16. Research and Information Needs for Heron Conservation

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The edifice of heron conservation must be constructed on a firm foundation of scientific information. Fortunately, as shown in previous chapters, there exists for many herons and in many areas a considerable body of pertinent information. This information base is derived from surveys, studies, and conservation action undertaken around the world, much of it within the last two decades (Chapter 17). As much as feasible, this information base has been summarised in previous chapters of this book.

Nonetheless, there also remain significant information needs that must be filled through inventory, research, and long-term monitoring if heron conservation is to proceed. For a few species the information base is limited to a few observations of their presence and behaviour. For many species, we know little more than places they occur and their basic biology. Even for the best-known species and continents, significant information gaps exist. For example, only in Europe is the understanding of population sizes and dispersion sufficient to understand population status in any quantitative way.

Information needs include population data, ecological information, and basic biology. It would be remiss however to confine discussion to biology alone. The fundamental threat to herons is not their biology but the economic and political forces affecting the landscape.

In this chapter, various information needs are noted to focus attention on the studies most needed. The results of the previous chapters underlie much of this discussion, and it also draws on previous syntheses (Hancock and Kushlan 1984, Kushlan 1992, 1997, Sheldon and Slikas 1997, Hafner 1997a, Cezilly 1997, Bildstein 1997).

The Literature

It should be recognised that much of the information of value to heron conservation remains unpublished or poorly published. A scan of the chapters will reveal how

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much of the information of this book is derived (thankfully) from personal communications. Information resides in unpublished reports, the "grey" literature, in people's memories or notebooks, theses and so forth. An important slice of the published literature is unavailable to most western authors because it is published in a language not traditionally used by international science; see for example the chapters on Asia. A critical need is to continue to discover and access this information, to produce translations of various works, to develop international data banks to which data can be easily contributed, and to continue to develop expert networks such as professional societies and the Heron Specialist Group. The first information need for heron conservation is to continue to access and synthesise what is already known.

Socio-economics

The connectivity of herons with human dominance of the landscape is central to understanding heron conservation issues. Human cultures that value or protect wildlife or animals or all of nature provide protection for herons as well. The status of herons on the Indian subcontinent is specifically enhanced in Hindu areas. Human cultures that have achieved a high level of prosperity can afford to appreciate environmental protection of their wildlife and natural landscape. There is a critical need for study and evaluation of the relationship of human cultural attitudes to heron conservation. In developing species – or regional – conservation plans these cultural understandings need to be explicitly considered in planning.

The economics of heron conservation have been little studied. The gravest threats to heron conservation worldwide are wetland loss and alteration and human depredation, especially in aquacultural situations. These threats are entirely economically driven. In the developed portion of the world, formal environmental assessment and impact analysis require an understanding of the impact of economic forces on heron populations, and conversely the economic impact of herons (both positive and negative). The economics of heron conservation require intense study.

Population status

From the information summarised in the geographic chapters, it is clear that data on the numbers of herons composing regional and national populations are severely limited. For most continents, the chapter authors can do no more than indicate the presence or absence of a species from a country in their status tables. Western Europe enjoys the best population estimates due to having few species, a restricted number of nesting sites, an admirably long-standing tradition of counting birds, and the core presence of the Heron Specialist Group. Overall, the best population knowledge is found especially in the United Kingdom, France, Netherlands, and northern Italy. On other continents, breeding population estimates could be in error by ten or even a hundred fold. This is true even in North America, where population estimates can be inferred from the hit-or-miss record of surveys, but the reliability of the estimates within a power of one or two remains suspect.

For many herons, counting is made easier by their periodic concentration in colony and roost sites. However, colonies need to be found and the birds then counted, with some acceptable degree of accuracy. Herons also gather in wintering sites. Estimates there also are few and less exhaustive because most wintering areas

The gravest threats to heron conservation are economically and politically driven. This aquaculture development destroyed large mangrove areas in Cambodia. The impact of economics on herons and conversely the economic impact of herons represent an immense potential for future research. Photo: Taej Mundkur.

are relatively inaccessible. Many species instead of concentrating are highly dispersed, and wintering birds may be indistinguishable from year-round residents. So it is not clear what populations are being counted.

The state of knowledge of the status of non-colonial species is even worse than for those that congregate at times during their annual cycle. These species are often cryptic, shy of people, highly dispersed, and in inaccessible habitat. These species require the development of inventory techniques uniquely suitable to their unique situation.

It is well appreciated that accurate population estimates provide the most useful metric for conservation. Population numbers are the surest way of monitoring population changes. Knowing the size of the overall population and the proportion of a population using specific sites allow the identification of important heron areas and assessment of risks faced by population segments of concern. Knowledge of global or regional population sizes is particularly critical for determining and asserting the importance of specific sites as key to the population. Since we recommend using the Ramsar criteria, whereby 1% of a population using a site renders that site key to the species, the ability to estimate the total population size is paramount.

However, determining and evaluating heron population numbers require advances in both methodology and conservation infrastructure. Regarding methodology, a fundamental need is for detailed studies of the efficacy of available techniques in individual applications. Dodd and Murphy's (1995) study of Great Blue Herons is an excellent model for such research. Although aerial surveys have long been used both to locate and count colonies, it has become increasingly apparent that errors (generally underestimates) are too high for conservation purposes (see for example Rodgers et al. 1995, Frederick, Towles et al. 1996, Dodd and Murphy 1995). While random or systematic aerial surveys can be used to locate colony sites, only small colonies of large, top-nesting birds can be counted with sufficient accuracy from the air. Aerial censuses, if used, must be corrected by ground counts in ways that are appropriate for each application (Pollock and Kendall 1987). Accuracy and precision problems are also found in ground-based census techniques (Erwin 1980b, Dodd and Murphy 1995). One of the most significant research needs for herons is to study and account for bias in counting techniques, to develop monitoring programmes that measure the bias, and to develop models to estimate population size incorporating the biases of the data.

The difficulty of compiling an inventory of heron populations in lesser developed countries, the bulk of their range, cannot be overstated. Some of the areas thought to be most critical for herons are inaccessible due to remoteness, cost of access, lack of infrastructural support, or—very importantly—civil unrest.

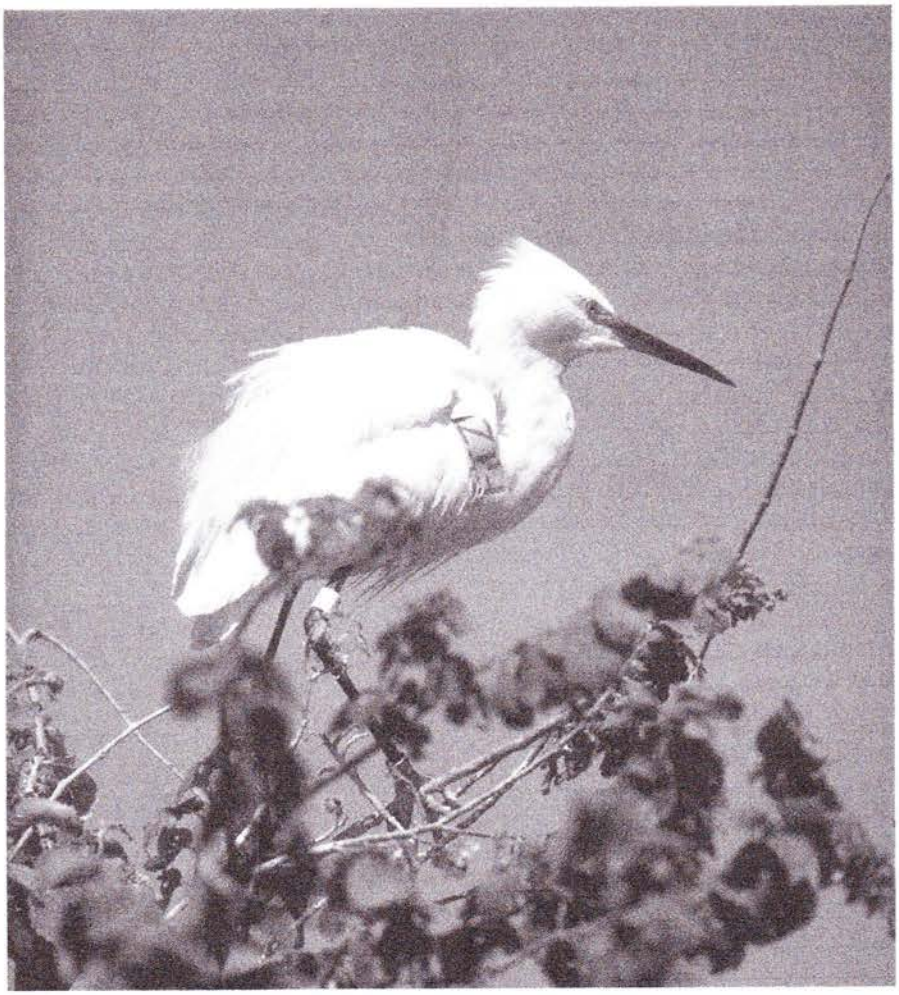
Regarding infrastructure, within each appropriate political or environmental entity, government agencies, NGOs, and citizens need to work together to develop inventory and monitoring programmes to provide more accurate estimates of heron populations, in both summer and winter. It should not be overlooked, however, that there are considerable political impediments for governments and NGOs to work together in most parts of the world. It is even more difficult to connect governments and NGOs to the local human populations that control the outcome of heron conservation in most locations. Since scarce resources must be combined to accomplish conservation objectives, research and models are needed to discover and demonstrate mechanisms by which collaborative conservation can be undertaken.

The resources and organisational structure must be developed to provide for repeated censuses. How this is to be accomplished will differ among applications, and various models need to be tried, evaluated and reported. Development of monitoring infrastructure may, in itself, be considered a research need. The special challenges of accomplishing this in lesser-developed countries, noted above, should be carefully considered. Creating interacting networks of important locations of shared heron populations, developing continental monitoring schemes, north–south and east–west dialogue and assistance, and developing cost- and manpower-effective techniques are needed. Models that work are critically needed.

The importance of population estimates notwithstanding, for many applications the trend of population change rather than absolute numbers may be what is required for conservation monitoring. This too needs to be quantitative within regions and within populations, and must account for bias. Techniques used in any application should aim to allow detection of at least a 20% change in numbers between years of the populations being monitored (Parnell et al. 1988).

Of course an important consideration is that population indices must be sensitive enough to reveal such trends, and this requires considerable additional research.

Evaluation of trend data can suggest when population trajectories are such as to require management intervention. Monitoring programmes need to be developed at several scales, local, national, and continental. To make monitoring data useful, monitoring data collected at different scales need to be collected in a standardised way (Erwin 1985b). Furthermore, new ways of sampling wild populations, particularly using capture–recapture models, hold great promise for development of effective population and trend estimation (North and Morgan 1979, Kushlan 1992, Nichols 1992). The data need to be shared through communal data management systems, which in the best situation should allow data to be made available electronically to any interested person who may wish to conduct analyses. The development of compatible, accessible monitoring programmes requires considerable research and development in the many different kinds of settings in



Little Egret. An individually recognisable bird in the Camargue. Capture–recapture models are increasingly used to estimate demographic trends and also for bias estimation. Photo: Olivier Pineau.

which monitoring has to occur. Sharing ideas and models through publication of case histories is essential.

The success of trend analysis is generally dependent on the messiness of the data. Designing monitoring programmes with sufficient statistical rigour to conduct predetermined analyses is essential, and an exceptionally high priority in heron conservation. In the past, uncertainties inherent in combining data sets taken over different times, areas, and methods have reduced interpretive reliability. Studies leading to standardised monitoring protocols are highly desirable; and, if history is a guide, developing techniques to evaluate unstandardised or "messy" data sets will remain equally important.

Population numbers or trends are necessary but not sufficient to appreciate population status. For most species, basic demographic parameters are little known. This need is especially acute in relatively long-lived birds such as herons, in which current population sizes in themselves are seldom indicative of the long-term health of the population. Without knowing and monitoring age-specific survival, gender-specific survival, age at first breeding, short- and long-term reproductive success, and the factors influencing success and adult survivorship, it is difficult to understand the causes of trends being observed and therefore to begin appropriate conservation measures. It is particularly critical that additional studies be conducted of heron survivorship. Cezilly (1997) pointed out that the efforts put into assuring nesting success may be futile if the fate of the population depends more on variation in adult survival.

Distribution

The geographic distribution of herons can change over surprisingly short periods of years. Expansion of the Cattle Egret throughout much of the world in this century is the most notable example, but other species on all continents have expanded or contracted ranges in recent decades. Range changes need to be monitored. Some range changes are geographic shifts without population change. When distribution changes are detected, studies into causes are needed in order to determine if conservation action is required.

The vagility of some heron species suggests that conservation is usually required at a scale above that of the local colony site or feeding area. Populations need to be understood in terms of their regional demographics. It is likely that the source–sink concept of metapopulation analysis would be a valuable approach to heron population biology. To accomplish this, studies need to be undertaken of dispersal (Cezilly 1997). Ringing, colour marking, and perhaps genetic studies are needed.

Most herons are migratory, and for most of these species, little is known about their movements, particularly the range of decisions available to individual birds. Studies in the Mediterranean suggest that annual differences occur in the numbers of birds migrating and the extent of their movement. For some species, conditions on the wintering grounds are believed to significantly affect survivorship (Chapter 11). It is therefore critical that important stopover locales and wintering areas be identified and sufficiently understood to support conservation action if needed. Even in North America, wintering locations are only superficially known (Mikuska et al. 1998). Locations where a significant proportion of a population winters need to be identified and put under conservation protection, as important

heron areas. Research on heron dispersal, migration patterns, stopover locations, and wintering sites is needed. Fortunately techniques are available, involving ringing, visible marking, radio telemetry, and satellite telemetry, if the resources to conduct the studies can be secured. The recommendation for increased ringing and telemetry study is critical to heron conservation. In winter, roost site dynamics and foraging habitat may play roles in bird survival and need to be better understood.

As noted above, there are probably specific locales for most species that support a significant portion of a population. While the criteria for such areas may differ among species, the Heron Specialist Group in this book adopts the Ramsar criterion that a site is important to herons if it supports 1% or more of a species or a species segment for some part of the year. These locales, which can be called Important Heron Conservation Areas, need to be identified and described for all heron species worldwide, as a significant research task. The maps in this book are a starting point for further research.

Conservation populations

One of the more fundamental information needs, in heron conservation is determining what constitutes a population of conservation interest (Kushlan 1997). Although a principal goal of heron conservation should be to preserve the genetic diversity of the family worldwide, the genetic structures of heron populations are totally unknown. The study of the biochemical genetics of widespread species is essential to understand the scope of variation to be conserved and how this variation is packaged within population segments suitable for conservation planning. Herons such as the Great White Egret, Little Egret, Green-backed Heron, and Black-crowned Night Heron need to be characterised genetically over their nearly cosmopolitan ranges. For the first three of these, there even remain doubts as to the most appropriate species limits, thereby requiring higher-level biochemical taxonomic study (Hancock and Kushlan 1984). A number of species are currently subdivided into subspecies, which must be re-examined using biochemical techniques if they are to become useful conservation units. In this book, we identify some populations that have not been taxonomically discriminated as being of conservation importance (Chapter 17). It is crucial that genetic studies be brought to bear on the question of what is a population of conservation interest.

Population biology

Much is known about the population biology of many herons. However, there continues to be a critical need for demographic studies of herons, particularly reproductive success and survival. This requires long-term studies, utilising ringing, telemetry, state of the art analytical tools and modelling. Recent reports of such long-term studies, such as Hafner et al. (1998a) and Thomas et al. (1999), show the value of understanding the roles of competition, differential survival, nesting success, and survival on population stability. Analytical techniques and the sophistication of the scientific questions that can be asked of a data set are developing quickly. The availability of long-term demographic data sets is critically limited. There is a crucial need for long-term population biology studies to produce the data sets that can be mined by the quickly developing field of population biology.

A Squacco Heron chick. A capture–recapture study on the local Camargue population was initiated in 1999. Photo: Carol Durand.

Habitat conservation

Habitat quality is as essential to herons as it is for other species (see Chapters 9, 10, 11). However, defining habitat quality is not easy and, despite overlapping requirements, differs somewhat among species and among geographic areas. A fundamental research need for each species is to identify the critical habitat elements that are required for its life cycle. While these differ among species, nesting and feeding habitat requirements are often similar for sympatric colonial nesting species.

For most of the heron world, understanding of heron biology requires understanding of the functioning of wetlands. Research on the ecology and function of wetlands is an essential prerequisite to heron conservation. What should be especially encouraged is the study of wetland function as it directly affects herons.

The strong connection of herons with wetlands should not divert attention from other heron habitats. Some of the most endangered herons use forests rather than wetlands. Our knowledge of what constitutes quality for herons in forest habitats is non-existent. Research is needed on the effects of felling trees, clear cutting, stream alteration, runoff changes, burning, and other human-caused changes on herons in forests (Chapter 4).

Nesting habitat

Much is known about the basic nesting habitat of a majority of species (Chapter 9). For several species, requirements are known in sufficient detail to guide creation of artificial nesting sites and feeding habitats. For little-known species, requirements often can be inferred from what is known of similar species. As a result conservation action in protecting nesting habitat can in many cases proceed without additional research. The effectiveness of such action does however need to be monitored, scientifically evaluated, and reported on.

Interspecies interactions are less known. The effect of nesting site competition among species in mixed colonies is unclear in most cases. To the extent that competition has conservation implications, these interactions should be better understood. Known or suspected examples include colony site effects of expanding heron populations, especially Cattle Egrets, as well as the effects of other species, such as cormorants.

Human interactions with nesting herons and their habitat need to be further studied. It is well known that humans and their domestic animals can adversely affect heron habitat; conversely humans can also protect and manage heron habitat. Herons can be disturbed by intrusive human activities, and herons also have the ability to acclimatise to non-intrusive human activities. Additional study on the many and diverse relationships of heron nesting and heron habitat to human activities is crucial, in all areas and for many species.

Herons are well known to affect the plants on which they nest. In some situations, long-term occupancy of colony sites leads to changes in plant community structure and not uncommonly to the death of trees and shrubs they are using. Provided that sufficient alternative colony sites are available, herons can readily shift from a damaged site to another to begin the habitat cycle anew. If sufficient alternative sites are not available, it may prove necessary to actively manage the limited supply of potentially suitable sites. In these situations, it is necessary to study more precisely the direct causes of impact so as to develop habitat management strategies.

In many areas there seem to be shifts of nesting herons from inland sites to the coasts. Presumably this is due to a reduction of quality in inland sites, and perhaps even an increase in quality of coastal sites. In that this seems to be a common response of herons to development pressures, it needs to be studied in both the local context and as a generality.

Feeding habitat

The conservation of heron feeding habitat is profoundly more complex than that of nesting habitat. Physical features of the habitats typically used by herons differ among species, ranging from deep water (large *Ardea*), coral reefs (reef herons), densely vegetated marshes (bitterns), river banks (Agami Heron), and damp pastureland (Cattle Egret), to dry grassland (Black-headed Heron). Even species that feed communally use their habitat in subtly different ways. Furthermore, herons are for the most part flexible species with wide habitat potentiality. Thus habitat conservation needs to take into consideration the individual needs of each species, in the various kinds of conditions in which each species occurs. As a result research is needed on the individualised habitat requirements of various species in various locations at various times of year. Because habitat conservation is inherently

accomplished at the local scale, studies similarly need to be local, even if guided by the generalised knowledge of the species. Such studies need to be a priority in locales deemed to be Important Heron Conservation Areas.

Most herons, most of the time, depend on wetlands for their nesting and feeding habitat. As a result heron conservation is intimately tied to wetland conservation (Kushlan 1997). Protection, management, loss, alteration, enhancement, restoration, and creation of wetlands can profoundly affect the status and trends of local heron populations. Many studies have documented how many species of herons use wetlands, one lesson being that subtle changes in the functioning of a wetland can adversely affect heron population stability. Local studies are still required to test generalisations and determine best management practices for local situations. Especially it is essential that heron conservation be linked tightly to wetland conservation activities; how this is to be done in specific situations needs to be studied. Regional management of heron habitat, in concert with other ecosystem and bird conservation goals, appears to be the most hopeful approach to local heron conservation (Kushlan 1992). However, how such management plans can be devised and implemented requires considerable study. Successful and unsuccessful case histories need to be published for wider evaluation and adoption.

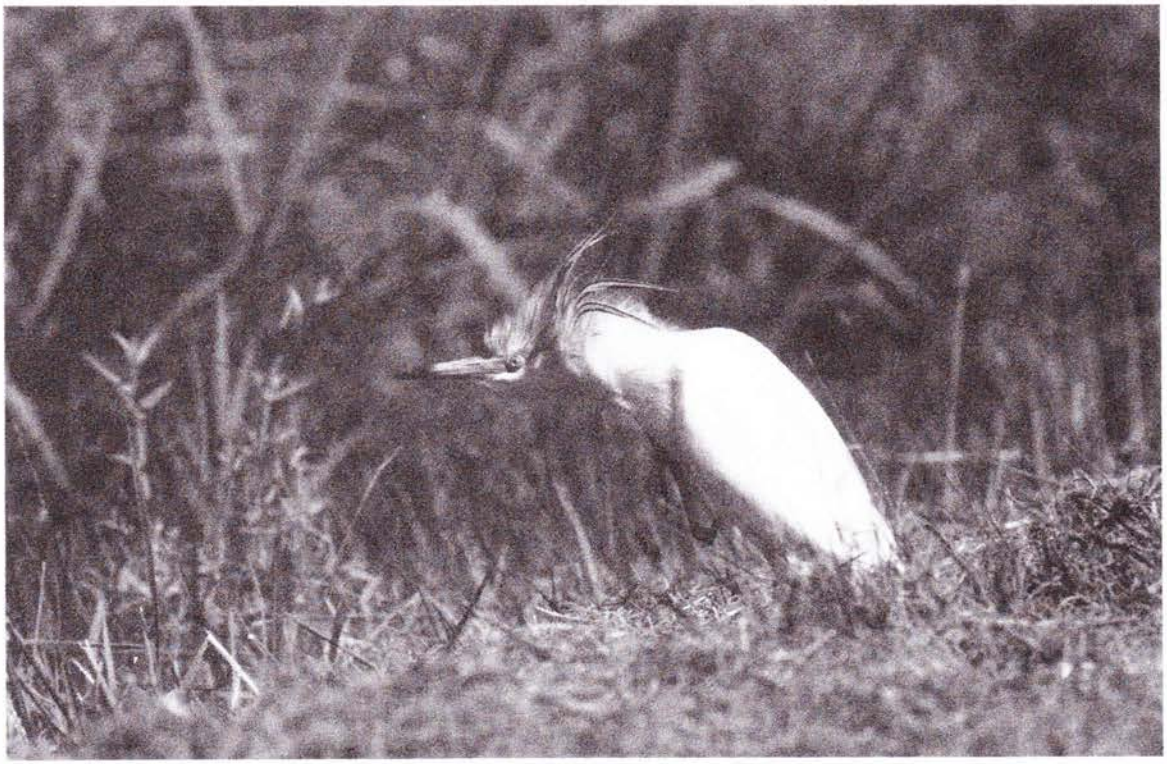
Because of the extent of alteration of wetlands, the principal heron habitat worldwide, conservation often involves wetland restoration or even wetland creation. Herons, with their ecological flexibility, are often among the most obvious species to use a restored or created wetland, and may be suitable indicators of restoration success. It is essential to understand how wetlands may be restored in ways that are conducive to supporting heron populations. With such knowledge the role of herons as indicators of wetland restoration success can be enhanced and appropriate strategies developed for use in other applications.

Past studies uniformly indicate that the most crucial feature of a heron's habitat is food availability. Availability has at least three components: suitability (including species, size, capture susceptibility), abundance, and accessibility. As a result, prey availability depends in complex and changing ways on such habitat variables as water depths, speed and direction of water depth change, temperature, dissolved oxygen levels, rainfall, and timing of availability (tidal, seasonal, day–night). There is also a geographic component in that prey must be available sufficiently close to colony or roost sites and must vary temporally in ways that the herons can adjust to.

With respect to habitat selection, it is likely that variability may be as important as availability. So for each combination of species and locale, the relative importance of these and other variables need to be determined relative to their impact on herons. From a conservation perspective, these need to be understood within the context of available conservation strategies and active management options. Again, such studies are of highest relative priority in areas deemed to be Important Heron Conservation Areas.

Wintering habitat

Habitat used in the non-breeding seasons is as crucial as that used in nesting seasons (Chapter 11). The role of wintering habitat on the population stability of European herons has been well appreciated (Chapter 1). It is likely to be similar for other populations. So little is known about heron ecology on their wintering areas that few



Squacco Heron. The wintering sites of birds that nest in Europe are not well known. Photo: Jacques Delpech.

conservation recommendations are available at present. The additional study of herons on their wintering habitat is a crucial link in heron conservation.

Artificial habitats

While it is essential to understand how herons survive in natural conditions, increasingly habitats available to herons have been altered by human activities. It is in most situations not a matter of whether heron habitat has or will be altered, but to what extent it is being altered. What needs to be understood is how specific alterations alone and as cumulative impacts affect heron habitat use, and therefore population stability. Like other habitat questions, these need to be determined in each application, following guidance provided by general species knowledge.

Aquaculture will be an increasing threat and benefit to herons, worldwide (Chapter 13). Current information suggests that herons are of economic consequence in aquaculture under only restricted conditions. Herons, nonetheless, are often blamed for economically significant losses. It is essential that the true economic impact of herons in various aquacultural situations be definitively determined. In that in many situations other water birds seem to have far greater impact than herons, it is crucial that the relative roles of all potential predators be understood.

Studies to determine alternative, heron-friendly aquacultural practices remain necessary as a high priority.

Contaminants

Contaminants are fundamentally habitat issues, in that herons gain exposure through habitat use, especially via feeding. Tissue concentrations of contaminants in heron tissue are known from many areas around the world, and there is little evidence of population-scale effects of contaminants on herons (Kushlan 1997). However, sub-lethal effects of contaminants on herons in nature are poorly known.

Contamination continues to be a significant issue in heron conservation worldwide (Chapter 12). Baseline contaminant information needs to be gathered from countries and areas not yet sampled. The value of long-term monitoring of contaminant burdens in herons is clear (Chapter 12). Such studies should be continued and expanded. Contaminants especially need to be studied in populations that appear to be declining or otherwise show signs of stress.

To the extent that herons accumulate or show sub-lethal responses to contaminant exposure, they may serve a bioindicator function (Kushlan 1993b; Chapter 15). Further research is required on the long-term, population-level effect of sub-lethal contaminant exposure on herons and on the degree to which such effect can be used in bioindication.

Conservation scale

To the extent all conservation is local, management action must be local as well. Examples, models, and case histories of successful and unsuccessful heron management need to be published.

Heron conservation undoubtedly must also be managed at a higher scale, given herons' large home ranges and seasonally variable use of the landscape. So local management needs to be placed within a regional context. Determining the best approaches to accomplish integrated management across geographic scales requires new approaches. Landscape level analysis, geographically explicit models, geographical information systems, decision support systems, adaptive management, and other weapons in the developing arsenal of landscape ecology need to be applied to questions of heron conservation. Research and adaptive approaches need to be used to determine the most effective conservation delivery systems in various settings. Case histories need to be published so as to increase transference of experiences to similar situations.