Wading-bird Science: A Guide for the Twenty-first Century

KEITH L. BILDSTEIN

Hawk Mountain Sanctuary, 1700 Hawk Mountain Road, Kempton, PA 19529 USA
Internet: Bildstein@say.acnatsci.org

Abstract.—Wading bird biologists have made significant and substantial contributions to the fields of avian evolution, systematics, physiology, ecology, population dynamics, and conservation. To date, progress in the field has been methodical, incremental, and predictable. Most previous work has focused on the natural history of wading birds, and many workers in the field talk to each other more than to colleagues in other areas of biology and conservation. Progress has been greatest in areas where individuals and, especially, groups of researchers, have studied wading birds over long periods, large areas, or both; or have conducted experiments in conjunction with field observations. The greatest advances yet to come in the field will accrue to those who (1) form partnerships and integrate their efforts into the larger fields of avian biology, mainstream ecology, and conservation science, (2) operate at scales appropriate for the questions at hand, and (3) take advantage of emerging technologies and resources.

Key words.—Multidisciplinary studies, multitaxon studies, research resources, scaling, wading birds.

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"*A fool is someone who has never made an experiment.*" – Erasmus Darwin, 1731-1802

Wading birds—especially colonial nesting wading birds—are one of the most conspicuous, popular, and well-known components of wetland ecosystems (Hancock 1984, Sharitz and Gibbons 1989). References to wading-bird biology date from the Old Testament (Jeremiah 8:7). Herons, egrets, bitterns, ibises, spoonbills, and storks routinely appear in ancient Egyptian art (Houlihan 1986). Earlier in this century, wildlife protectionists embraced the plight of wading birds, prime targets of plume hunters, as emblematic of the challenges facing bird conservation in North America. Today, nesting colonies and feeding aggregations of wading birds attract tens of thousands of visitors annually at sites such as Corkscrew Swamp Sanctuary and the Everglades National Park, both in Florida, USA; the Camargue Nature Reserve in France; Lake Nakuru National Park in Kenya, and Keoladeo National Park in India. The Colonial Waterbird Society—an international organization with more than 500 members—is devoted entirely to the study and conservation of colonial waterbirds, including colonial wading birds.

As a result of such abiding interest, wading-bird biologists possess a wealth of information regarding the natural history and biology of their birds (cf. Hancock and Kushlan 1984, Hancock *et al.* 1992). In addition, studies of colonial wading birds have made substantial and significant contributions to the fields of avian ecology, systematics, physiology, ecology, population dynamics, and conservation. But, while it would be easy for me to review the productive history of our field, I will not do so here. Individuals interested in such a summary should consult del Hoyo *et al.* 1992, and references therein. Rather, I will focus my remarks on the future of the field and how we might go about carrying it out. Because of space limitations, my references are representative, not exhaustive.

CLASSICAL WADING-BIRD SCIENCE

To date, progress in wading-bird science has been methodical, incremental, and predictable. Observational and descriptive studies have far out-paced experimental efforts. Most effort has focused narrowly on the natural history of the birds themselves, rather than on more broadly theoretical and ecological aspects. Overall, relatively few studies have formulated hypotheses, stated and tested predictions, and revised existing hypotheses in light of more recent results. Progress in the field has been greatest in areas where individuals and, especially, groups of researchers, have studied wading birds over long periods, large areas, or both; or have conducted experiments in conjunction with field observations.

Although single-site observational and descriptive studies of wading birds will continue to play an essential role, I believe that most major advancements in our field will accrue to those who (1) form new research partnerships and integrate their efforts into the broader fields of avian biology, wetlands ecology, and conservation biology, (2) operate at spatial and temporal scales appropriate for the questions at hand, and (3) take advantage of emerging technologies and resources.

BROADENING THE SCOPE OF OUR FIELD

Wading birds do not operate in isolation from the world around them. Neither should wading-bird biologists. Because most work in wading-bird science has focused on the natural history of wading birds themselves, those working in the field tend to talk to each other about their work rather than to colleagues in other disciplines of biology and conservation. As a result, much of the science generated by wading bird biologists goes largely unnoticed by those working in other areas of ecology (cf. Root 1987). All of us know what "we" are talking about, but few outside our field do.

As wading-bird biologists, we need to communicate more regularly with individuals outside of the field, and to integrate our efforts with those of other scientists and conservationists if we want to continue to make progress (Fig. 1).

One way to integrate our efforts into mainstream ecology and conservation biology is to present the results of our efforts at multi-taxon and interdisciplinary meetings, including those of the Animal Behavior Society, the Society of Conservation Biologists, the Estuarine Research Foundation, the Society of Wetlands Scientists, and the Ecological Society of America, among others; and to publish our work in the journals of these societies. Another strategy is to partner with researchers in other disciplines to achieve what would otherwise be impossible on our own. Davis and Ogden (1994) and Bildstein (1993) offer site-specific and species-specific examples of this approach. Others appear in recent issues of *Colonial Waterbirds.*

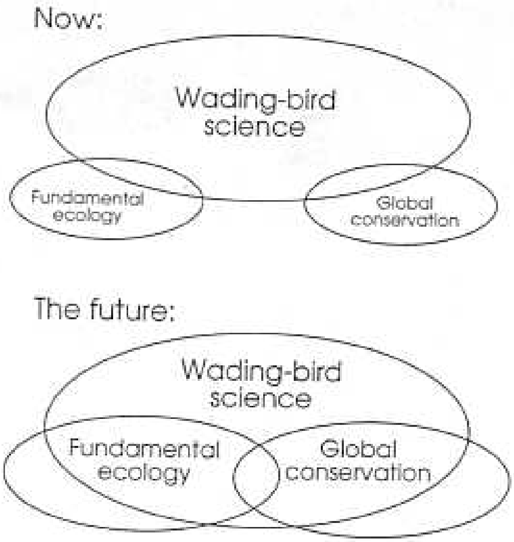

Figure 1. Current and future overlap among wading-bird science, mainstream ecology, and conservation. Greater overlap will bring greater integration of our efforts with those of our colleagues in other disciplines.

WORKING AT THE APPROPRIATE SCALE

Ecological processes operate across numerous spatial and temporal scales. Wading-bird science should do the same (cf. Wiens 1989). What is appropriate depends upon both the species being investigated and the questions being asked. Edwards *et al.* (1994) provides an excellent introduction to the importance of scale in ecology and conservation.

In many instances, long-term, large-scale investments are needed to understand how single species and entire systems function within their ecological domains. This is especially true in conservation biology, where an ability to predict ecological events requires a solid understanding of the temporal and spatial scales at which populations normally fluctuate. For example, much of the current debate regarding reasons for declines of many wading birds in the Everglades results from our ignorance of the habitat needs of these species throughout their wide ranges (cf. Davis and Ogden 1994).

Many species of wading birds inhabit enormous "ecological neighborhoods" (sensu Addicott *et al.* 1987) (cf. Frederick *et al.* 1996). Studies of such species need to be conducted at the appropriate scale. Unfortunately, researchers working on the same species at different sites frequently fail to communicate the results of their efforts to one another. We need to link such efforts more fully than we currently do.

My studies of White Ibises (*Eudocimus albus*) in coastal south Carolina (Bildstein 1993) offer an example of how working at the appropriate spatial and temporal scales, experimenting and collaborating with colleagues in other disciplines benefits wading-bird science.

I began studying White Ibises in 1981, soon after I had determined the species was an important avian consumer in salt marshes near Georgetown, South Carolina, USA. The birds I studied breed on Pumpkinseed Island, a 9-ha marsh island in Winyah Bay, and feed principally on brackish-water fiddler crabs (*Uca* spp.) and freshwater crayfishes (Cambaridae). Throughout the 1980s, Pumpkinseed Island hosted the largest wading-bird colony in the state, including hundreds of Great Egrets (*Ardea alba*), Snowy Egrets (*Egretta thula*), Tricolored Herons (*E. tricolor*), and Glossy Ibises (*Plegadis falcinellus*), together with thousands of White Ibises. Although the numbers of White Ibises breeding at the site fluctuated considerably between 1979 and 1989, the passage of Hurricane Hugo, a Category 4 storm with sustained winds in excess of 140 km h^{-1}, near the site in September of 1989, appears to have decreased the numbers of breeding pairs since then (Fig. 2).

But, while a long-term observational data set strongly suggests the storm affected the numbers of ibises breeding at the site, it does not explain the causal relationship. Another aspect of the study, however, does explain this relationship.

Although adult ibises at the site consume brackish-water fiddler crabs throughout the breeding season, in most years, parental birds feed freshwater crayfishes to their nestlings, so long as the latter are available—even when doing so requires flying up to 100 km one-way to freshwater feeding sites—at times when ample fiddler crab prey are readily available much closer to the colony site. To determine why parental birds did so, vertebrate physiologist Jim Johnston and I experimentally hand-reared nestling ibises on ad libitum diets of either fiddler crabs or crayfishes (Johnston and Bildstein 1990).

The results of our experiment left no doubt as to why parental ibises preferred crayfish prey for their young. The defining variable was salt.

The salt content of crustaceans typically reflects the salt content of the aquatic habitats in which they live, brackish-water fiddler crabs have twice the salt content of freshwater crayfishes. Nestlings hand-reared on high-salt fiddler crab diets, as well as those

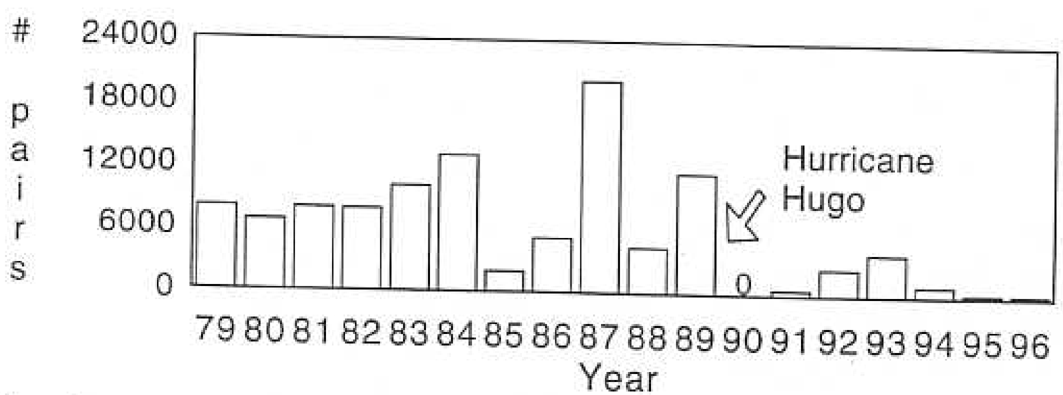

Figure 2. Numbers of pairs of White Ibises breeding at the Pumpkinseed Island, South Carolina, colony site, 1979-1996. The abrupt shift in numbers following the passage of Hurricane Hugo in September 1989, resulted from storm damage to the species freshwater feeding areas.

reared on crayfishes whose salt content had been raised, artificially, to that of fiddler crabs, lost weight, while nestling reared on low-salt crayfishes gained weight. The high-salt content of fiddler crab prey all but eliminates that prey item as a dietary staple for nestling ibises. Ibises fly long distances to secure freshwater prey for their young because they need to do so.

The results of this experiment, together with observations of the devastation that Hurricane Hugo caused to freshwater wetlands near the colony site, explain the relationship between the hurricane and ibis breeding at the site. White Ibises failed to breed at Pumpkinseed Island in 1990, the year following the hurricane, because storm damage had eliminated populations of freshwater crayfish near the colony site. The slow recovery of the population since then probably reflects the fact that ibises operate over enormous ecological neighborhoods (Frederick *et al.* 1996), and that most of the birds breeding at Pumpkinseed Island prior to the hurricane found other sites at which to breed subsequent to the storm.

My studies at Pumpkinseed Island illustrate how long-term single-site monitoring schemes, coupled with appropriate doses of corroborative experimental studies (Johnston and Bildstein 1990) and multi-site efforts (Frederick *et al.* 1996), can place researchers in a better position to understand how wading birds use the landscapes in which they occur.

TAKING ADVANTAGE OF NEW TECHNOLOGIES AND RESOURCES

Wading-bird science has changed since the turn of the century. New technologies and equipment—radio-transmitters, computers, geographic information systems, global position systems—have been added to a field arsenal that used to consist of collecting guns, hip-waders, punts, binoculars, and note pads. These new tools offer ample opportunities for those willing to learn how to use them, as well as for those willing to partner with someone who already knows how. Consider, for example, the use of radio telemetry.

Wading-bird biologists were among the first to use conventional radio telemetry (Hammerslough and Bjorklund 1968, Bateman 1970). Today, advances in the field include substantial miniaturization of radio transmitters for use on smaller species of wading birds (Kenward 1987), and the use of satellite receivers for tracking long-distance movements of larger species (e.g., Wood Storks [*Mycteria americana*], I. L. Brisbin, pers. comm.; Black Storks [*Ciconia nigra*], L. Peske, pers. comm.). The latter, especially, has tremendous potential for use in migration studies.

Initial satellite telemetry studies of Wood and Black storks, for example, suggest this technology will be useful in addressing a number of questions, including: How far, fast, and with how much daily variability do long-distance migrants move over short periods of time? Do individuals of the same species employ different movement strategies on migration, and, if so, what are the fitness consequences of such differences? Do individuals employ different strategies among years, and, if so, why?

Another facet of remote sensing that remains largely unused by most wading-bird biologists outside of south Florida involves aerial and satellite photography (Naveh and Lieberman 1994). Coupled with landscape ecology, and used in conjunction with even modest geographical information systems (GIS; Shaw and Atkinson 1990), this advancement is creating large-scale ecological maps with enormous amounts of spatially-explicit data of considerable value to wading-bird scientists (cf. Hannah *et al.* 1994).

FINAL THOUGHTS

Three forces affect the rate at which science progresses: luck, technology, and the appearance of new paradigms that help shape the questions we ask (Malmer and Enckell 1994). Wading-bird scientists have embraced the first two more than the third. The theories and "scientific methods" wading-bird scientists use today are far more similar to those of 50 years ago, than is the technology with which we pursue our efforts.

The 21st Century is not far off. Much of the research undertaken today will not be published until then. As wading-bird science enters the new millennium, I challenge my colleagues in this field to be innovative, to experiment, to test new and different hypotheses, to form new partnerships and interact with scientists in other disciplines, to integrate their data with existing spatial data sets, to work at the appropriate scale for the questions at hand, and to share their information with new audiences; in sum, to take risks and expand the scope of their research and conservation efforts. Doing so promises many rewards.

Finally, I do not want to leave the impression that we should cease doing what we already do so well. Single-site, observational and descriptive studies lay an essential foundation for more complex experimental and cross-disciplinary efforts. As our science matures, new initiatives will complement and strengthen our current methods, not replace them.

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