Studies in Avian Biology No. 15:340–348, 1994.

Prospects

PRESERVING AND RESTORING AVIAN DIVERSITY: A SEARCH FOR SOLUTIONS

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Abstract. I describe a strategy for maintaining avian biodiversity into the 22nd century that uses the tools of avian ecology and conservation biology. Underlying it are ten assumptions: 1) many of the present and past causes of avian jeopardy will be factors in the future; 2) the effects of a limiting factor cannot be eliminated or significantly ameliorated by actions taken at a scale that is finer grained than the scale at which the limiting factor operates; 3) high quality, well distributed habitat is the key to healthy bird populations; 4) the area of concern must be the entire historical range of a species; 5) restoration of habitat is critical; 6) faunal mixing resulting from anthropogenic habitat alteration is a threat to the integrity of avian communities; 7) alien non-avian species are threats as predators, competitors, habitat modifiers and disease vectors; 8) survival chances are enhanced if metapopulations exist; 9) research and management efforts should be conducted in a biological, rather than political, context and 10) the time to save a species is when it is common. This plan calls us to think globally and act locally, to consider proximate and ultimate factors affecting populations, to place more emphasis on research and conservation in biological rather than political contexts, and to acknowledge that growth of human population size is the driving force behind the loss of avian diversity.

Key Words: Conservation; neotropical migrants; management; research; scale.

"TO KEEP EVERY COG AND WHEEL IS THE FIRST PRECAUTION OF INTELLIGENT TINKERING"—Aldo Leopold

In this volume authors have reviewed and synthesized our knowledge about population trends and effects of human-induced environmental change, and presented case histories for many of the birds in the western United States. I provide a view of what might be done to help restore and maintain the viability and integrity of these avian populations. I will repeatedly refer to the need for an approach based on systems and a better understanding of the issues of scale, temporal, spatial, and biological, for designing research and recovery efforts. I emphasize the theme of building bridges among groups and working across political boundaries. My basic assumption is there exists an urgent need to proactively rather than reactively address conservation issues in biological rather than political contexts.

In seeking strategies to save, restore, and maintain avian diversity, I have looked to the past for solutions and guidance. The dramatic rebound of the peregrine falcon *Falco peregrinus* (Cade et al. 1988) with the banning of DDT and large scale reintroduction efforts shows the possibility of even eliminating pervasive threats from the environment. The recovery of the Aleutian Canada Goose (*Branta canadensis leucopareia*) following the removal of alien foxes from the breeding grounds and reduction in take by hunters is equally impressive (Rees 1989, Anonymous 1991). These are excellent examples of the need to address both proximate and ultimate factors limiting a population's size and distribution. In both cases, the proximate cause of decline was reproductive failure. But it was only when the ultimate causes were removed that the populations recovered.

As an insight to changes in western birds, Linsdale's (1930:105) review of the problems of bird conservation in California is instructive. He stated that "An examination of available information bearing upon population numbers in California birds reveals no single species which can be designated certainly on the verge of extinction. However, several species, or groups of species within the state are low in numbers and need watching and possibly, help in maintaining their statuses." He listed 17 species

TABLE 1. STATUS ATTRIBUTED TO BIRDS IN CALIFORNIA BY LINSDALE (1930) AND EHRLICH ET AL. (1992)

Species	In jeopardy	
	Linds-dale	Erlich et al.
Common loon (*Gavia immer*)[a]	no	yes
Brown Pelican (*Pelecanus occidentalis*)	no	yes
Least Bittern (*Ixobrychus exilis*)	no	yes
Reddish Egret (*Egretta rufescens*)	no	yes
Black-crowned Night-Heron (*Nycticorax nycticorax*)	no	yes
White-faced Ibis (*Plegadis chihi*)	no	yes
Aleutian Canada Goose (*Branta canadensis leucopareia*)	yes	yes
Fulvous Whistling Duck (*Dendrocygna bicolor*)	yes	yes
Canvasback (*Aythya valisineria*)	yes	yes
Harlequin Duck (*Histrionicus histrionicus*)	yes	yes
California Condor (*Gymnogyps californianus*)	yes	yes
White-tailed Kite (*Elanus leucurus*)	yes	no
Bald Eagle (*Haliaeetus leucocephalus*)	yes	yes
Northern Harrier (*Circus cyaneus*)	no	yes
Harris Hawk (*Parabuteo unicinctus*)	no	yes
Red-shouldered Hawk (*Buteo lineatus*)	yes	no
Swainson's Hawk (*Buteo swainsoni*)	no	yes
Golden Eagle (*Aquila chrysaetos*)	yes	no
Prairie Falcon (*Falco mexicanus*)	yes	no
Peregrine Falcon (*Falco peregrinus*)	yes	yes
Sharp-tailed Grouse (*Tympanuchus phasianellus*)	yes	yes
Black Rail (*Lateralus jamaicensis coturniculus*)	no	yes
Clapper Rail (*Rallus longirostris yumanensis*)	yes	yes
Clapper Rail (*Rallus longirostris obsoletus*)	yes	yes
Clapper Rail (*Rallus longirostris levipes*)	yes	yes
Snowy Plover (*Charadrinus alexandrinus*)	yes	yes
Long-billed Curlew (*Numenius americanus*)	yes	yes
Elegant Tern (*Sternus elegans*)	no	yes
Least Tern (*Sterna antillarum*)	no	yes
Marbled Murrelet (*Brachyramphus marmoratus*)	no	yes
Black Tern (*Chlidonias niger*)	no	yes
Yellow-billed Cuckoo (*Coccyzus americanus*)	no	yes
Common Barn-Owl (*Tyto alba*)	no	yes
Burrowing Owl (*Athene cunicularia*)	no	yes
Spotted Owl (*Strix occidentalis caurina*)	no	yes
Short-eared Owl (*Asio flammeus*)	no	yes
Willow Flycatcher (*Empidonax traillii*)	no	yes
Whip-poor-will (*Caprimulgus vociferus*)	no	yes
Purple Martin (*Progne subis*)	yes	yes
Sage Sparrow (*Amphispiza belli clementeae*)	no	yes
California Gnatcatcher (*Polioptila californica*)	no	yes
Western Bluebird (*Sialia mexicana*)	no	yes
Yellow-billed Magpie (*Pica nuttalli*)	yes	no

TABLE 1. CONTINUED

Species	In jeopardy	
	Linds-dale	Erlich et al.
Loggerhead Shrike (*Lanius ludovicianus mearnsi*)	no	yes
Yellow Warbler (*Dendroica petechia*)	no	yes
Common Yellowthroat (*Geothlypis trichas sinuosa*)	no	yes
Song Sparrow (*Melospiza melodia samuelis*)	no	yes
Song Sparrow (*Melospiza melodia maxillaris*)	no	yes
Song Sparrow (*Melospiza melodia pusillula*)	no	yes
Tricolored Blackbird (*Agelaius tricolor*)	no	yes
Bell's Vireo (*Vireo bellii pusillus*)	no	yes
Inyo California Towhee (*Pipilo crissalis eremophilus*)	no	yes
Savannah Sparrow (*Passerculus sandwichensis beldingi*)	no	yes
Lindsdale Yes; Ehrlich et al. No	5	
Lindsdale No; Ehrlich et al. Yes	34	
Lindsdale Yes; Ehrlich et al. Yes	14	

[a] Names used are those in American Ornithologists' Union checklists, 5th and 6th editions (AOU 1957, 1983). In some instances, only the California population or subspecies is in jeopardy.

and shorebirds, ducks, and geese as groups with problems. Five of these species were not listed by Ehrlich et al. (1992). However, 34 California taxa listed by Ehrlich et al. (1992) were not identified by Linsdale as having problems (Table 1).

The west is usually defined as the area west of the 100th meridian exclusive of Mexico (Peterson 1969), including the Hawaiian Islands; 750 bird species occur there. Using floristic provinces, ecoregions, (e.g., Bailey 1980) or physiographic regions that occur in whole or part west of the Meridian rather than political boundaries would allow full consideration of the birds of the Gulf and Pacific islands off Baja California, and of the Sonoran ecoregion that extends into Northern Mexico (Fig. 1). A recent survey of the avifauna of the North American continent exclusive of Mexico, but including Hawaii, found 92 species or subspecies that occur in the west, to be in jeopardy (Ehrlich et al. 1992, see also Atwood 1994). Of 33 extinctions of species and subspecies in the United States since European settle-

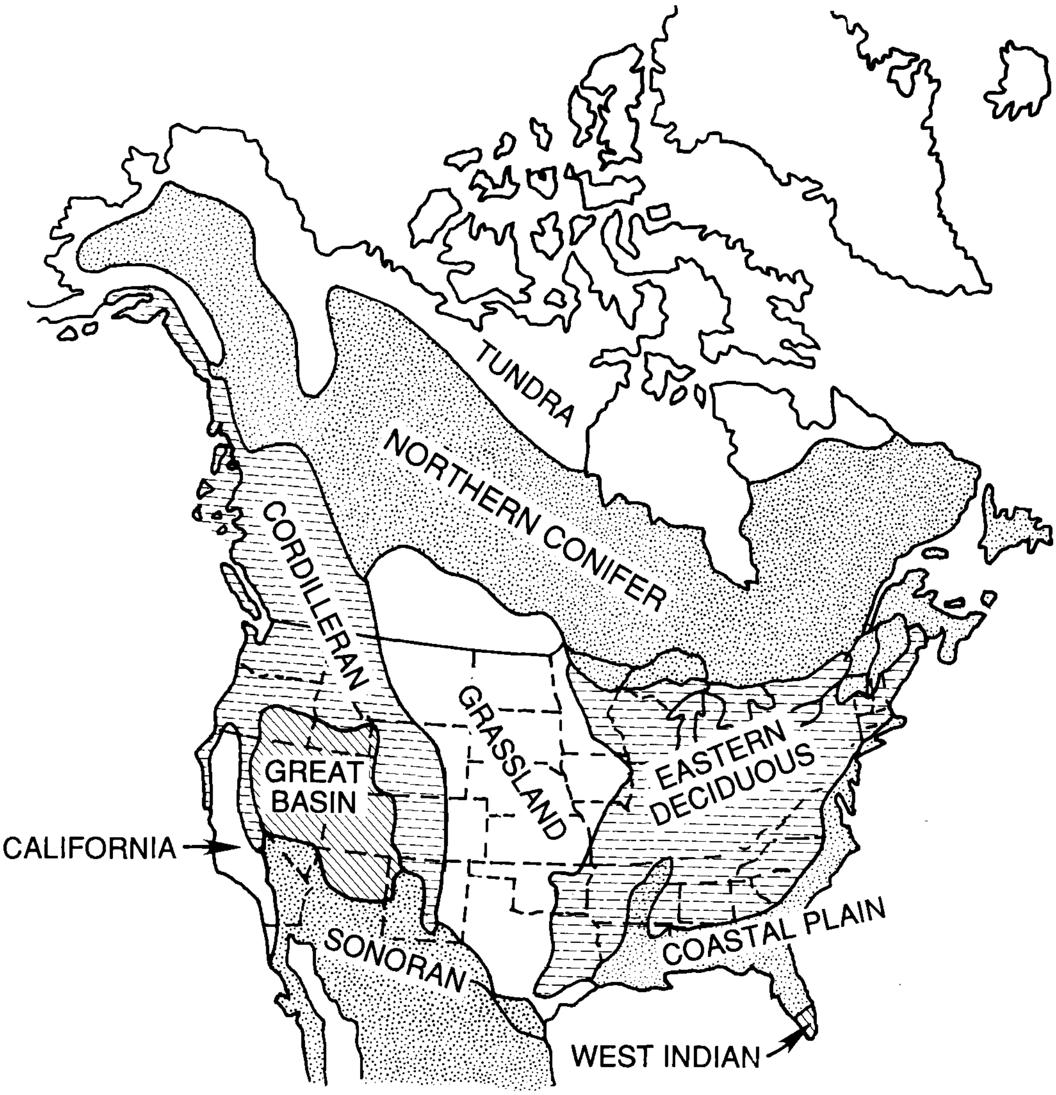

FIGURE 1. Spatial distribution of the ten floristic provinces of the continental United States and Canada (after Gleason and Cronquist 1964). Used with permission of Fritz Knopf. Taken from Knopf 1992.

ment, 25 (78%) have occurred in the west. The loss of populations has been much greater but undocumented. Add to this a minimum of 50 species extinct in the Hawaiian Islands as a result of the 1500 year influence of Polynesians before the arrival of Europeans (Olson and James 1991, James and Olson 1991).

The reasons for loss and placing in jeopardy of species have been varied and changing. In a worldwide review, King (1978) found that in the period 1600–1980, 91% of extinctions were due, at least in part, to the impact of introduced species: in 25% human take was a factor; while for 32% habitat loss or change was a consideration. There is currently a different mixture. Temple (1986) found that for currently endangered species, habitat modification was the single most important factor for 82% of the taxa, followed by excessive human take (44%), and introduced species (36%).

The ultimate cause of extinction and jeopardy is a human population whose de-

FIGURE 2. Top to bottom: Continental distributions of Bell's Vireo (*Vireo bellii*), California Thrasher (*Toxostoma redivivum*), and Tricolored Blackbird (*Agelaius tricolor*). The Least Bell's Vireo (*Vireo bellii pusillus*) is an endangered subspecies in the southwest. Used with permission of Fritz Knopf. Taken from Knopf 1992.

mands on the global ecosystem are greater than the planet can sustain on a long-term basis (Daily and Ehrlich 1992). The United States population increased from 3.9 million in 1790 to 249 million in 1990, with a projected population of 349 million by 2025 (U.S. Department of Commerce 1991). Because of the settlement patterns, rates of increase have been greater in the west in the past 150 years. With increased human populations and increased consumption of resources and goods (Daily and Ehrlich 1992) has come increased habitat loss, fragmentation, and loss of community integrity. Future wildlife losses can be anticipated to be greatest in those areas still having the greatest extent of intact native habitats (Knopf 1992).

In this section, I discuss specific issues that affect the avian populations in the west and lay out a plan for conserving them. I make ten assumptions:

1) Many of the factors that have resulted in the loss of bird species or reduction in their ranges and abundance will continue to be factors in the future.

2) Thriving avian populations require abundant, well distributed, high quality habitat.

3) The effects of a limiting factor cannot be eliminated or significantly ameliorated by actions taken at a scale that is finer grained than the scale at which the limiting factor operates. As an example, if regional lead accumulation leading to poisoning is a significant factor in the decline of California Condors (*Gymnogyps californianus*) (Wiemeyer et al. 1988, Pattee et al. 1990), then treatment of individual birds and provision of contaminant-free carcass at specific sites will not be enough to save the species. The sources of lead must be significantly reduced throughout the range of the species.

4) Conservation, research, and management efforts must nearly always transcend political boundaries (Figs. 1, 2) and perhaps more importantly, the mental boundaries that we create.

5) Restoration of habitats will frequently be necessary (see Ohmart 1994). If recovery or management efforts are restricted to the present range of a species, they may unnecessarily limit the long term viability of a species. An example is the recovery efforts for Hawaiian forest birds that focus on less than 25% of their historical ranges (Scott et al. 1986). Efforts throughout a species' historical range, not necessarily just its current range (Verner 1992), will be frequently necessary to restore avian populations fully.

6) Faunal mixing resulting from human induced habitat loss, fragmentation, and change may affect the integrity of avifaunas (Knopf 1992). Faunal mixing may occur as the direct result of introductions by man or as the result of habitat alteration, e.g., creation of riparian corridors, urbanization of an area (Emlen 1974), or habitat loss and fragmentation which can result in the expansion of a species range. Change is a natural process, but we need to minimize the human induced changes if we are to maintain our native avifauna.

7) Alien non-avian species are a threat as predators, competitors, habitat modifiers, and disease vectors. The most harmful impacts of introduced species usually occur on islands.

8) The survival chances of species are greatly enhanced if a metapopulation structure can be maintained or reestablished (Sabelis et al. 1991, Gilpin and Hanski 1991).

9) Restoration efforts should be placed in a context of physiographic region, ecoregion, a species range, or some other biologically meaningful framework.

10) The time to save a species is when it is common.

GENERAL ACTION PLAN

What can we do to make a difference?

1) "Think globally, act locally." Most of the species that occur in the west spend a portion of their time elsewhere, some as far away as the polar seas. Thus, efforts to maintain the numbers as well as the genetic diversity and population structure of shearwaters should consider conditions throughout their range to include oil pollution, gill netting, competition from commercial fisheries in their wintering areas, as well as the sanctity of their southern hemisphere breeding grounds. The importance of cooperative international efforts in bird conservation has been realized since passage of the Migratory Bird Treaty Act. It has been more recently augmented by several recent programs, particularly efforts to establish hemisphere reserves for migrant shorebirds (Myers et al. 1987), the North American Waterfowl Management Plan (U.S. Department of the Interior and Environment Canada 1986) and The Partners in Flight project (Stangel and Eno 1992), which involves international programs to protect or restore populations of neotropical migrants. Similar efforts are needed to make ecosystems and species ranges the common currency guiding conservation and development decisions.

2) Consider both the proximate and ultimate factors. Proximate causes are those that are acting to cause the immediate decrease of a species. Ultimate causes are those that were responsible for the original decline to a point of jeopardy. The proximate cause may be decreased reproductive success, as in the case of the Peregrine Falcon, but simply increasing reproductive success through brood augmentation or release of captive-reared offspring was only a partial solution to the problem. Reducing DDT in the environment was the solution, as it was the ultimate cause of reproductive failure (Cade et al. 1988). Similarly, recovery efforts for Masked Bobwhite Quail (*Colinus virginianus ridgwayi*) were not successful despite supplementing wild populations with thousands of captive reared birds. The problem was poor habitat, and only when a long-term drought was broken and grazing

pressure reduced or eliminated, did the population begin to show signs of recovery (Gabel and Drobrott 1989).

3) Clearly and loudly articulate the relationship between the increase in human populations and the natural world (Daily and Ehrlich 1992, Ehrlich and Ehrlich 1991).

4) Emphasize research and conservation efforts in biological rather than political contexts (Knopf 1992). Species do not recognize political borders (Fig. 2). In a review of 5 years of *The Condor,* fewer than 5% of the published papers were appropriately extrapolative to a biologically defensible unit. Our arguments for the protection of species would be more forceful if we could defensibly make inferences beyond our study sites and coherently link the hierarchical levels of biological organization.

SPECIFIC ACTIVITIES FOR SOCIETIES

1) Fund the visit to annual meetings of active foreign scientists. Collaborative research is born out of partnerships, mutual respect, and friendship.

2) Sponsor and publish proceedings of symposia that address critical areas in conservation biology or particularly sensitive species of birds. In doing so, involve managers and devote a significant portion of the proceedings to management issues. Examples of this type of effort include:

Ecology and Management of the Spotted Owl in the Pacific Northwest (Gutiérrez and Carey, eds. 1985)

Conservation of Marine Birds of North America (Bartonek and Nettleship 1979)

Ecology and Conservation of Neotropical Migrant Landbirds (Hagan and Johnston 1992)

Endangered Birds (Temple 1978)

3) Conduct research in foreign countries, applying the suggestions of Short (1984) and Verner (1992) in tropical areas.

4) Publish in Spanish the titles and abstracts of articles appearing in ornithological journals.

5) Provide ornithological journals for foreign libraries, establish biological documentation centers in Latin America and Pacific Island countries, and sponsor individual subscriptions to foreign scientists (Duffy 1988, Strahl 1992, and Foster et al. in press).

6) Encourage development and funding of a network of bird observatories in this hemisphere (New World Bird Observatory Network, NEWBORN). In addition to their research efforts, they can be a source of inspiration for conservation. An excellent model is the Point Reyes Bird Observatory, with its strong scientific program, involvement in conservation issues, and commitment to public participation and education (Salzman 1989).

7) Encourage publication of more conservation-oriented manuscripts by ornithological journals. Possible incentives include: a) awards for the best conservation-oriented papers; b) direct assistance for research.

8) Initiate an Adopt-An-Island Program. Individual islands would be adopted by individuals, groups of individuals, small bird clubs, and private companies. These groups would play active roles in eliminating alien plants and animals from North Pacific Islands (Harrison 1992). There are many examples of alien predator species having devastating impacts on island birds (terrestrial and marine) (see Temple 1986 and Loope et al. 1988). Equally devastating are the effects of introduced ungulates and other herbivores (Bailey 1956). While there have been efforts to control these species on some islands and some impressive successes, e.g., foxes were eliminated from many of the breeding islands of the Aleutian Canada Goose, the elimination efforts have not been systematic, and the losses continue. New Zealanders have pioneered effective programs to remove alien predators and herbivores from small islands (Towns et al. 1990).

9) When papers presented at society meetings have particular significance to avian conservation, ask the local committee to invite the media. Provide them with ab-

stracts, contact names, and numbers. Getting issues into the public eye can make a difference.

10) As a society, have a fund-raiser for a specific conservation activity. One possibility is fully stocking libraries at several Pacific Island research facilities that have a policy of lending to other libraries in the region. This effort could augment the establishment of biological documentation centers in Latin America by the U.S. Fish and Wildlife Service (Duffy 1988). Explore a joint venture with the U.S. Information Agency to translate key articles and monographs to Spanish and Portuguese and to make additional literature available through the USIS Network of overseas libraries.

Individual Actions

1) In maintaining species we must seek to maintain self-sustaining metapopulations that retain their full evolutionary potential, rather than a single population that may be no more than a living museum exhibit with a low probability of long-term survival.

2) Write letters to newspapers and our elected representatives. Scientists are well respected by the public and by political leaders.

3) Participate in breeding bird surveys or initiate a breeding bird census. Be part of the loose network of people monitoring our birds.

4) For westerners in particular, get to know your nearby National Forest or Bureau of Land Management district. Meet with the staffs of these public agencies when you see things that displease you, and compliment them when they do something right. Participate in the planning process, and alert managers to any problems.

5) Take a business person to lunch or in the field. Share your knowledge of and enthusiasm for the resource.

Effective conservation requires that we examine issues on scales larger than individuals and breeding seasons (Scott et al. 1993). We must define our sampling universes by biological criteria and draft our findings so that they can be extended to larger biological, temporal, and spatial scales (Wiens 1989, Landres 1992). We need to think hierarchically, for the scale at which we ask questions and initiate management actions affects the answers and responses we obtain (Wiens 1989). Think in terms of landscapes and ecosystems that birds perceive, rather than political boundaries. We are fortunate in the west, for we still have vast tracts of unpeopled lands. With the exception of the Hawaiian Islands, most of the historic avifauna is still with us, but times are changing and changing fast. For a window to the future, one needs to look no further than the coastal sage community of Southern California. Once widespread and considered a nuisance habitat, it now occupies but a fraction of its historical range. One bird species associated with it, California Gnatcatcher (*Polioptila californica*), is threatened, and more than 80 plants and animals are at risk. If we are to be even marginally successful in our efforts to maintain bird species as self-sustaining metapopulations in natural environments, then we must increase our research, management, and restoration efforts at the systems level of organization. The best time to save a species is when it is still common.

ACKNOWLEDGMENTS

I thank D. Wilcove, M. Jennings, J. Jehl, N. Johnson, L. Kiff and R. Banks for comments and thoughtful discussion of the information presented in this chapter. Thanks to F. Knopf who graciously provided permission to use previously published figures. K. Bennett and K. Merk patiently and graciously worked with me to translate my draft manuscript into acceptable journal form.

This contribution is no. 701 of the Idaho Forest Wildlife and Range Experiment Station, and was funded in part by the Idaho Cooperative Fish and Wildlife Research Unit and Idaho Department of Fish and Game.

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