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COMMENTARY

Biodiversity and Research on Seabirds

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Biodiversity has become the cause of the moment, and a good thing this is, as concern over biodiversity has focused attention on loss of species because of destruction of rainforest, trade in endangered animals, and the lack of protected wildlands. While biodiversity is most often considered to be the number of species in an ecosystem (e.g., Wilson 1988), it is also the genetic variability within species and the diversity of ecological roles and processes within communities or ecosystems (e.g., Anon. 1987, McNaughton 1989, Oldfield 1989).

Biodiversity, in any of its forms, is an issue that has not attracted much attention from seabird biologists. This may be because seabirds are not very diverse, representing only about three percent of the world's birds, so that we don't study what we don't have. It may also be that, because seabirds are long-lived, studies of them tend to be longer term, causing seabird biologists to be cautious about new research approaches. Finally, it may be because seabird biologists have too often tended to see their study organisms as ends in themselves, rather than in the wider context of the ecosystems in which they live. Whatever the reason, I wish to argue that biodiversity is in fact a fitting and important topic for seabird biologists and that we need to redirect our thinking and some of our research effort as a result.

In terms of number of species, seabird biodiversity is in relatively good shape, at least compared to some other groups; only 43 (15%) of approximately 288 seabird species are on the ICBP list of threatened and endangered birds (Collar and Andrew 1988). However, if we look at the data more closely, we find that over 30% of the Procellariidae, Pelecanidae, and Fregatidae are in trouble (Table 1). The most threatened group is the genus *Pterodroma*; almost half of its species are listed. These percentages may be even higher if isolated island populations of petrels and shearwaters turn out to be separate species.

There are some indications that endangered species and families with a high proportion of threatened species are relatively neglected in terms of research. For example, while there is a strong relationship (Spearman Rank Correlation $r = 0.899$; $n = 16$) between the number of species in a seabird family and the percent of citations in Colonial Waterbirds during 1983-1991; there is no correlation at all ($r = 0.045$, $n = 16$) between the percentage of endangered species in a family and the percentage of citations. An initial survey

Table 1. Number of seabird species (based on Harrison 1983), percentage of threatened or endangered species in seabird families (Collar and Andrew 1988), and percentage of 605 citations of different seabird families in Colonial Waterbirds (vol. 6-14).

Family	Number of Species	Percent Threatened/ Endangered	Percent Citations
Spheniscidae	17	18	1.8
Diomedeidae	13	15	2.0
Procellariidae	62	31	9.9
Hydrobatidae	20	15	4.0
Pelecanoididae	4	25	0
Phaethontidae	3	0	1.1
Pelecanidae	7	36	4.3
Sulidae	9	11	4.6
Phalacrocoracidae	27	11	7.1
Fregatidae	5	40	1.0
Chionididae	2	0	0
Stercorariidae	7	0	2.6
Laridae	46	11	30.4
Sternidae	41	10	25.3
Rynchopidae	3	0	1.1
Alcidae	22	4	4.6

indicates that only 37% of the threatened and endangered seabird species and only one-quarter of threatened and endangered gadfly petrels (*Pterodroma* spp.) have research or conservation efforts directed to them (ICBP Seabird Specialist Group, unpubl. data). Surely some of the research and conservation effort that goes into seabird families with few endangered species, such as the Laridae and Sternidae, could be diverted to threatened and endangered species in other families. Even a single study of a little-known *Pterodroma* species can be sufficient to focus attention on its problems and to begin the slow process of mustering resources for its conservation (e.g., Brooke 1987, Tompkins 1985).

Turning to biodiversity at the genetic level, we have had numerous extirpations of colonies in the past, and the process continues today (e.g., de Korte and Silvius in press). Thinking only at the species level, such losses may not appear particularly serious. But we may be losing much of the genetic diversity important to the survival of species. Species are made up of clusters of demes or interbreeding populations that may have relatively little or no interchange between them. These demes may have adapted to local conditions that are very different from those elsewhere in the species' range. For example, a deme at the southern, warmer end of the range of an arctic seabird might be better able to cope with global warming and could provide the genes that allow a species to persist, rather than to be forced farther and farther north. Another deme might include greater flexibility in foraging, allowing a species to adapt to changes in prey, whether caused by climate change or by human activities. Still other demes might be more tolerant of human activity so that birds can nest on rooftops or other human structures. Finally, some demes may have developed resistance to the diseases of domestic birds.

Unfortunately, for most seabird species, we have absolutely no idea of the genetic structures of their populations. Few seabird biologists have looked at gene frequencies, gene flow, or inbreeding, although such studies, using modern genetic techniques, are relatively easy to undertake (e.g., Randi et al. 1989, Burson 1990, Moen 1991). Banding studies, although they take longer, can also provide much the same information (e.g. Brooke 1978, Spendelow pers. comm.), but relatively few banding studies are designed to look at these questions.

While most seabird species are not in danger of taxonomic extinction, at the community or ecosystem level a great number of seabird species are ecologically endangered or even extinct, in that they have ceased to play their former roles. For example, there were once tens of millions of Peruvian Boobies (*Sula variegata*) and Guanay Cormorants (*Phalacrocorax bougainvilli*) off the coast of Peru (Hutchinson 1950). The islands of Peru were virtually covered by these nesting seabirds. In the past, they consumed substantial proportions of the total marine productivity of the rich Humboldt upwelling ecosystem. The guano produced by them may have had a strong fertilizing effect on inshore waters, further enhancing productivity. Exploitation of their guano by humans was for awhile the dominant economic activity of Peru (Murphy 1925). Today, there are still several million boobies and cormorants nesting off the coast of Peru. No one considers them in any immediate danger of extinction, but ecologically they are now at best only minor cogs in the upwelling ecosystem. (Duffy in press).

Similarly, the big islands of Hawaii were probably nesting sites for large numbers of seabirds before the arrival of the Polynesians and Europeans led to a rash of avian extinctions (Olson and James 1982). Seabird excreta must have made an important contribution to terrestrial nutrient cycles; seabird nesting may even have determined vegetation patterns over wide areas of the islands. Today, several species of petrels are regarded as endangered on Hawaii, but enough individuals of the other species exist on offshore islands so that there is relatively little concern for the existence of most species (Harrison 1990).

Unfortunately, we still know little about the function of seabirds in marine or terrestrial systems. The complex tuna/porpoise/seabird associations of the Pacific (Au and Pitman 1986), the symbiosis between seabirds and surface-feeding game fish elsewhere (e.g., Coblentz 1985), the interactions among seabird species in feeding aggregations (Hoffman et al., 1981), and the role of seabirds in nutrient and vegetative cycles on islands and inshore waters (Bosman and Hockey 1988, Tatur 1989) are all promising lines of research, but few seabird biologists work on them. In many cases, we may have very little left to work with compared to the past, but this is all the more reason to study what remains.

Finally, oceanic islands are important contributors to biodiversity and are perhaps the most vulnerable of all ecosystems to loss of biodiversity (Carlquist 1965). Seabirds are among the most characteristic species groups of oceanic islands, and they are also large, relatively easy to study, and biologically well-known, at least compared to many other taxonomic groups. Monitoring seabirds might be among the best ways of assessing the health of individual island ecosystems because seabirds are extremely sensitive to the introduction of terrestrial predators and to human exploitation and disturbance (Moors 1984, Nettleship et al. *in press*). Again we need research on the degree of similarity between the responses of seabirds and of other groups to both natural and anthropogenic perturbation.

All these examples suggest that seabirds can add to the study of biodiversity. We need not jump on the biodiversity bandwagon just because it has rolled by, but we should incorporate those topics of biodiversity that add to our understanding of seabirds or that use seabirds to increase our knowledge of ecosystems and all the species in them.

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