The use of biological information in endangered species

Laura C. Hood & Andra S. Ewton

Abstract

Habitat conservation plans (HCPs) under the Endangered Species Act (ESA) can be powerful tools for incorporating protection for wildlife in urban and suburban land-use planning. Urban areas and cities have developed HCPs so that growth can occur while adverse impacts to endangered species and other wildlife are mitigated, often through preservation of important habitat.

Two large studies have been conducted to examine the use of science in HCPs. In the first study, Defenders of Wildlife examined 24 plans in detail to learn about the best and worst aspects of HCPs to date. In the second study, the senior author participated in a 1-year project sponsored by the National Center for Ecological Analysis and Synthesis (NCEAS) and the American Institute of Biological Sciences (AIBS), in which scientists across the country developed a detailed database about each of 43 selected HCPs.

The 2 studies reveal major problems with the information underlying HCPs, and the lack of a precautionary approach to protecting wildlife as development occurs. The quality of data underlying the choice of mitigation strategies indicated that the selection of mitigation techniques is often little better than a guess. Overall, for each step of HCP development (status, take, impact, mitigation, and monitoring), the quality of data and analyses were assessed, and in 33 - 49% of cases, the data and analyses were inadequate for making good decisions in HCPs. More troubling, inadequate information was not addressed by taking more precautions. Plans with inadequate data were not more likely to have adaptive management provisions, and only 22 of 43 plans had a clear biological monitoring program. In 23% of cases, take precedes mitigation, despite the uncertainty associated with mitigation effectiveness.

Regional HCPs involving county and city governments can, in theory, overcome inadequacies described here because local and state governments can provide funding (in addition to federal agencies), and planning can occur at an ecosystem level, avoiding piecemeal habitat destruction associated with individual projects. Pima County in Arizona is engaged in the preliminary stages of a promising multiple-species HCP process, spurred by obligations for protecting the endangered cactus ferruginous pygmy-owl (*Glaucidium brasilianum cactorum*). The high degree of uncertainty about pygmy-owl ecology combined with the extremely small size of the Arizona pygmy-owl's population makes it imperative to apply precautionary measures in this planning process, including immediate habitat protection.

INTRODUCTION

The Endangered Species Act (ESA) prohibits the "taking" of endangered species. The term "take" is broadly defined to include killing, harassing, or harming individuals. Individual landowners or local governments can receive a permit from the U.S. Fish and Wildlife Service (USFWS) to destroy endangered species' habitat (an incidental take permit), provided that they develop and implement a Habitat Conservation Plan (HCP) that minimizes and mitigates the impact to the species. Typically, the mitigation requires the landowner to set aside (often through purchase) habitat elsewhere to replace habitat lost through development. Any nonfederal landowner, whether a private citizen, corporation, county, or state can develop an HCP.

Only 12 HCPs were approved between 1982 and 1992. Since 1992, however, there has been an explosion of such approvals – as of 25 March 1999, 251

Authors' address: Defenders of Wildlife, 1101 14th St. NW, Suite 1400, Washington DC 20005

HCPs were approved covering over 4.4 million ha, with over 200 additional plans in development. HCPs can last from 1 to 100 years, and the area of individual HCPs varies from less than a hectare to 2 million hectares. In sum, HCPs have become the most prominent mechanism to address threatened and endangered species on nonfederal lands. As the HCP program has grown, so has controversy about whether these plans result in further imperilment of already endangered species (Hall 1997; Kaiser 1997; Shilling 1997; Hood 1998). Conservationists have particularly criticized the "No Surprises" policy, which was adopted in 1994 and became a regulation in 1998. This rule states that landowners will not be required to provide additional land or money beyond measures delineated in the HCP, even if the original HCP results in unintended detrimental consequences for imperiled species. Some conservationists have requested a moratorium on all HCP approvals until key reforms are made, and others are pursuing litigation to challenge the "No Surprises" rule.

Metropolitan areas and counties that harbor endangered species can plan to protect those species into the future through scientifically-based HCPs. Many cities are growing rapidly and expanding into natural and agricultural landscapes that harbor endangered species. Consequently, many cities have developed HCPs so that growth can occur while adverse impacts to endangered species and other wildlife are mitigated, often through preservation of important habitat. Through zoning ordinances, development fees, and voter-approved bonds, urban HCPs can be powerful tools for protecting sensitive areas and generating funds for land acquisition and plan implementation, provided that scientific information is available and precautionary approaches are used. Cities such as San Diego CA, Sacramento CA, Las Vegas NV, and Austin TX have developed these conservation plans, with varying degrees of success (Hood 1998).

Nevertheless, a tremendous amount of biological information is necessary for an adequately informed HCP, and these data requirements are multiplied in large-scale, urban HCPs involving multiple species. Planners need data for each step of the HCP process, including data on the ecology and status of the species involved, the size and trend of the population on the property for determining how much take is likely to occur, the likely impact of the project on the species as a whole, and the likelihood of success of mitigation and management techniques that will offset those impacts. Scientists have criticized some HCPs because scientific information was unavailable or misused (Bingham and Noon 1997, Buchanan et al. 1997; Shilling 1997; Hood 1998; Kareiva et al. 1999). In this paper, we examine to what extent important data are available for HCPs, and what steps can be taken to protect species better when little information is available. We underscore that municipalities and urbanizing counties are particularly able to incorporate more research and precautionary measures into regional plans for imperiled species. Finally, we describe the need for precautionary measures, including preliminary land acquisition and protection, to conserve endangered species in one Arizona County's regional planning effort, which is currently in the initial stages.

METHODS

Defenders of Wildlife Study

In the first study, we examined 24 plans in detail to learn about the best and worst aspects of HCPs to date (Hood 1998). We selected the 24 plans so that they represented the diversity of HCPs in terms of size, geographic location, and taxa addressed. For 4 major aspects of HCPs, scientific, legal, funding, and public participation, we identified the best and worst examples of HCPs to illustrate how they can be improved in the future.

Analyzing each plan involved several steps. First, we read the plan and associated documents such as environmental impact statements, the federal agency's biological opinion and management/monitoring plans. We then talked to various people involved in each plan from federal officials to local biologists and conservationists. If there was an updated (i.e., within the last 10 years) recovery plan for species associated with the conservation plan, we obtained the recovery plan and analyzed the relationship between the recovery and conservation plans. Through these techniques, we assessed each element of each plan and compared plans to each other. In this way, we were able to find general trends, as well as to identify good and bad examples of specific aspects of conservation plans.

NCEAS/AIBS Study

In addition to the research by Defenders of Wildlife, a group organized by Dr. Peter Kareiva, University of Washington, and sponsored by the National Center for Ecological Analysis and Synthesis (NCEAS) and the American Institute of Biological Sciences (AIBS), completed a 1-year project to evaluate the extent to which scientific data and methods were used in developing HCPs (Kareiva et al. 1999). Although HCPs are often heavily driven by economic and political decisions, the group did not attempt to analyze those dimensions of HCPs. Rather, the group focused on the scientific information available to inform plan decisions and the manner in which that information was used. The group analyzed 43 HCPs in detail. As with the

Defenders of Wildlife study, the sample of HCPs was selected to represent the range of size, duration, geographical locations, and plan types typical of all approved HCPs. The group also analyzed general characteristics of the vast majority of approved HCPs (sample size = 208).

For each of the 43 HCPs, researchers performed a literature review of academic and "gray literature" (often reports prepared by government agencies) for information on the imperiled species involved in each plan, including all sources cited in the HCP. Information about the context and chronological development for each HCP was gathered in interviews with FWS biologists, consultants who worked on developing plans, and various landowners. The goal was not to judge the overall quality of the plans, but rather to illuminate what types of data are available and how they are used in making the decisions that formulate HCPs.

Detailed data was taken in a standardized fashion to ensure consistency and to facilitate data analysis by using 2 questionnaires: 1 focused on attributes of the plans themselves, and the other focused on biological information about the species involved in these plans (sometimes students evaluated > 1 threatened or endangered species per plan). The questionnaires were thorough, including 176 questions per plan studied and 789 questions per species in each plan. This paper, therefore, is based upon 3 samples of HCPs: a 208-plan sample used for characterizing HCPs, a 43-plan sample of detailed information, and a 24-plan sample used in the Defenders of Wildlife study for selecting illustrative examples. Through the combination of detailed quantitative approach in this study (Kareiva et al. 1999) and the broader policy approach in the Defenders of Wildlife report (Hood 1998), a clear picture emerges about trends in HCPs and how they can be improved, particularly for urban areas.

RESULTS

Trends in HCPs

The most visible HCPs are the large plans covering hundreds of square kilometers, but, from the sample of 208 HCPs, there was no trend in size of HCPs over time. The increasing number of landscape-level plans was offset by the similarly increasing number of small-scale plans for individual projects. Of the 244 HCPs that were approved by the end of 1998, 17 were large-scale plans that addressed urbanization and development in an urban/suburban area (Table 1). These plans were large-scale and long-term usually designed to plan urban growth while setting aside habitat for multiple endangered species. Indeed, 10 of the 17 plans addressed multiple endangered species. Of the 15 that were not short-term, interim plans; the average duration was 30.1 years. The median area covered by 13 of these plans (excluding 2 which involved linear kilometers of beach) was 28,340 ha, and the mean HCP area was 76,513 ha. All 15 of the plans primarily involved permits for activities that result in permanent damage to wildlife habitat (e.g., housing development).

Science in HCPs

Detailed analysis of individual plans has revealed significant gaps in scientific information needed for well-informed HCPs. Much of the missing information concerns the status of the species addressed. For two-thirds of the species examined, there were not enough data to determine what proportion of the population would be affected by the proposed development. This is particularly troubling considering that 75% of the species addressed in the sample of 43 plans were declining in population when the take permits were authorized, and only 5% were increasing in population. For take likely to result from the proposed development, in 49.3% of cases, no data in the HCP or associated documents addressed the level of take in terms of the estimated number of individuals displaced or killed. In some of those cases, however, take was measured in terms of amount of habitat disturbed. When the HCP documents included an estimate of the proportion of the species' population to be taken under the plan, usually the expected level of take was either a small percentage (1% or less) or all (100%) of the population on the HCP land (Figure 1).

HCPs often involve mitigation strategies that have little data to indicate their probability of success (Bingham and Noon 1997; Buchanan et al. 1997). On a 4-point scale from 0 to 3 (3 being proven to work), the quality of data underlying the choice of mitigation strategies was usually between 1 (very little, or quite unreliable) and 2 (moderately well-understood and reliable). This indicates that the selection of mitigation techniques is often little better than a guess (Figure 2). Overall, for each step of HCP development, the quality of data and analysis were assessed, and often these data and analyses were inadequate for making well-justified decisions in HCPs (Figure 3).

The lack of available information on species and mitigation techniques, however, does not necessarily preclude the development of HCPs that are more scientifically based. Habitat conservation planners can incorporate many precautionary measures to reduce uncertainty for species. For example, having mitigation precede take would reduce risk for species, yet in 23% of cases take actually preceded mitigation. In another example, adaptive management (steps to change management over time based upon new information or changed conditions) should be more common for HCPs with more uncertainty and less information. Unfortunately, for the 43 HCPs studied, 45% of the cases with insufficient data included a discussion of adaptive management, whereas 77% of the cases with adequate data did so ($\hat{e}^2 = 9.5$, $P < 0.05$). Adaptive management itself, however, must be based upon biological monitoring that gives some indication of when management strategies should be changed. However, only 22 of 43 plans had clear monitoring programs associated with them.

One potentially effective way to increase the amount and reliability of scientific information is to incorporate independent scientists into the HCP process, especially through formal peer review. From the Defenders of Wildlife study's sample of 24 plans, only 2 involved an independent scientific review panel. One of them (for large plans in southern California) involved providing conservation guidelines before the planning began, and the other involved a scientific review of information for the first HCP for San Bruno Mountain (Bean et al. 1991).

DISCUSSION AND RECOMMENDATIONS

The lack of information on various crucial aspects of HCPs, including the species' ecology, the impact of the HCPs take allowance on the population, and the effectiveness of proposed mitigation measures introduces substantial uncertainty in predicting effects on endangered species. Private landowners are shielded from this uncertainty because they are assured (through the "No Surprises" regulation) that they will not be responsible for paying for changes to HCPs if the plans have unintended detrimental consequences.

While uncertainty is minimized for landowners, HCPs need to include more precautionary measures to reduce risk and uncertainty for endangered species (Noss et al. 1997). Unfortunately, our results show that such precautionary measures, including adaptive management, biological monitoring, and conservation strategies that protect habitat before take occurs, are often absent. This absence of precautionary measures is more troubling when we consider that many HCPs are missing critical biological information.

In addition to precautionary strategies, other measures would improve considerably the effectiveness of HCPs in protecting endangered species. In particular, HCPs should be consistent with recovery of species. The involvement of independent scientists with training and experience in wildlife conservation (including peer review) should be encouraged more often, in order to improve the quality of information for HCP decision-making. In addition, habitat conservation planning at a large scale can reduce the habitat fragmentation and lack of monitoring associated with multiple small HCPs for individual projects.

Urban/Suburban HCPs

Although HCPs often have insufficient data and analysis upon which to base conservation strategies, incorporating precautionary principles and requiring that HCPs be consistent with recovery can reduce uncertainty for species. The improvements that are necessary for HCPs can most easily be achieved at a regional scale. In theory, regional, urban/suburban HCPs involving county and city governments are particularly promising because the cost of protecting and managing land can be distributed equitably, local governments can provide funding (in addition to federal agencies), and counties and municipalities often can impose zoning and planning ordinances to implement the HCP. Perhaps most importantly, planning can occur at a landscape level, avoiding piecemeal habitat destruction associated with individual projects (Noss et al. 1997).

Sonoran Desert Conservation Plan, Tucson, Arizona

Pima County, Arizona is engaged in the preliminary stages of a regional, multiple-species HCP process, combined with a Sonoran Desert Conservation Plan (SDCP) for protecting sensitive habitat as well as other open space. These planning efforts (SDCP/HCP) were spurred by obligations for protecting the endangered cactus ferruginous pygmy-owl (*Glaucidium brasilianum cactorum*), but the final HCP is likely to involve incidental take permits for other federally listed species. The bird's population in Arizona is extremely small (78 individuals as of spring 1999), and the majority of individuals live in desertscrub habitat in a rapidly developing area to the northwest of Tucson. The multiple-species HCP will benefit from habitat acquisition and protection from the SDCP. The plan proposes to protect riparian areas, ecological corridors, and sensitive habitat. Under this planning effort, Pima County has also been attempting to secure funds for pygmy-owl research and for a biological assessment of pygmy-owl habitat and potential natural reserve areas.

Thus far, funding has only been available to conduct research on the pygmy-owl, including its habitat requirements, movement patterns, genetics, and population surveying. This research is only the first step in what will be a much larger effort to gather the necessary data for decision-making for the regional multiple-species HCP. A technical advisory committee has been formed to guide the collection and use of scientific information throughout the process, and this group will be essential to ensuring that the highest quality information is incorporated into the plan. The technical issues are immense, including: (1) assessing the biological resources and subsequently identifying target species and communities for planning; (2) assessing the major threats to the viability of communities and species of concern; (3) classifying vegetation types and assembling GIS maps; (4) prioritizing areas for protection to maximize achievement of conservation goals; (5) designing monitoring, research, and adaptive management programs during implementation of the plan. Throughout this process, the technical advisory committee should remain separate from a steering committee, in order to protect the credibility of scientists and their assessments.

Cactus Ferruginous Pygmy-Owl:
The Need for Immediate Protection

In areas where options to conserve habitat are diminishing daily, as in the rapidly developing area northwest of Tucson, precautionary measures must be employed to conserve ecologically important land first, before the habitat is completely consumed. In the case of the endangered cactus ferruginous pygmy-owl, most of the known owls constituting the core breeding population occur in the rapidly developing area northwest of Tucson. There is an urgent need to protect this core breeding population, which exists primarily on private land, if this species is to survive and recover in Arizona. Withholding immediate protection in the hope of detecting additional core breeding populations jeopardizes the survival and recovery of the species, as the survival of the core breeding population northwest of Tucson will continue to be an important biological component to the recovery of the species in Arizona, regardless of the discovery of additional breeding populations. Because the Arizona population of pygmy-owls is so small and because so little is known about the distribution and ecological requirements of pygmy-owls, protecting pygmy-owl habitat northwest of Tucson is essential to any planning effort in that region. Indeed, allowing destruction of such habitat during the SDCP/HCP's planning process would present an unacceptable risk to the viability of an already critically imperiled species, and may make conservation and recovery of the owl through the SDCP's planning process impossible.

The degree of uncertainty about pygmy-owl ecology combined with the unacceptably high risk to pygmy-owl persistence associated with habitat destruction makes it imperative to apply the precautionary principle to guide the SDCP/HCP. In the face of risk and uncertainty for species, the precautionary principle dictates that it is better to take action to protect habitat and preserve options than to do nothing while waiting for more information. In the case of the pygmy-owl, the precautionary principle translates into up-front habitat acquisition of the core breeding population's habitat as part of mitigation for the SDCP/HCP. A private-public partnership to conserve this critical area will jumpstart the multiple-species HCP associated with Pima County's SDCP. Specifically, large parcels of intact habitat connected with dispersal corridors should be designated as an urban national wildlife refuge administered by FWS with cooperation from various partners.

Acquisition and protection of habitat northwest of Tucson is timely because of the pygmy-owl's dependence upon this area, the increasing destruction and fragmentation of the ironwood forest, the traditional cultural uses of the land that could be restored, and the proximity to an urban area with volunteers to assist with maintenance and management. Moreover, immediate acquisition and protection is timely because real estate values are increasing, and because federal funding through the Land and Water Conservation Fund may be available this year, but may not be as plentiful next year. Although this acquisition would obviously have to occur before a scientifically-based planning process is in place, there is enough information to indicate that protection of this habitat is vital to minimizing the risk of extinction for the pygmy-owl. In conclusion, protecting the Arizona population of pygmy-owls from imminent extinction has catalyzed the SDCP/HCP planning process in Pima County, bringing national attention and perhaps, federal dollars to the region. Establishing an urban national wildlife refuge complex northwest of Tucson would help to ensure the success of the plan and to establish good faith in the process by all stakeholders. In sum, Pima County has a significant opportunity through the SDCP/HCP to undertake scientifically based planning that avoids inadequacies of some earlier HCPs, provided that scientifically sound planning procedures are used, including precautionary actions on behalf of imperiled species.

ACKNOWLEDGMENTS

We are grateful to NCEAS, AIBS, Dr. Peter Kareiva, and the working group of 119 scientists who were involved in collecting data about HCPs.

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Table 1: Large-scale HCPs addressing urbanization and development in an urban/suburban area (of HCPs approved by the end of 1998)

HCP Name	Location	Species	Duration (yrs)	Area (ha)	Year Approved
Bakersfield, Metropolitan Area	Kern County, CA	San Joaquin kit fox[a] (*Vulpes macrotis mutica*)	20	106,073	1994
Balcones Canyonlands	Travis County, TX	golden-cheeked warbler[a] (*Dendroica chrysoparia*)	30	256,275	1996
Clark County Short-term HCP	Clark County, NV	Mojave desert tortoise (*Gopherus agassizii*)	3	9,049	1991
Clark County Long-term HCP	Clark County, NV	Mojave desert tortoise (*Gopherus agassizii*)	30	212,551	1995
Coachella Valley	Riverside County, CA	Coachella Valley fringe-toed lizard (*Uma inornata*)	30	28,340	1986
Fieldstone, City of Carlsbad	San Diego County, CA	California gnatcatcher[a] (*Polioptila californica californica*)	30	776	1995
Iron County HCP	Iron County, UT	Utah prairie dog (*Cynomys parvidens*)	20	5,019	1998
Lake Mathews	Riverside County, CA	Stephen's kangaroo rat[a] (*Dipodomys stephensi*)	50	4,858	1995
Massachusetts Fisheries & Wildlife	Coast of MA	piping plover (*Charadrius melodus*)	2	322 km of coast	1996
Natomas Basin	Sacramento, CA	giant garter snake[a] (*Thamnophis gigas*)	50	21,596	1997
Orange County Central Coastal Plan	Orange County, CA	California gnatcatcher[a] (*Polioptila californica californica*)	75	84,210	1996
Riverside County Short-term HCP	Riverside County, CA	Stephen's kangaroo rat (*Dipodomys stephensi*)	2	1,781	1990
Riverside County Long-term HCP	Riverside County, CA	Stephen's kangaroo rat (*Dipodomys stephensi*)	30	218,623	1996
San Bruno Mountain	San Mateo County, CA	mission blue butterfly[a] (*Icaricia icarioides missionensis*)	30	1,457	1983
San Diego Multiple-species Conservation Program	San Diego County, CA	California gnatcatcher[a] (*Polioptila californica californica*)	30	235,726	1997
Volusia County	Volusia County, FL	loggerhead turtle[a] (*Caretta caretta*)	5	81 km of coast	1996
Washington County	Washington County, UT	Mojave desert tortoise[a] (*Gopherus agassizii*)	20	54,656	1996

[a] This plan allows incidental take for multiple species (in addition to this species).

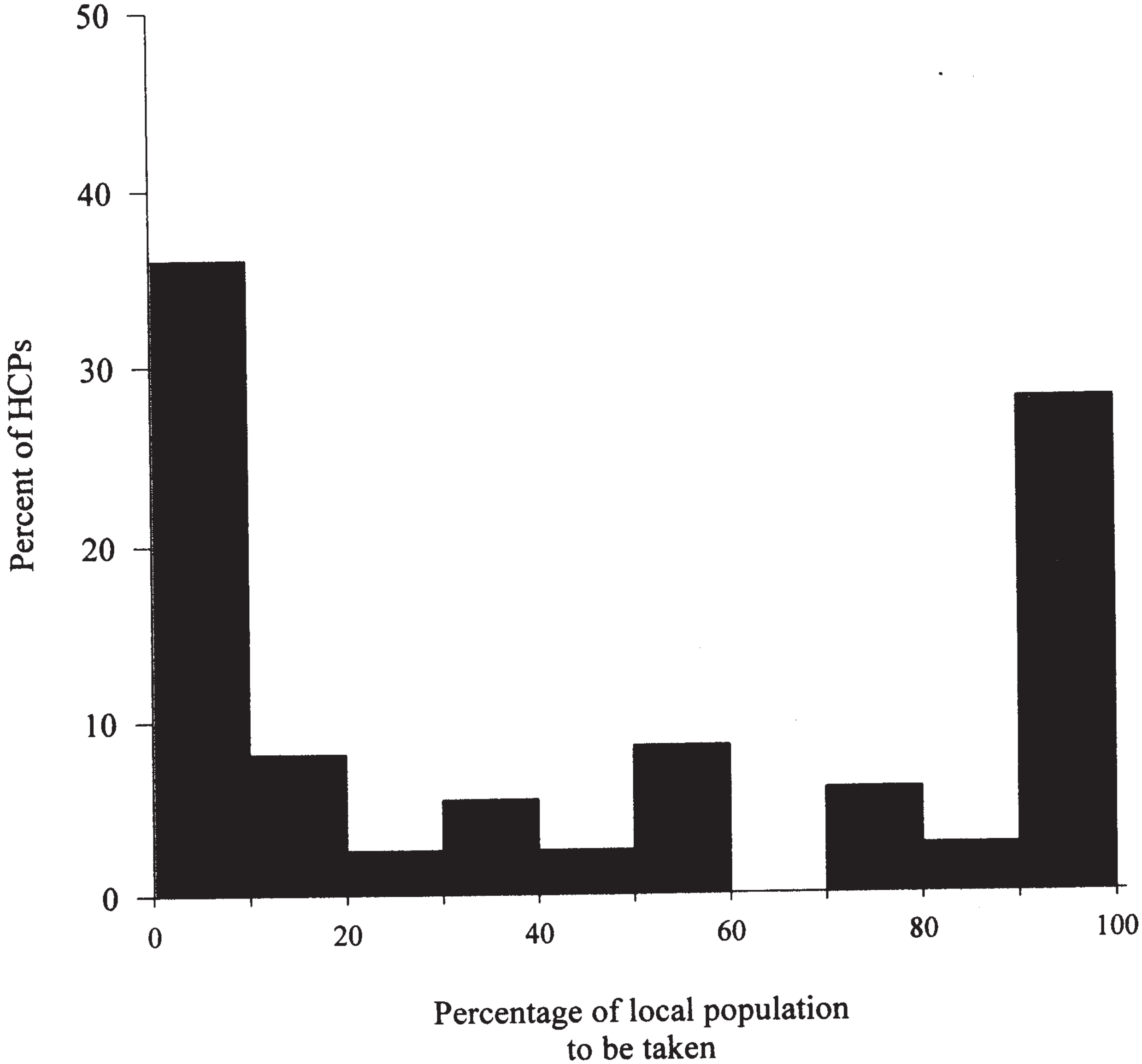

Figure 1: Percent of species' population in the HCP area that will be taken under HCPs. The majority of HCPs involve either avoiding take or estimating that nearly the entire population will be taken.

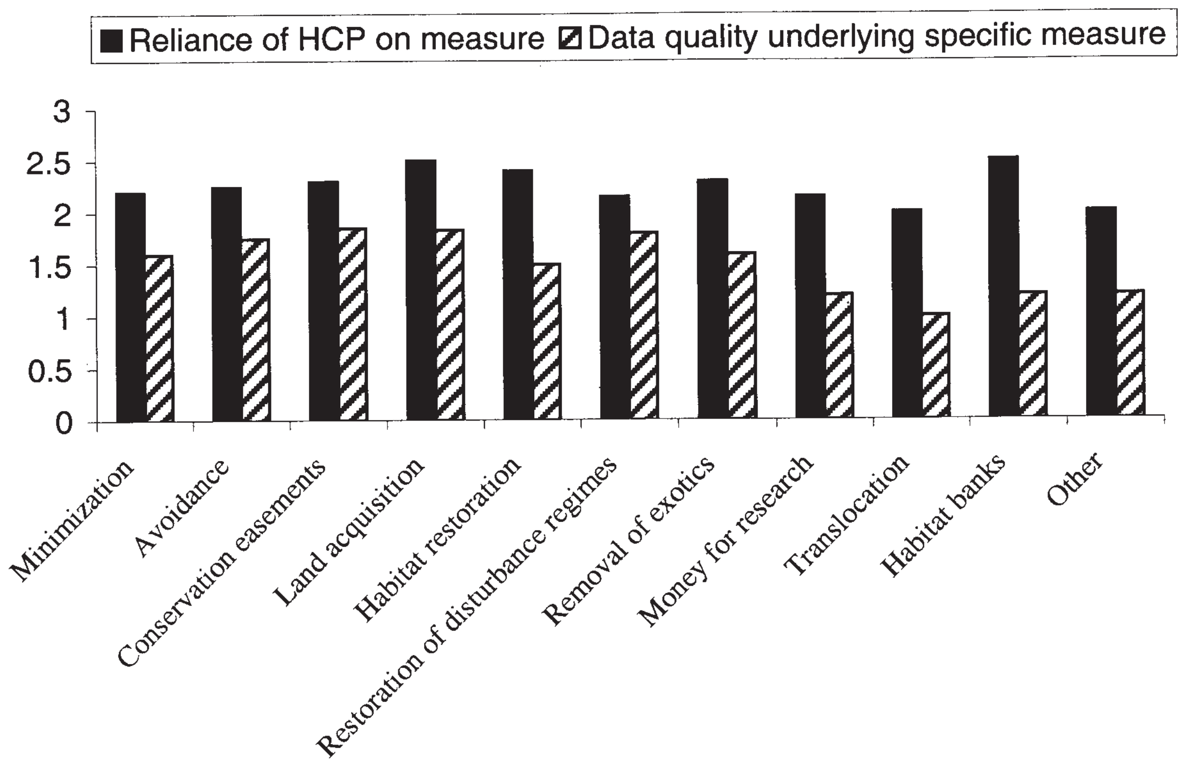

Figure 2: Quality of data underlying the choice of mitigation strategies for HCPs, and the reliance of HCPs upon those mitigation strategies. Mean data quality for any given mitigation measure generally lies between 1 (very little, or quite unreliable) and 2 (moderately well-understoodd and reliable).

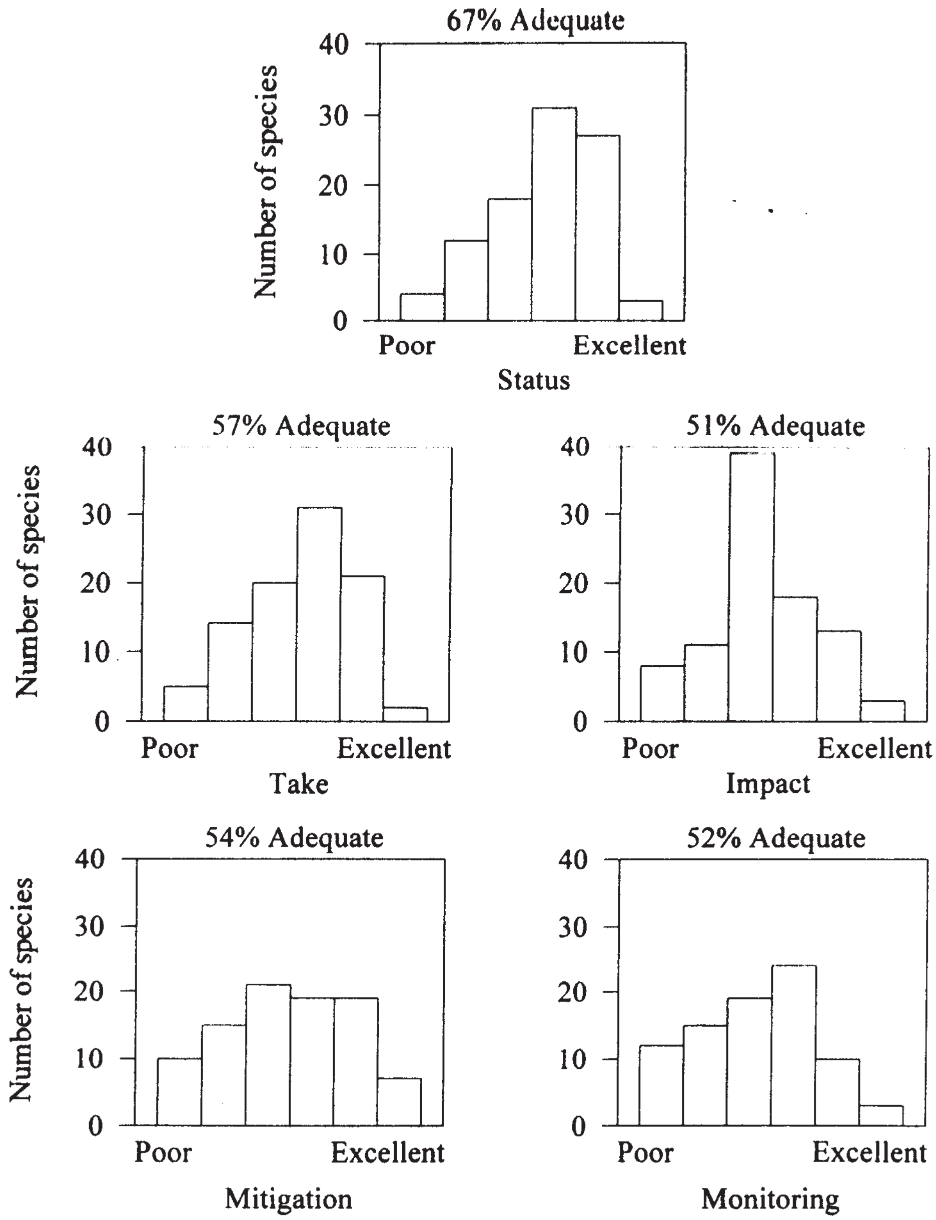

Figure 3: Quality of data and analysis used for the 5 major stepa in HCPs: status, take, impact, mitigation, and monitoring. Above each histogram is the percentage of cases in which the data and analysis were judged adequate for making HCP decision.