toward systematic and strategically coordinated actions aimed at alleviating threats and restoring natural ecosystems to a state in which populations are self-sustaining.

Numerous reviews and essays have evaluated ESA recovery plans and offered recommendations for improving the recovery planning process (e.g., U.S. General Accounting Office 1988; Culbert & Blair 1989; Dixon & Cook 1989; Tear et al. 1993; Clark 1994; Schemske et al. 1994; Miller et al. 1994; National Research Council 1995; Tear et al. 1995; Foin et al. 1998). Recovery plans have also been scrutinized in the political arena, where the ESA awaits reauthorization by Congress (the ESA technically expired in 1993 but has been refunded on an annual basis). In recent years, several congressional bills have proposed a substantial restructuring of the ESA that would place increased emphasis on recovery planning by more explicitly defining how and when recovery plans should be written (e.g., U.S. Congress, House of Representatives 1999; U.S. Congress, Senate 1999).

Despite this academic and political attention, no comprehensive, systematic, quantitative analyses of ESA recovery plans themselves have been undertaken. Among the reviews cited above, only a few were based on quantitative analysis of data from recovery plans (e.g., Schemske et al. 1994; Tear et al. 1995; Foin et al. 1998). Some reviews and analyses were based largely on qualitative evaluations and case studies, whereas others focused on improving implementation through restructuring agencies or revision of the ESA itself (e.g., Clark et al. 1994). To effectively make such improvements, existing recov-

ery plans need to be evaluated so that successes can be reinforced and repeated and shortcomings avoided or corrected. How can we hope to improve recovery planning when so little is known quantitatively about the attributes and effectiveness of existing recovery plans? The lack of a detailed quantitative study of recovery plans is itself a serious impediment to improving recovery planning, because plan quality, implementation, and effectiveness are inherently linked.

The Recovery Plan Review Project

Project Genesis, Structure, and Goals

The recovery-plan review project had its genesis in 1998, when P.D. Boersma recognized the need for an in-depth review of recovery plans and enlisted support from the Society for Conservation Biology (SCB), the USFWS, and the National Center for Ecological Analysis and Synthesis (NCEAS) to conduct a systematic and comprehensive review of ESA recovery plans (Boersma 1999). The project's approach to this review was to collect data on a sample of individuals drawn from the "population" of approved recovery plans and to analyze that data to identify general characteristics of the population. The specific goals of the recovery-plan review project were to (1) compile a database on the characteristics and content of a large, representative sample of recovery plans; (2) quantify important patterns, trends, and differences among the plans in the database through the use of statistical analyses; and (3) make recommendations for improving recovery plans. A more comprehensive description of the project's genesis, structure, and development is provided by Hoekstra et al. (2002*a*).

Selecting a Sample

As an initial step, William F. Fagan of Arizona State University, in consultation with USFWS personnel, drew a random post-stratified sample of 181 of the 931 species listed under the ESA that had USFWS–approved recovery plans as of the end of 1998. Although the NMFS also produces ESA recovery plans, the project focused on USFWS recovery plans because the USFWS has jurisdiction over the majority of ESA–listed species. Fagan selected plans that ensured a sufficient number of plans in key groupings as defined by year of plan completion, taxon, single-species versus multi-species plans, and unrevised versus revised plans.

Completion dates of the sample plans ranged from 1977 through 1998. The plans covered 85 plant and 96 animal species. The sample included 100 species from single-species plans and 81 species drawn at random from 29 multispecies plans and 6 ecosystem plans. Lastly, plans for 68 species had been revised, whereas those for 113 species were unrevised. The sample included nearly 20% of all ESA–listed species with approved recovery plans.

Characterizing Recovery Plans

The next major step in the project was development of a data-collection method that would be comprehensive and reliable and would accommodate the wide diversity of recovery-plan structure and content. To standardize responses and minimize subjectivity, G. Orians and students in a graduate seminar at the University of Washington developed a detailed pilot questionnaire requiring project participants to record specific data about each sampled plan. At a December 1998 workshop, university faculty, USFWS biologists and policymakers, and representatives from conservation organizations and industry evaluated the pilot questionnaire. Based on their comments, project leaders revised the questionnaire.

The finalized questionnaire solicited general descriptive information about ESA listing documents and recovery plans, such as plan length, length of time between listing and recovery-plan completion, composition of recovery team, and total number of species covered by the plan. The questionnaire also solicited more-detailed data such as available information on species' biology and natural history, threats to the species, prescribed management actions, monitoring protocols, plan administration and implementation, and criteria against which recovery would be measured.

In all, the questionnaire required project participants to consider more than 2600 specific questions about the attributes and content of each sampled recovery plan. Only information contained in the recovery plan and the original listing document for each species was used to respond to each question. This standardized the scope of the review. To limit subjectivity and facilitate quantitative analysis of the data, responses to each question were coded according to a list of appropriate standardized responses (e.g., yes/no, a set of categorical responses such as taxonomic group, or a series of ordered factors that reflected relative ranking or magnitude such as the intensity of a threat to a species). Some questions required a count or text response. Special response codes were available for questions that were not applicable or answerable for a particular recovery plan. Questions were written to minimize ambiguity, though some subjectivity was unavoidable for queries about qualitative attributes.

To structure the review, project leaders adapted a strategy from a recent analysis of ESA habitat conservation plans which entailed using a consortium of universities to collaborate on collection and analysis of data (Kareiva et al. 1998; Harding et al. 2001; Watchman et al. 2001). While the questionnaire was being developed, Boersma recruited colleagues from 19 private and public

universities across the United States to lead graduate seminars, each of which then completed the questionnaire for 6–10 recovery plans. Seminar participants entered their results into a centralized online database. (The project questionnaire and database are available at http://www.nceas.ucsb.edu/recovery.) More than 325 researchers participated in the project.

Calibrating Data and Quality Control

Before reviewing their subsample of plans, university seminar participants reviewed the recovery plan for the Hawaii tree cotton (*Kokia drynarioides*). This calibrated data collection and helped clarify uncertainties and ambiguities in specific questions. It also provided an index of consistency between seminars. Results of this initial effort suggested that, overall, data collection at different universities was consistent and well calibrated. Responses to 37% of the questions were at least 94% consistent (i.e., no more than one seminar recorded a different response), and responses to 68% of the questions were at least 75% consistent (i.e., no more than four seminars recorded a different response) (Hoekstra et al. 2002*a*). When seminars did respond differently to a question, the magnitude of that "error" was small (Hoekstra et al. 2002*a*).

To be conservative when analyzing data about sampled recovery plans, we excluded questions that yielded highly inconsistent responses. For example, a lengthy series of questions on the expected costs of recovery tasks was discarded because plans were highly variable with respect to presentation of economic projections, making consistent data collection difficult and meaningful comparisons impossible. For a more detailed description and discussion of project methods and data consistency, see Hoekstra et al. (2002*a*).

Analyzing Data and Project Results

At two workshops held in 2000, USFWS personnel and graduate students and faculty from the university seminars collaborated on data analysis. Workshop participants were initially organized into small working groups charged with examining general issues such as plan content and structure, monitoring provisions, and prescribed management actions. Subsequent to these initial analyses, participants reorganized themselves into working groups that examined specific aspects of recovery plans in more detail (e.g., plan implementation, internal plan consistency, plan authorship).

To date, project participants using the project database have published over 15 peer-reviewed papers. Individually, these papers provide important insights into particular aspects of recovery plans. This paper, however, provides an accessible synthesis of all project analyses for those interested in the development and implementation of ESA recovery plans. We review project results, briefly summarizing and prioritizing key findings and recommendations.

Findings and Recommendations

Analyses by project participants affirmed that the USFWS has improved on many aspects of the recovery planning process. Over time, for example, more recovery plans included population viability analysis (Morris et al. 2002), used quantitative data (Gerber & Hatch 2002), included updated information during plan revision (Harvey et al. 2002), and enhanced the diversity of authorship (Gerber & Schultz 2001). Another commendable aspect of recovery planning was a general consistency in identification of threats between the listing document for a species and the threats described in the recovery plan (Lundquist et al. 2002). But to focus attention on ways in which the recovery planning process could be improved further, the research, findings, and recommendations associated with this project emphasized deficiencies.

Most efforts to improve recovery plans will likely require some level of additional resources, but a gap exists between available resources and the needs of recovery-plan programs (Miller et al. 2002). We recognize it is unlikely that USFWS resources for recovery-plan development and implementation will increase significantly in the near future. With this in mind, we emphasize those findings and recommendations that we believe could improve the recovery planning process with the least effort and cost. We clustered and ordered our recommendations into four groups, ranked according to our projections of the relative immediacy of expected benefits and the practicality of actual implementation: (1) improving the use of science in recovery-plan development and implementation, (2) improving plan structure and development, (3) making better use of agency resources and personnel, and (4) addressing generic failings in conservation biology. Addressing the problems identified in the first group could provide the most immediate benefits, whereas those in the last group are likely the least tractable.

Improving the Use of Science

Explicit use of quality science in recovery planning should help insulate the USFWS from external and internal criticism, improve plan quality and implementation, and benefit listed species (Boersma et al. 2001). Although some recommendations require collecting additional or more timely data (e.g., monitoring the current status of species), project participants identified many areas in which better use of available biological data and other information could improve recovery plans with

little expenditure of limited agency resources. Our recommendations in the section below focus on improving the application of available science in drafting, implementing, and evaluating recovery plans. In particular, the USFWS should (1) make threats a primary focus, (2) specify adequate monitoring tasks for species status and recovery tasks, and (3) ensure that data on species status are current, quantitative, and documented.

MAKE THREATS A PRIMARY FOCUS

Threats have received insufficient attention in recovery plans. Recovery plans identified threats to listed species but generally did a poor job of addressing how they might be alleviated or mitigated (Lawler et al. 2002; Schultz & Gerber 2002). Basic information on the specific nature of threats was often lacking (Lawler et al. 2002), making the critical job of prioritizing recovery tasks difficult. Tasks that directly addressed threats were often lacking (Schultz & Gerber 2002). Specifically, 37% of all threats identified in recovery plans did not have recovery tasks identifiably associated with them (Lawler et al. 2002). Furthermore, threats rarely appeared to influence monitoring prescriptions or implementation of recovery tasks (Brigham et al. 2002; Campbell et al. 2002). Decisions about which species to include in multi-species recovery plans were not apparently influenced by threats; species in multi-species plans were no more likely to face similar threats than species in individual recovery plans (Clark & Harvey 2002).

We recommend that the USFWS organize and prioritize recovery tasks according to the expected effect on threats facing the species. Similarly, lumping species together in multi-species plans may be better justified on the basis of the similarity of threats than on that of taxonomic relatedness or geographic proximity (Clark & Harvey 2002). More explicit attention to the amelioration of threats in recovery plans would likely improve the success of recovery efforts.

SPECIFY MONITORING TASKS FOR SPECIES STATUS AND RECOVERY TASKS

Monitoring in recovery plans was seriously inadequate. For example, information critical to effective monitoring was often missing entirely (Campbell et al. 2002). Many plans lacked provisions for monitoring key aspects of recovery planning, such as species status, threats, and implementation of recovery tasks (Campbell et al. 2002). On average, only 55% of management actions (e.g., captive breeding, habitat restoration) had monitoring associated with them (Boersma et al. 2001). In addition, many plans requested no information that would allow determination of whether recovery tasks were effective when implemented. Inadequate monitoring is a problem in other endangered-species management programs as well (e.g., Kareiva et al. 1998; Harding et al. 2001). Without adequate monitoring, one can neither judge success nor learn from failure. Provisions for effective monitoring must be a priority in every recovery plan.

ENSURE THAT SPECIES STATUS–TREND DATA ARE CURRENT, QUANTITATIVE, AND DOCUMENTED

The ultimate measure of recovery-plan effectiveness is recovery itself. But because recovery may take decades and threats to many species are increasing, too few species have recovered enough to date for agency decisions to be used to delist or downlist species as a measure of effectiveness. This does not mean that the ESA is ineffective. Despite the small number of officially recovered species, the ESA may have effectively prevented as many as 192 extinctions (Schwartz 1999). Nonetheless, it is important to assess plan effectiveness. A logical alternative is to document changes in the status of listed species over time. Effective recovery plans should lead to improvements in species' status.

The ESA requires the USFWS to report such estimates of "status trends" for species with recovery plans to Congress every 2 years. Status trends are categorized as improving, stable, declining, extinct, or unknown, and they take both population size and threats into consideration. The quality of these data is inconsistent and of questionable accuracy, however, because trends for some species are simply the best guesses of USFWS personnel (Boersma et al. 2001). Furthermore, submission of this information to Congress has been plagued by substantial delays that potentially outdate the data. The most recent report to Congress was issued in 1999 but was current only through 1996 (USFWS 1999). More recent status-trend data for the 1998 and 2000 reports have been collected by the USFWS but are not presently publicly available (D. Crouse, personal communication).

Despite these problems, the USFWS data on status trend remain the most accessible measure of plan effectiveness and were thus used in several project analyses reviewed below. To ensure that these important data are accurate, documented, and timely, the USFWS needs to improve procedures for collecting and reporting status trends. We recognize that sufficient agency resources may not be available to conduct regular status reviews of all U.S.–listed species, but we strongly believe that these data are essential for effective recovery efforts. One way additional data might be collected is for scientists from academia, nongovernmental organizations, and other government agencies to partner with the USFWS to gather needed data on an ongoing basis. As a foundation for its recovery efforts, the USFWS should maintain a current, publicly available database of high-quality estimates of status trend. This would allow for more timely and refined assessments of recovery efforts.

Improving Plan Structure and Development

Recovery plans need to be dynamic and action-oriented documents rather than edicts eternally etched in stone. Longer plans are not necessarily better, take longer to write, and may be more difficult to revise (Boersma et al. 2001). Shorter, more focused, adaptable plans with concrete recovery tasks and goals should yield tangible benefits to recovery efforts. We believe that the development and revision of recovery plans need to be more dynamic. Recovery-plan development should focus more on continuously generating thoughtful advice to guide near-term decisions than on producing weighty but static plans that may become increasingly irrelevant over time. Administrative actions the USFWS could take to improve the development and implementation of recovery plans include (1) keeping authorship teams small yet diverse, (2) making existing administrative designations more biologically relevant, (3) improving and standardizing the revision process, and (4) reevaluating the use of multi-species plans.

KEEP AUTHORSHIP TEAMS SMALL YET DIVERSE

Increased diversity of plan authorship improved plan quality and implementation. Species in recovery plans with nonfederal authors were more likely to exhibit improving status trends (Boersma et al. 2001). Increased implementation of recovery tasks was positively associated with recovery teams comprised of more state and local government and nonagency representatives (Hatch et al. 2002). But decreased implementation was associated with increasing numbers of representatives from federal agencies and environmental organizations (Hatch et al. 2002). Simply increasing the number of authors without enhancing diversity did not correlate with better plans or improved status trends for listed species (Gerber & Schultz 2001). Having a single author may be administratively efficient, but project analyses suggest that diverse authorship teams benefit recovery efforts by better representing important stakeholders in plan development and perhaps by engendering broader stakeholder support for plan implementation.

Recognizing the importance of diversity in recovery planning, the USFWS published a joint policy with the NMFS in 1994 to formally encourage such diversity (USFWS & NMFS 1994). This policy is too recent to be evaluated, but project analyses suggest that implementation of this policy should have a positive effect. We encourage the USFWS to continue its efforts to diversify participation in the recovery-planning process while balancing the competing need to keep authorship teams manageably small.

MAKE EXISTING ADMINISTRATIVE DESIGNATIONS MORE BIOLOGICALLY RELEVANT

Key administrative designations such as designation of conflicts between species conservation and human activities, recovery-priority rankings, and critical habitat designations have the potential to greatly benefit recovery efforts. For species with conflict designations, more recovery tasks were implemented (Lundquist et al. 2002), but potential benefits were not always realized. Official USFWS recovery-priority rankings did not influence the likelihood of plan revision (Harvey et al. 2002). In addition, higher recovery-priority rankings were not correlated with more implementation and monitoring of recovery tasks (Campbell et al. 2002; Lundquist et al. 2002). If recovery-priority assignments are to have practical meaning, they need to be incorporated into both the development and implementation of recovery plans.

Designation of critical habitat did not correlate with increased availability of information about species' habitat requirements, more frequent prescriptions for habitat acquisition or requirements, or increased inclusion of habitat-based recovery criteria in recovery plans (Hoekstra et al. 2002*b*). Expanding the analyses of Hoekstra et al. (2002*b*) and using the same methods, we found that the status trends of species with designated critical habitat were not significantly different from those for species with no such designation ($G = 1.34$, $p = 0.51$) (Fig. 1). Failure to detect a significant effect of critical-habitat designations could simply be a statistical artifact of limited sample size. The absence of a substantial and unambiguously positive effect suggests, however, that the influence of critical habitat on status trends is limited at best. This finding bolsters the conclusions of Hoekstra et al. (2002*b*), who suggest that critical habitat designations do not influence recovery plans. Given that

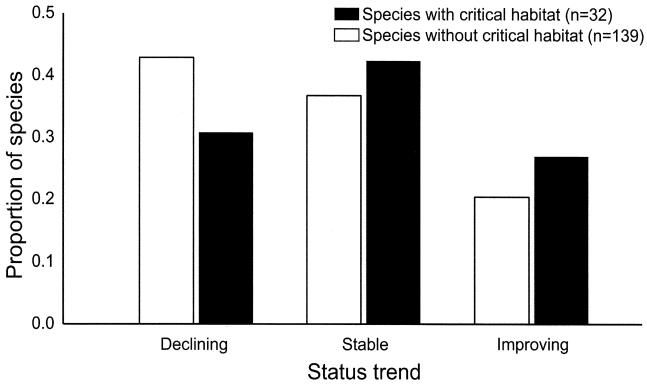

*Figure 1. Comparison of status trends for species with and without designated critical habitat. A somewhat smaller proportion of species with critical habitat exhibited declining status trends, and slightly larger proportions exhibited stable or improving status trends. Differences were not statistically significant (*G *= 1.34,* p *= 0.51), however, suggesting that critical habitat designations have not substantially increased the likelihood that species will exhibit improving status trends.*

the process of designating critical habitat can delay recovery-plan development or implementation, such results are cause for concern.

The ESA requires the USFWS to designate recovery priorities for all species (including conflict designations) and critical habitat for most listed species. Therefore, we expected recovery plans to have taken better advantage of the additional information and regulatory protections provided by these designations whenever they precede recovery plan development. The USFWS should make a greater effort in recovery planning to capitalize on existing administrative designations to more clearly define and better justify management actions, monitoring programs, and recovery goals.

IMPROVE AND STANDARDIZE REVISION PROCESS

The optimal time to incorporate new information and employ adaptive management is during plan revision, but recovery-plan revisions failed to take advantage of this opportunity. Revised recovery plans included more information on species biology, status, and threats but did not clearly link that information to management actions, monitoring protocols, or recovery criteria (Harvey et al. 2002). More recovery tasks from revised plans were implemented (Lundquist et al. 2002), but species whose plans had been revised were no more likely to exhibit improving status trends than if their recovery plan remained unrevised (Boersma et al. 2001). Although new information is regularly incorporated during plan revision, the USFWS needs to pay additional attention to how that information is integrated into other elements of recovery plans to improve plan quality and effectiveness.

REEVALUATE USE OF MULTISPECIES PLANS

By nearly all measures, single-species plans provided a better foundation for recovery efforts than multispecies plans. Among earlier plans, species included in multispecies plans were four times less likely to exhibit improving status trends (Boersma et al. 2001). This finding is particularly disturbing given that, through 1998, over 55% of all species with recovery plans were covered by multispecies plans (Clark & Harvey 2002). Multispecies plans had fewer recovery tasks implemented (Lundquist et al. 2002) and less diverse authorship (Gerber & Schultz 2001). Multispecies plans were also less likely to include species-specific biological information or adaptive-management provisions or to be revised (Clark & Harvey 2002). The lumping of species into multi-species plans did not appear to be based on biologically logical criteria (i.e., similarity of threats; Clark & Harvey 2002). Given that the majority of species with recovery plans are now addressed in multispecies plans and that these plans appear to be less effective, the USFWS needs to carefully reevaluate its use of multi-species plans to ensure that species recovery is not compromised in the interest of administrative expediency.

Making Better Use of Agency Resources and Personnel

In addition to undertaking administrative actions to improve recovery-plan quality and effectiveness, the USFWS could also take administrative actions to improve the institutional framework for the recovery-planning process which might offer substantial benefits with relatively small investment of agency resources. Specifically, we recommend that the USFWS (1) develop new recovery-plan guidelines, (2) assign personnel explicit responsibility for overseeing plan implementation, (3) expand personnel training, and (4) track how funds are spent in recovery programs.

DEVELOP NEW RECOVERY-PLAN GUIDELINES

The USFWS should require additional training in the art of writing a high-quality recovery plan. Many recovery plans were well written, but many were not. Some plans were internally and externally inconsistent, and a few older plans appeared to be copied directly from other plans with insufficient thought for the individual species covered (Dixon & Cook 1989; Campbell et al. 2002). A natural tension exists between the time and expense required to craft individualized plans and the need to produce plans in a timely and cost-effective manner. Appendix 1 of the USFWS 1990 Recovery Plan Guidelines provides a basic format for recovery plans. But after reviewing these guidelines, we believe that additional guidance is needed.

Plans written solely in accordance with prefabricated forms will not substantially improve recovery outcomes, but providing a more detailed and annotated template could reduce the amount of time spent reinventing the wheel. To avoid uninformative, duplicative plans, templates should dictate format and organization rather than specific text. The internal consistency of plans also could be improved through checklists of questions. For example, does each threat have an assigned recovery task? Does that task have monitoring associated with it? If the threat cannot be addressed, what is the reason? The USFWS needs to provide more guidance on the mechanics of drafting optimal recovery plans.

MAKE PERSONNEL EXPLICITLY RESPONSIBILE FOR IMPROVING PLAN IMPLEMENTATION

When agency personnel focused attention on recovery plans, implementation improved. More recovery tasks were implemented when plans established a centralized database, designated a committee to coordinate implementation, or established a system to monitor imple-

mentation (Hatch et al. 2002). Although increasing authorship diversity may improve implementation, the fewer parties actually responsible for implementation of recovery tasks, the more effective the implementation (Hatch et al. 2002). Increased implementation of recovery tasks was correlated with use of single-species plans, critical habitat and conflict designations, plan revision, and presence of a recovery coordinator and database (Lundquist et al. 2002). For every recovery plan, the USFWS should develop an implementation monitoring system, establish a centralized database for information on species' status, and designate a small, diverse committee to coordinate implementation.

EXPAND PERSONNEL TRAINING

Modern tools of conservation biology were underused in recovery plans. Many of these tools were developed recently, usually by biologists outside the USFWS. Effective recovery efforts will likely to need to employ these tools. For example, the National Research Council (NRC 1995) recommended that implementation of the ESA involve more use of such tools as population viability analysis (PVA). Although use of PVA by the USFWS has increased in recent years, <15% of the plans in our sample presented information on PVA (Morris et al. 2002). Even when plans discussed PVA, the information required to undertake a PVA was usually unavailable and requests to fill in these information gaps were inadequate (Morris et al. 2002). The USFWS should provide regular training in current conservation biology practices to all personnel charged with writing and implementing recovery plans.

TRACK EXPENDITURES OF RECOVERY PROGRAMS

Funding is critical to successful implementation of nearly all conservation programs. But only a few studies have attempted to analyze the role of funding in endangered species recovery (e.g., Wilcove & Chen 1998; Baker 1999; Restani & Marzluff 2001; Miller et al. 2002). Miller et al. (2002) observed a relationship between increased recovery funding and improved status trends. Given the importance of funding to recovery efforts, project participants had hoped to explore patterns of funding associated with recovery plans and to link these patterns to the quality or success of plans. Unfortunately, budgets and cost estimates were too variable in format and completeness to be included reliably in analyses of the project database (Boersma et al. 2001; Hoekstra et al. 2002*a*). We believe it is axiomatic that, without sufficient resources, neither recovery-plan development nor implementation can be successful. Unfortunately, this critical element of recovery planning is almost impossible to document at a plan level. The USFWS needs to develop a consistent and accurate method of tracking the amount of resources invested in recovery of individual species and the effectiveness of those investments. Such data could then be used to improve accountability and funding allocation decisions.

Addressing Failings of Conservation Biology

Some of the problems identified with recovery plans may reflect problems of the relatively young and rapidly developing discipline of conservation biology. Thus, these challenges must be confronted broadly in the field of conservation biology, especially by our graduate and post-graduate training in conservation, at the same time these issues are addressed by agencies responsible for recovery plans. Two notable examples are taxonomic bias and inability to effectively link biology, ecology, and management. First, the taxonomic bias that plagues recovery plans is also evident in the pages of conservation journals, where vertebrates and charismatic species receive a disproportionate amount of attention (Clark & May 2002). Second, few scientists are skilled at linking basic biology or ecological theory to management options (Floyd 2001). We need to train the next generation of conservation biologists to be more effective at melding ecology with management. Meanwhile, the USFWS could make more concentrated efforts to (1) reduce taxonomic bias and (2) collect and fully integrate key biological information.

REDUCE TAXONOMIC BIAS

Taxonomic bias was pervasive in recovery plans. In general, vertebrate species received more attention in recovery-plan development and implementation than other animals or plants. Taxonomic bias was documented in implementation of recovery tasks (Lundquist et al. 2002), plan revision (Harvey et al. 2002), monitoring (Campbell et al. 2002), plan authorship (Gerber & Schultz 2001), designation of critical habitat (Hoekstra et al. 2002*b*), collection of biological information (Schultz & Gerber 2002), tasks to address threats (Schultz & Gerber 2002), and selection of plan type (e.g., single-species plans) (Clark & Harvey 2002). Such taxonomic bias appears to be at odds with the goals of the ESA and may reduce the likelihood of recovery for many species. Although legal constraints (e.g., Congressional earmarking of USFWS funds for select species, the language of the ESA itself which gives greater protection to animals than plants) may result in some unavoidable taxonomic bias, the USFWS needs to explore ways to be more even-handed in developing and implementing recovery plans.

COLLECT AND FULLY INTEGRATE KEY BIOLOGICAL INFORMATION

Biological information in recovery plans was insufficiently used, and key information was often missing. Plans often failed to link species biology with other im-

portant features of recovery plans (Brigham et al. 2002; Schultz & Gerber 2002), such as quantitative recovery criteria (Gerber & Hatch 2002). This is particularly important because species whose recovery goals were well linked to biology appeared more likely to be improving in status (Boersma et al. 2001; Gerber & Hatch 2002). In developing recovery plans, the USFWS needs to more clearly acknowledge when critical biological information is missing and then prescribe mechanisms and incentives to ensure that this information is collected and integrated into plans. This will facilitate better linkage between biological information and recovery tasks, monitoring, and implementation.

Collateral Benefits of the Project

In addition to the benefits the project provided to ESA recovery planning, it also produced a number of collateral benefits. Student participants gained experience working on a large-scale, collaborative research effort and with large datasets. The project encouraged cooperation between universities and a governmental agency toward a practical goal (Boersma & DeWeerdt 2001). Participants developed familiarity with the recovery-planning process and an appreciation for the challenges regulatory agencies face in developing and implementing effective recovery plans. In addition, the USFWS acquired an extensive programmatic review at relatively low cost. The project was not problem-free, but our experiences could inform future efforts. This project could serve as a model for additional studies in which the expertise and membership of professional societies and universities are recruited to address other issues in conservation biology.

Project participants focused on ESA listing and recovery-plan documents, understanding that these documents are only part of the recovery-planning process. We appreciate that the most important aspects of recovery are not the documents per se, but rather the commitment and efforts of the people involved in their implementation and on-the-ground recovery. We hope that the findings and recommendations from this project will benefit those efforts.

Acknowledgments

We thank M. Bean, D. Crouse, F. James, K. Kohm, R. Lohoefener, M. Miller, and an anonymous reviewer, who provided insightful comments that greatly improved the paper. D. Boersma's efforts were supported, in part, by the Pew Fellows Program in Marine Conservation, an initiative of The Pew Charitable Trusts in partnership with the New England Aquarium. The recovery-plan project was funded by the Society for Conservation Biology, the U.S. Fish and Wildlife Service, and the National Center for Ecological Analysis and Synthesis, a center funded by the National Science Foundation (grant DEB 94–21535), the University of California–Santa Barbara, the California Resources Agency, and the California Environmental Protection Agency. The project director was D. Boersma. J. Bradley, D. Crouse, W. Fagan, J. Hoekstra, P. Kareiva, J. Miller, G. Orians, and J. Regetz all helped with parts of the project. A complete list of the more than 325 seminar and workshop participants is available at http://www.nceas.ucsb.edu/recovery/acknowledgments.html.

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