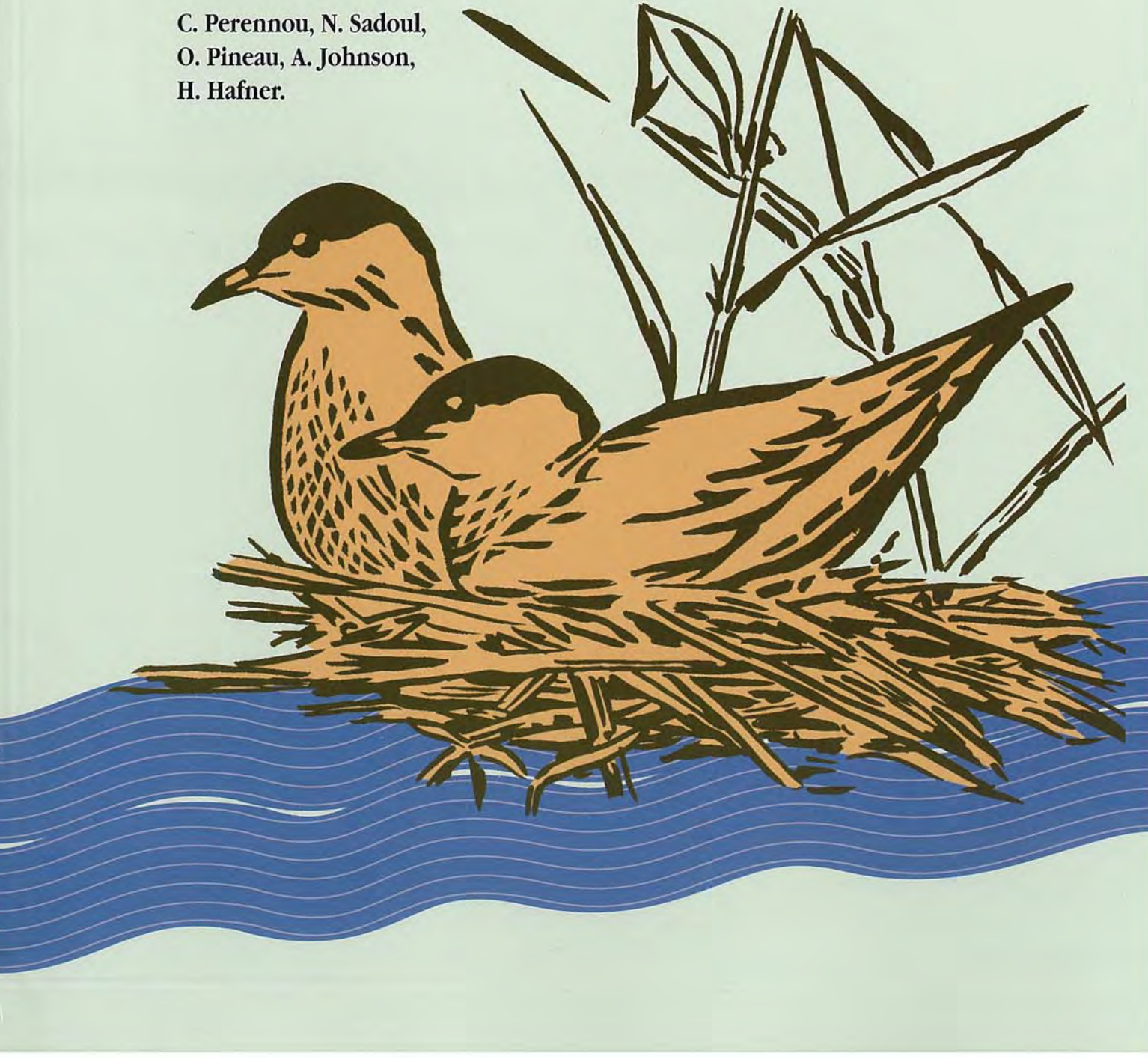
MedWet

Conservation of Mediterranean Wetlands

Management of nest sites for colonial waterbirds

C. Perennou, N. Sadoul,
O. Pineau, A. Johnson,
H. Hafner.



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MedWet

The MedWet action

The Mediterranean basin is rich in wetlands of great ecological, social and economic value. Yet these important natural assets have been considerably degraded or destroyed, mainly during the 20th Century. To stop and reverse this loss, and to ensure the wise use of wetlands throughout the Mediterranean, a concerted long-term collaborative action has been initiated under the name of MedWet.

A three year preparatory project was launched in late 1992 by the European Commission, the Ramsar Convention on Wetlands of International Importance, the governments of Spain, France, Greece, Italy and Portugal, the World Wide Fund for Nature, Wetlands International and the Station Biologique de la Tour du Valat.

This project focuses on that part of the Mediterranean included within the European Union, with pilot activities in other countries such as Morocco and Tunisia. Two thirds of the funds are provided by the European Union under the ACNAT programme and the remainder by the other partners.

The concept of MedWet and its importance for the wise use of Mediterranean wetlands was unanimously endorsed by the Kushiro Conference of the Contracting Parties to the Ramsar Convention in June 1993.

The MedWet publication series

Wetlands are complex ecosystems which increasingly require to be managed in order to maintain their wide range of functions and values. The central aim of the MedWet publication series is to improve the understanding of Mediterranean wetlands and to make sound scientific and technical information available to those involved in their management.

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2. Functions and Values of Mediterranean wetlands
3. Aquaculture in Lagoon and Marine Environments
4. Management of nest sites for Colonial Waterbirds

Conservation of Mediterranean Wetlands
MedWet

Management of nest sites

for Colonial Waterbirds

C. Perennou, N. Sadoul, O. Pineau
A. R. Johnson, H. Hafner

Number 4

Series editors : J. Skinner and A. J. Crivelli

H Hafner

Preface

Many people are especially fascinated by species that are rare, or those that aggregate in large numbers, and enjoy visiting areas where they can still be found. The former may symbolise that nature still has its secret and unexplored dimensions, despite the penetration of the human species into every ecosystem in the world. The accumulation of large numbers in one place may give us some comfort that despite the overwhelming number of humans on this planet there are still places where other species have the upper hand over us. Colonial waterbirds are such a dominating ecological feature in many wetland sites.

We know, of course, that large numbers by no means protect a species from becoming threatened through habitat change. As Birdlife International has shown in its recent publication *Birds in Europe*, 38 per cent of all European bird species have declined in numbers and/or distribution range during the past 20 years. This slow, but steady decrease of "widespread" and "common" species is as significant a dimension of biodiversity loss as the extinction of rare species. It particularly affects species in ecosystems such as wetlands which have so far escaped conversion into intensively managed farmland. Colonial waterbirds are prime examples.

Worldwide, wetland ecosystems have been greatly affected by human activities; the Mediterranean region is no exception. Even if all the remaining wetlands were now effectively protected it is unlikely that the decline of colonial waterbirds in these habitats would come to an automatic halt, or even reverse itself. Active management is needed for stabilising these bird colonies, let alone for restoring their numbers. Since this book is dealing with the practical question of how we can help in the re-establishment of such colonies it is another most welcome and important contribution by the MedWet Programme towards the protection of the integrity and diversity of Mediterranean wetlands and their fauna and flora.

Dr Christoph Imboden
Director-General, Birdlife International

Night heron.

Contents

G. Navizet

Introduction

The wetlands of the Mediterranean are widely acknowledged to be vital for wildlife. The deltas, lakes, marshes and lagoons support internationally important populations of colonial waterbirds.

However, as tourism and industry continue to expand and human populations increase, the pressures upon the natural environment, particularly wetlands and their bird populations, go on unabated.

Colonial waterbirds are those species which breed communally: for example, herons, spoonbills, flamingoes, terns, cormorants and pelicans. Often large, noisy and smelly assemblages of spectacular birds, colonies can number anything from just a few pairs to thousands of individuals. Depending on the species, breeding sites will be tall trees, islands, copses or reedbeds.

Grey herons are amongst the most widespread colonial waterbirds in the Mediterranean.

Colonial waterbirds pose very specific management problems. In contrast to dispersed breeders such as ducks, the loss of a single breeding site can result in the loss of a whole population, particularly where alternative, suitable sites are unavailable. When a site is lost, the natural inclination of a wildlife manager is to seek to replace it. However, numerous problems may be encountered along the way. The aim of this booklet is to help the manager to solve them.

To help secure a place for these birds in this increasingly hostile world, conservation organisations have already compiled extensive data on the construction of artificial nest sites for many species, colonial or otherwise, and produced interesting case studies.

This experience has been acquired mainly in the USA, the UK and in northern Europe. As an increasing number of people (e.g. researchers, nature reserve managers, civil servants) become involved in colonial waterbird management in the Mediterranean, there is a need to synthesize the information essential to the management of nest sites, and to make it available to the conservation community.

M. Gunther / Bios

A colony of tree-nesting white storks in Turkey

Introduction

To be of real conservation value, any plan for an artificial nest site must take into account a wide range of factors, such as the biology of the species in question, the local human context and the local hydrology. All these elements should be considered before a decision is made to create a site.

The table on page 14 lists the 31 species of colonial waterbirds in the Mediterranean region which are dealt with in this booklet. Strict seabirds such as shearwaters, petrels and the shag are not included as their ecology differs extensively from that of species living in inland and coastal wetlands. One species, the white stork, has been included despite its variable nesting habits (see box).

In addition to these 31 species, the western reef heron has been recorded nesting in mixed pairs with the little egret in colonies in Spain and France, and the roseate tern breeds occasionally in Spain.

The Mediterranean is here considered in the broad sense, taking in all of Portugal, Morocco and former Yugoslavia, the Mediterranean parts of France and Egypt (excluding the Red Sea), and all other countries that have a Mediterranean coastline.

Is the white stork a colonial waterbird?

The white stork is not strictly a wetland bird since it can forage in both wet and dry habitats; and neither is it strictly colonial.

A census in Spain[1] in 1984 showed a wide range of breeding patterns, from isolated nests to colonies of 65–75 pairs, sometimes mixed in with other waterbirds (egrets, herons) or even terrestrial species (ravens, raptors).

The white stork can therefore be regarded as a facultative colonial waterbird.

1 - After Lazaro et al., 1986

Population estimates and recent trends of colonial waterbirds in the Mediterranean

		Breeding population (pairs)	Wintering numbers (ind.)	Trend	References
Cormorant[D]	*Phalacrocorax carbo*	-	100,000*	▲	2
Pygmy cormorant[D]	*Phalacrocorax pygmaeus*	1,900 - 2 350	25,000*	▲	2 - 6
Great white pelican[D]	*Pelecanus onocrotalus*	300 - 500	-	▼	4
Dalmatian pelican[D]	*Pelecanus crispus*	340 - 500	-	■	4 - 6
Night heron[D]	*Nycticorax nycticorax*	29,000 - 37,000	> 2,000	▲	1-6
Squacco heron[D]	*Ardeola ralloides*	4,500 - 13,000	< 500	▼	1-6
Cattle egret[D]	*Bubulcus ibis*	100,000	200,000	▲	1
Little egret[D]	*Egretta garzetta*	30,000	15 000	▲ West	1
Great white egret[D]	*Egretta alba*	100 - 500	7,000 - 17,000*	-	1 - 2
Grey heron	*Ardea cinerea*	15,000	5,000 - 10,000	▲	1
Purple heron[D]	*Ardea purpurea*	4,500 - 8,800	isolated individuals	▼	1-6
White stork[D]	*Ciconia ciconia*	42,000 - 65,000	-	▲ West ▼ East	6 - 7
Glossy ibis[D]	*Plegadis falcinellus*	650 - 1,800	-	▼	6
Spoonbill[D]	*Platalea leucorodia*	1,400 - 4,100	-	▲ West ▼ East	6
Greater flamingo[D]	*Phœnicopterus ruber*	Max 40,000	110,000	■▲	Pers. data
Black-winged stilt[D]	*Himantopus himantopus*	23,000 - 33,000*	-	-	6
Avocet[D]	*Recurvirostra avosetta*	< 5,000	29,000 - 56,000	-	6 - 8
Common pratincole[D]	*Glareola pratincola*	5,200 - 11,200**	-	-	6
Mediterranean gull[D]	*Larus melanocephalus*	8,700 - 9,000	-	▲	3
Black-headed gull	*Larus ridibundus*	30,000 - 300,000	-	-	2
Slender-billed gull[D]	*Larus genei*	5,800 - 6,200	-	▲	3
Audouin's gull[D]	*Larus audouinii*	13,000 - 14,000	-	▲	6
Yellow-legged gull	*Larus cachinnans*	120,000 (West Med.)	350,000	▲	2
Gull-billed tern[D]	*Gelochelidon nilotica*	4,600 - 9,800**	-	▼	6
Caspian tern[D]	*Sterna caspia*	50 - 200 (Turkey)	-	▼	6
Lesser crested tern	*Sterna bengalensis*	1,740 (Lybia)	-	-	5
Sandwich tern[D]	*Sterna sandvicensis*	2,500 - 2,900	-	▲	Pers. data - 6
Common tern[D]	*Sterna hirundo*	11,200	-	-	3
Little tern[D]	*Sterna albifrons*	16,300 - 30,000**	-	-	3 - 6
Whiskered tern[D]	*Chlidonias hybrida*	7,000 - 14,500	-	▼ West	6
Black tern[D]	*Chlidonias niger*	600 - 1,400**	-	▼ West	6

Legend
▲ Increasing
▼ Decreasing
■ Stable (recent trends : 1970 - 1990)
- No quantitative data
D Species on Annex 1 of the Bird Directive of the European Union

References
1 - After Hafner (in prep.) and personal data Hafner
2 - Rose et Scott (1994)
3 - After Aguilar *et al.*, (1993)
4 - Crivelli (1994)
5 - Meininger *et al.*, (1994)
6 - After Tucker et Heath (1994)
7 - Hancock *et al.*, (1992)
8 - Piersma (1986)

*- *These data include the Black Sea (no Mediterranean -only data).*
**- *These figures do not include North Africa or Israel (no data available).*

Introduction

A sound understanding of the requirements of colonial waterbirds is a prerequisite to any conservation action. The first chapter "Characteristics and funtioning of a breeding colony" therefore reviews the factors which determine successful breeding in colonial waterbirds.

The key question as to when the creation of an artificial nest-site is justified is debated in the second chapter, which also includes a review of the factors, biological and otherwise, that must be considered when planning to (re)create an artificial nest site for colonial waterbirds. The second chapter "Some principles before creating a new colony site" also includes a checklist of the key points that have to be assessed in a feasibility study before any implementation.

Lastly, the third chapter "Technical fact-sheets" presents a guide, including technical data sheets, to the creation of artificial nest sites.

It must be emphasised that current information on Mediterranean colonial waterbirds is by no means complete. While greater flamingoes and herons have been studied in depth for decades in Spain, southern France and Greece, data on ibises, waders and cormorants is much less comprehensive. Spoonbills, pelicans, gulls and terns fall between these two extremes, with studies being more recent but already bringing very valuable results. These differences are reflected in the reviews and examples which follow.

M&C Denis-Huot / Bios

The glossy ibis is one of the least studied colonial waterbirds in the Mediterranean. It's ecological requirements are little known.

C. Ruoso / Bios

Characteristics and functioning of a breeding colony

The colony site is the location where nests occur in close association. The birds gathered in such a site form the colony. Colonies are organized by various types of social interactions, for example stimulations and flocking behaviour.

Colonies are not distributed at random. Sites are carefully selected by the birds to satisfy their requirements.

Although coloniality differs considerably between species, all the birds share the same fundamental requirements during reproduction:

- the colony site must be protected from predators, disturbance and adverse weather conditions (especially strong winds) ;
- nesting material must be available;
- the site must be located close to feeding areas that provide sufficient food for the parents and their chicks throughout the breeding season.

The cattle egret is currently expanding rapidly in the Western Mediterranean and in Europe.

The establishment of a successful breeding colony will only be possible if these general conditions are met simultaneously. Breeding success is a key factor in the dynamics of colony size and colony persistence, influencing whether birds will attempt to reproduce in the same site the following year. In cases of massive failure, they are more likely to shift to another site.

The dynamics and persistence of colonies is dealt with later in the chapter.

E. Barbelette / Bios

Gulls, such as these Mediterranean gulls breed in large colonies on islands.

Colony site requirements

Colony site requirements can be divided into safety and intrinsic site features.

Safety from predation and disturbance

Social interactions between individuals make colonies usually noisy places which, as a result, are highly detectable by predators. Birds may develop different traits (high nest density) and behaviour (vigilance, mobbing) to deter avian predators from the colony. Nevertheless, they are usually powerless when faced with predatory mammals.

A colony site isolated from terrestrial predators is therefore a major prerequisite for nesting. Colonial waterbirds have evolved various means of achieving maximum security:

- terns, gulls, waders and flamingoes nest on islands surrounded by water deep enough or wide enough to deter most predators, including humans ;
- herons, cormorants and storks nest high enough above the ground to be beyond the reach of terrestrial predators ;
- herons and ibises nest in areas where a dense undergrowth deters predators

Many species (e.g. herons, egrets, ibises) are quite adaptable and will readily make use of the local availability of one, or several, of these nesting areas.

For example, in the complete absence of surrounding water or dense undergrowth, herons may nest 25 metres high in trees; yet colonies of the same species also occur on the ground, on remote islands several kilometres from the shore, where the surrounding water provides protection.

Disturbance by people or predators is a major cause of nest abandonment by colonial waterbirds.

The disappearance or lack of breeding sites, induced by human activities for example, may drive birds to nest on unusual sites. In the Camargue there is a lack of optimal breeding sites for waders, gulls and terns due to both landscape changes by man and competition from an increasing population of yellow-legged gulls. As a consequence, they often breed on non-isolated islets or dykes where they suffer heavy predation and disturbance, resulting in poor breeding success.

Isolation of the colony site is normally required throughout the breeding season, until the chicks fledge. However, for some species (e.g. avocet) this is a requirement only during incubation as the chicks are nidifugous and leave the nest soon after hatching, or because they gather in crèches, as with greater flamingo and slender-billed gull. Crèches are mobile and can, under the guidance of a few adults, move to safer areas to flee disturbance or the drying-up of the surrounding water.

Hence, although the breeding success of avocet and slender-billed gull nesting on non-isolated dykes in the Camargue is low, it is still greater than for other species nesting in the same conditions, but which have not developed similar behaviour.

G. Bortolato / Bios

Young avocets, which are nidifugous, can follow their parents soon after hatching, out of reach of danger.

Characteristics and functioning of a breeding colony

J. C. Munoz / Bios

Audouin's gull at nest.

Audouin's gulls in the Ebro delta[1]

The prevention of human disturbance, when combined with an adequate nest site located close to food sources, can yield quite spectacular results.

Thirty years ago, Audouin's gull was considered the Mediterranean's most endangered colonial waterbird: only 800 pairs were known, the entire world population.

Following increased protection of the Ebro delta in Spain, and especially of the Punta de la Banya which breeding seabirds and waders recolonised, Audouin's gull started to nest there in 1981.

In 1994, the overall Mediterranean population had risen to over 14,000 pairs, with over 10,000 located in the Ebro delta.

It is certain that an increased food availability (e.g. offal from trawlers, expansion of rice-fields) played a major part.

However, such recolonisation and the present high rate of increase, possibly the largest for any colonial waterbird in the Mediterranean, would not have been possible had the breeding site not been well protected against human disturbance.

1 - after D. Oro, pers. comm. and Anonymous (1994)

Through natural selection, these strategies may be considered as anti-predator adaptations, with birds selecting sites with regard to their security. However, they are most sensitive and less able to adapt when facing anything "unusual" (in an evolutionary time-scale), such as many human activities. Therefore, wildlife managers usually have to introduce strict rules to avoid direct disturbance such as egg and chick collection, nest photography, aircraft overflying colonies...

Greater flamingoes, for example, are very sensitive to disturbance by humans, aircraft or anything out of the ordinary. On different occasions in the last 25 years in the Camargue, a photographer, an escaped black swan and a child's balloon have all caused major losses of eggs and/or chicks (2000+, 300+ and 3000+ respectively). For such gregarious and attractive species, colony wardening may be required during the breeding season, especially prior to and during the laying period.

The disturbance of a colony causes the adults to fly away leaving eggs and chicks at the mercy of predators.

B. Pambour / Bios

Colony site features

The features of a colony site are the physical or biotic parameters (type of substrate, vegetation type and height etc.) which allow birds to place and build their nests in optimal conditions. Such features help to protect eggs and chicks against rain, wind or hot sun, avian predation, aggressive neighbours and so on, and are important considerations in the selection of the colony and the nest sites.

Individual birds seek out the best conditions, relative to the species, to maximize brood survival. The location of the colony site varies considerably between species groups: in trees and bushes – pygmy cormorant, herons, egrets, glossy ibis and spoonbill – ; in reedbeds – purple heron, spoonbill, pelicans – ; on the ground on islands – pelicans, greater flamingoes, gulls, terns and waders – ; on floating vegetation such as *Nymphaea* – whiskered tern – or variably on islands, cliffs or trees – cormorant.

Adequate nest material must be available within or near the colony. Nest material can be reed – for purple heron and Dalmatian pelican – ; sticks – tree-nesting herons – ; shingle – little tern – ; *Cardium* shells – gull-billed and sandwich terns – or mud or sand – greater flamingo –. However, species are quite adaptable: for example, in Mauritania the grey heron is known to build its nest mostly from pelican bones and the cormorants there use the heads of dead flamingoes chicks!

J. Mayet / Bios

The cattle egret uses sticks to build its nest.

O. Pineau

A colony of tree-nesting herons, surrounded by water.

- Tree-nesting species

Wet deciduous or coniferous woods (ash, alder, poplar, willow, juniper, pine), as well as thickets of tamarisk are commonly used in the Mediterranean by cormorants, herons, ibis and spoonbill. Cork oaks near water, and thickets of cornel are also suitable breeding sites, particularly for herons. The height of the nests above the ground or water varies between one metre (in the case of thickets) and 25 metres. If all other conditions are fulfilled, even small woods a quarter-hectare in size can host up to a thousand pairs.

Tree-nesting species choose different types of tree according to their branch structure and the way they react in the wind.

Stands of introduced eucalyptus trees are rarely used for nesting, although in the Mediterranean region they are frequently encountered near marshes and lagoons. It is thought that their structure is not suitable as the branches are flexible and break easily.

Where suitable trees are lacking, some colonies are established in low stands of shrub such as olive, cane (*Arundo donax*), bramble, *Atriplex* and *Suaeda*. Monospecific colonies of little egrets, a particularly adaptable species, are even found on the ground, in grassland or in *Salicornia* shrubland ; such as in Turkey (Camalti Tuzlasi near Izmir), Tunisia (Lake Tunis, Kneiss and Kerkenna islands) and France (Etang de Sigean), where colonies are located on islands.

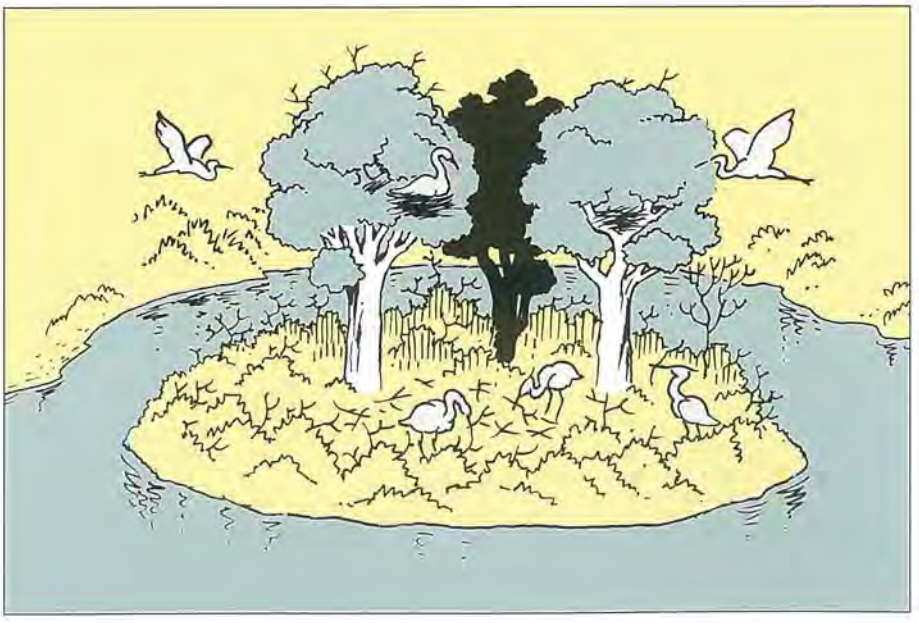
Characteristics and functioning of a breeding colony

In the Camargue, an area characterised by frequent high winds, breeding herons and egrets prefer to nest in ash and alder, presumably because these have quite rigid branches; willow are rarely used, and only if they are sheltered. In contrast, in the Pô valley (northern Italy), where strong winds are less frequent, as well as in Greece (Lake Kerkini) and in Albania/Montenegro (Lake Skadar), large heron colonies of over 1000 nests can be found in willows or young trees.

For most colonial waterbirds, nest material, whether twigs, mud or gravel, must be found in abundance within or close to the colony.

Nest material is vital for the structure of the nest to provide protection for eggs and chicks. Most tree-nesting species build stick nests. Little egret nests, for instance, are relatively small in relation to the mean body mass (500 g) of an adult bird. Three nests examined in the Camargue contained 138, 190 and 220 dead sticks/branches, most of them about 30 cm long (range 3–50 cm). An average-sized colony of several hundreds of nests therefore requires very large quantities of material, which the birds collect as close as possible to their nest site.

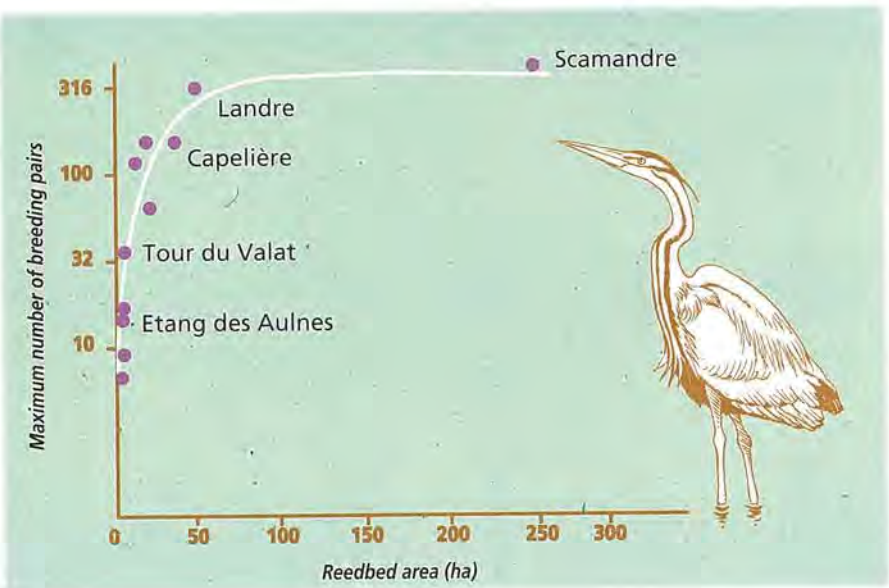
In general, deciduous woods which support breeding colonies are characterised by a thick undergrowth in the peripheral zones (which offers security) and discrete open sectors in the central zone, which allow easy collection of nest material on the ground. Nest material is usually more abundant in the centre because the trees are older and provide more dead sticks. A wood which is uniformly covered with thick undergrowth may be less attractive because of the difficulties the birds encounter in reaching the dead sticks and branches.



The ideal colony site: surrounding undergrowth and water deter humans; older, more mature trees in the centre provide nest material.

• Colonies established in reedbeds

Reedbeds of *Phragmites australis* provide the vital breeding sites for purple heron, a vulnerable species, while they are an important, but not exclusive, breeding habitat for pelicans, ibis and spoonbill. Nests are usually built well above the ground or water with branches and/or reed stems.



Relationship between the reedbed area and the maximum number of nesting pairs of purple herons it can hold.

Source : Moser (1984)

Purple heron colonies

In contrast to woodlands, the size of colonies established in reedbeds can be limited by the area of available reedbed.

In the Camargue a study[1] showed that all areas of reedbeds greater than 10 hectares were occupied by breeding purple herons. Below 30-40 hectares, the size of a colony was limited by the space available, whereas in larger areas the size of the colony was not affected by the size of the reedbed. However, it is not known whether such a relationship is also valid for other species of colonial waterbirds nesting in reeds.

The size of the reedbed is not the only important factor; its location, overall structure and hydraulic regime are equally vital[2].

1 - Moser (1984)
2 - See technical fact-sheet 14

Characteristics and functioning of a breeding colony

J.C Munoz / Bios

Although they usually nest in trees, cattle and little egret may nest in reedbeds provided their safety is assured.

In a few Mediterranean wetlands with good feeding areas but no suitable woodland, important mixed colonies of typical tree-nesters have been reported in reedbeds. Such colonies of various heron species (e.g. cattle egret, little egret, night heron) are known in the Ebro delta and Albufera de Valencia (Spain), in Lake Mikri Prespa (Greece), and in Lake Tonga (Algeria). Colonies of glossy ibis and spoonbill are established in reedbeds at Lakes Mikri Prespa and Mitrikou in Greece.

In the Camargue, grey herons nest mostly in reedbeds, probably because of the frequent, strong, northern wind, the "Mistral", which regularly prevents successful nesting in trees. The absence of tall, strong trees, which are more wind-resistant, is another possible factor.

- Ground-nesting species

Ground-nesting species (terns, gulls, waders and flamingoes) prefer sheltered islets and islands isolated from the mainland in salt marshes, lagoons or salinas. Sand bars, one of the traditional breeding habitats of terns, have gradually been abandoned due to an increasing human presence. As with Audouin's gulls in the Ebro delta, the introduction of strict rules to control human activities may allow birds to recolonise this habitat. Common terns and little terns also breed on sand and gravel banks and islets in rivers, for example in the Pô and Durance rivers.

According to the species and to the locality, nest-site selection varies in relation to vegetation cover and flood avoidance. Thus, unlike Mediterranean gulls and black-headed gulls, slender-billed gulls, terns and avocets avoid high vegetation such as *Salicornia*, *Salsola* or *Suaeda*, and nest instead either on bare sand or on low vegetation such as *Obione*.

These latter sites are lower, nearer the water and more vulnerable to flooding. Although their nests are not settled inside vegetation, these species nevertheless seek the proximity of vegetation for protection against the weather (hot sun, rain or wind) and predation.

Differences in water level and vegetation growth can influence the suitability of a site and the timing of nesting. In human-controlled habitats such as salinas, where water levels are usually more stable, flooding is not the major cause of breeding failure.

Nests may be constructed with small branches and grasses, settled either on *Salicornia* (black-headed gull), on the ground among *Salicornia* vegetation (Mediterranean gulls) or on open ground (yellow-legged gull) or may be limited to a small excavation in sand, shingle, gravel, *Cardium* shells or windrow (avocet and tern species).

In greater flamingoes, nests are made of mud which, during the breeding season, the birds scrape up with their bill from earth surrounding their nests. The continued "excavation" year after year can contribute to erosion of the nest site and may justify human intervention where alternative, suitable breeding sites are not available.

In the Camargue, where there is a shortage of breeding sites, colonial waders, gulls and terns colonise muddy islets and dykes. In the absence of nest material or appropriate permeable ground, eggs are laid directly onto the mud which can become sticky after rain or when exposed to spray. When this happens, incubating birds cannot turn their eggs and they abandon their clutches. Breeding success thus decreases.

Feeding habitat requirements

All Mediterranean colonial waterbirds rely exclusively upon animal food, whether vertebrates (fish, snakes and amphibians), or invertebrates (e.g. beetles, chironomids, dragonfly larvae, crayfish and shrimps...).

Waterbird colonies must be located near adequate sources of food, especially for the chick-rearing period.

Birds tend to optimise the duration of foraging trips so as to find the right trade-off: the greater the time a bird forages, the more food it is likely to bring back, but also the higher the energy cost and the probability of predation of chicks waiting for food at the colony. Adults therefore choose colony sites which are close to rich feeding areas. Moreover, they are able to make use of special conditions to obtain most of the food needed by their brood in a very short time (see box below).

Using data from various regions of the world, it has been shown that wading birds (ibises, storks, herons) need to consume between 10–20 per cent of their body weight daily ; this increases heavily when two to five fast growing chicks have to be fed as well. Therefore colonies require large amounts of food to feed such a "mass" of birds and their offspring.

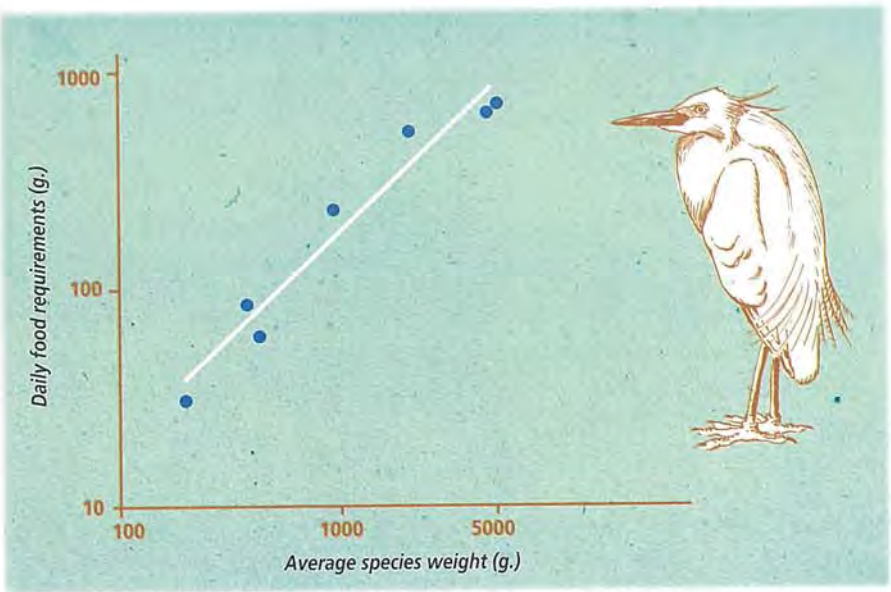
Making use of favourable, local situations

Studies of the little egret in the Camargue[1] have shown that most food is obtained in summer in the first few hours of the day, when birds feed in dense aggregations on shoals of mosquito fish *(Gambusia affinis)*.

The respiration needs of aquatic macrophytes cause a depletion in oxygen during the night obliging mosquito fish to come to the surface to breathe in the early morning, something most other fish species cannot do.

Then, as daylight arrives, photosynthesis recommences and increases the amount of dissolved oxygen in the water, enabling the fish to retreat deeper into the vegetation, thus avoiding predation. Egrets therefore use this short span of 2–3 hours just after dawn, and this peculiarity of the mosquito fish, to catch the fish concentrated at the surface, and hence satisfy the daily food requirements of their young.

1 - *Hafner et al. (1993)*

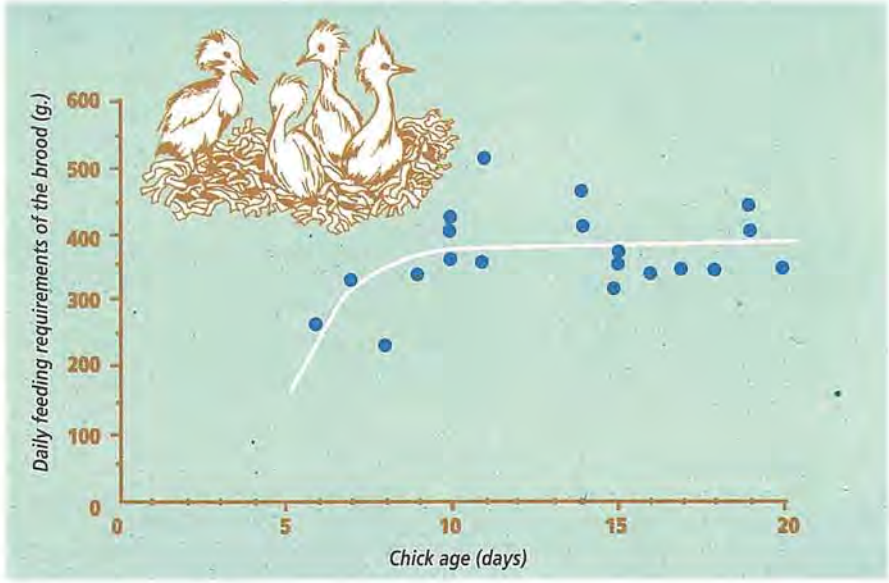


The daily food requirements of wading birds are 10-20% of the species' mean body weight

Source : Kushlan (1978).

Since the environment has only a limited "carrying capacity", it is not possible for an unlimited number of colonial waterbirds of one species to exist in the same area. And since all pairs have roughly the same feeding requirements during the rearing period, the bigger the colony, the more competition there will be between breeding pairs for food. Thus, the colony size is partly regulated by food availability around the colony, as well as by other species breeding at the same site.

Great white pelicans use a very elaborate fishing technique, which starts with a flock surrounding a shoal of fish.



Little egret chicks grow rapidly and the brood's daily food intake quickly stabilises at 350 grammes per day.

Source: Hafner *et al.* (1993)

Distance and size of feeding grounds from the colony

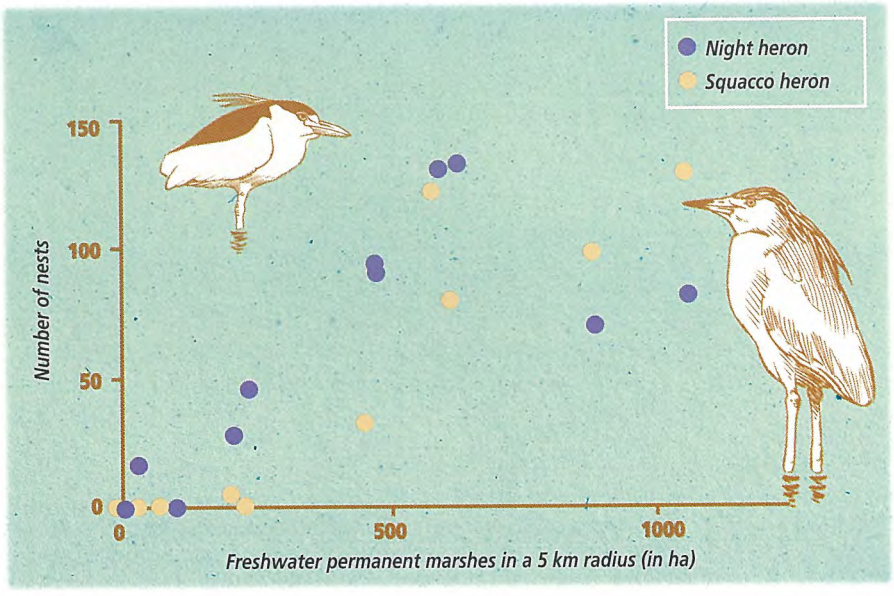
While for most species of colonial waterbirds, their preferences for nest sites are fairly well understood, their feeding requirements remain rather poorly known in quantitative terms, despite the need for such information for practical conservation.

For example, how much feeding habitat is necessary to support a mixed species colony of a given size? And how diverse and rich in prey should the habitat be? Unfortunately, studies on feeding ecology are difficult and generally involve considerable costs of manpower and material, i.e. equipment for radio telemetry, nest balances etc.

Nevertheless, over the past 20 years knowledge on the size and type of feeding area required to sustain heron and egret populations has improved greatly thanks to international collaboration between researchers around the Mediterranean.

Studies[1] at 30 nesting sites in southern France, Spain, Algeria, Tunisia, Israel, Greece and Italy have shown that breeding populations of night heron, little egret, squacco heron and cattle egret may be limited by the size and quality of the freshwater habitat. Large, plurispecific colonies were only found where there were over 800 hectares of freshwater habitat within five kilometres of a colony site. Below this threshold, the potential colony size decreased rapidly.

1 - Hafner & Fasola (1992)



The colony size depends on the surrounding area of freshwater habitat

Source: Hafner & Fasola (1992).

For many species the energy costs of flight become too high if they have to forage beyond 10-15 kilometres in order to raise the brood.

The differences in foraging range between species are related to each species' body size and specific behaviour. Large-bodied birds are usually able to travel further than smaller ones because their energy cost of flight is lower. For example, of the fish-eating species nesting at Lake Mikri Prespa (Greece), the pelicans and cormorants regularly fly, between March and May, to fish in Kastoria Lake, about 45 kilometres away. Here the slightly warmer water at a lower altitude enables fish to be active, and thus detectable to birds, earlier in the season. However, the smaller pygmy cormorant from the same colony do not travel as far.

Among terns, which carry fish to their chicks one by one, the smaller little tern forages closer to the colony site (up to 3 kilometres) than the larger sandwich tern (15 kilometres), while the common tern is intermediate both in feeding range (8 kilometres) and in size.

The foraging range may increase if the species has developed energy-free flight techniques such as soaring or ways of storing and processing food items in their body. For instance, gulls store food in their crops and regurgitate it for their chicks; they are able to make longer foraging trips than terns.

Pelicans and greater flamingoes make exceptionally long flights and may travel 100 kilometres or more to feed; pelicans reduce the cost of flight by soaring, whilst flamingoes are able to process and concentrate the food while they are away from the colony, by producing a special secretion in their crop, which they later feed to their chick.

Pushing back the limits of food collection

In the eastern Mediterranean, two species of pelican nest at the same place, lake Mikri Prespa in Greece. Their gliding ability and foraging requirements differ: the Dalmatian pelican can feed in both deep and shallow water, and can fly and glide at any time of the day, whereas the white pelican needs shallow water to forage and will not leave the colony until thermals set in late in the morning.

Because shallow water is not always available, the white pelican is sometimes obliged to feed 100 kilometres away, spending the night on the feeding ground and returning to the colony in the early afternoon of the following day. When the single chick is old enough and its two parents can forage at the same time, it can be fed on average once a day (every other day by each parent). However, in bad weather, which prevents the formation of thermals and therefore the parents from foraging, the chick may be fed only every other day.

Conversely, Dalmatian pelicans can feed their chicks several times a day because they can use any feeding area, from 100 metres to many kilometres away from the colony, leaving the colony at dawn and returning at dusk, an impossible task for the white pelican.

Thus, although they belong to the same family of birds, the differing feeding strategies of the two species produce quite different life styles.

Richness and diversity of feeding grounds

The richness in prey, as well as the environmental diversity, determines the area that breeding birds from a colony will have to prospect to find sufficient food. The poorer the area, the further the birds will have to forage. Good habitat diversity around a colony will offer a wider food range, which in turn can ensure a more predictable food supply for the whole duration of the breeding season. In such situations, where an important prey species dwindles during the breeding season, birds have the option of shifting to another habitat and other prey.

In Portugal, a study[1] showed that both large and small colonies of little and/or cattle egrets can exist with a much smaller area of freshwater habitat nearby than is demonstrated in Figure p. 32. The size of cattle egret colonies was mostly limited by the area of dry pastures and crops within 5 kilometres, while the number of little egret nests depended on the combined area of freshwater and brackish habitats.

Throughout the Mediterranean region, large and diverse populations of herons are found only where extensive, freshwater feeding sites exist. In other situations, colonies may be large, but are less diverse.

The requirements of heron and tern colonies located along rivers (the former are commonly encountered in Greece and Turkey) have apparently yet to be studied; they can be expected to be quite different from freshwater marsh colonies since feeding grounds are linear.

The shallow, permanent freshwater marshes necessary to large, plurispecific heron colonies have become a vulnerable and rare habitat in the Mediterranean region. Herons have been able to adapt to some extent; in Italy and Spain in particular, the most important populations now use man-made habitats instead, for example rice-fields and adjacent irrigation systems. Other adaptations to transformations by man are possible as well.

1 - *Farinha & Leitao, in press*

Characteristics and functioning of a breeding colony

Plurispecific colonies: an example of the importance of the diversity of feeding habitats

Plurispecific colonies can only occur where there is good ecological diversity of feeding habitat around the colony site and because the attendant species have different diets and foraging ranges. The birds segregate by selecting different habitats, while their overlap in food is high. It seems that habitat is more important than food in the segregation of trophic niches.

The illustrations on the following pages represent typical resource partitioning by Mediterranean plurispecific colonies, as found in deltas, such as the Camargue, the Ebro or the Göksu.

Colonial waterbirds and introduced (prey) species: a complicated issue

In Spain, it has been shown[1] that the introduced American crayfish *(Procambarus clarkii)* and the Pumpkinseed fish *(Lepomis gibbosus)* have become an important source of food for a grey heron population. The crayfish accounted for only 1.2 per cent of all prey collected in 1986 but this rose to 24 per cent in just four years; the proportion in terms of biomass rose from 0.3 to 6.2 per cent.

In Spain and Portugal, researchers consider that the American crayfish is now also a vital prey for white storks[2], and that they may have contributed to the species wintering in larger numbers in Iberia in recent years. In the Camargue, introduced mosquito and pumpkinseed fish can be a major source of food for some heron colonies[3]. In the two Prespa lakes in Greece, the introduced fish *Pseudorasbora parva* is an important food source for the pygmy cormorant[4].

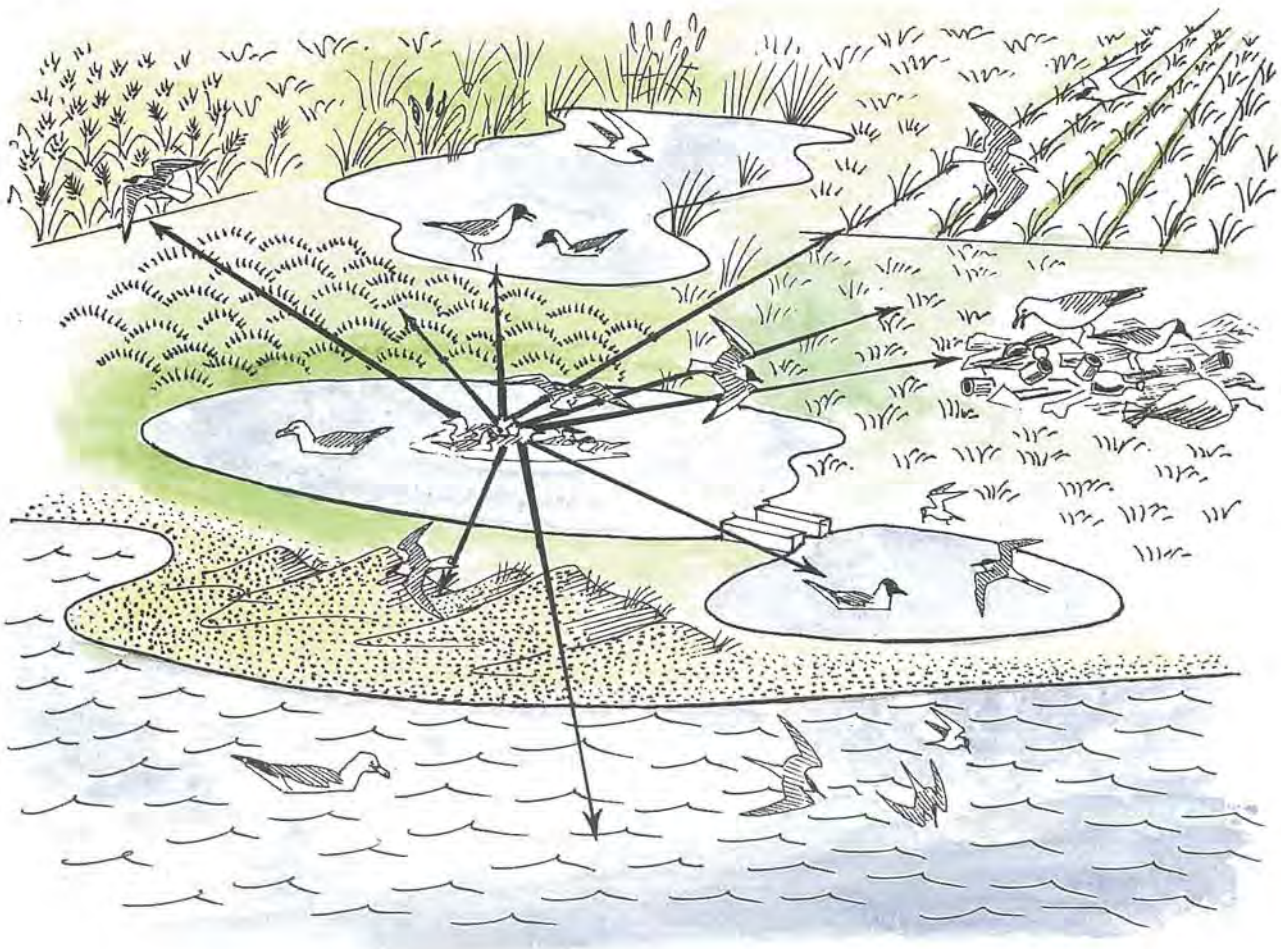
So, while they should never be recommended because of their potentially harmful impact on aquatic ecosystems and native prey species, the introduction of alien species has locally provided additional food sources for some colonial waterbirds.

1 - *Peris et al. 1994*
2 - *Mañez et al., 1994*
3 - *Hafner, pers. data*
4 - *Crivelli, comm. pers.*

Avocets and slender-billed gulls feed only in brackish lagoons and salines, largely on invertebrates that can reach enormous densities (between 500 and 1000 grammes per square metre) and, for the latter, fish. The sandwich tern is the only species that depends exclusively on the sea for food; little and common terns partly forage at sea, mainly along the coast, in addition to lagoons and salines. Freshwater marshes and their artificial substitute, rice-fields, are used by the gull-billed tern and Mediterranean gull, both of which feed on crustaceans, amphibians and insect larvae. Little and whiskered terns also seek small fish and insects in these marshes.

In the Camargue, a mosaic of different habitat types, natural and artificial, and ranging from freshwater to the sea, allow terns, gulls and waders to breed together in large numbers.

Drawing by Serge Nicolle.



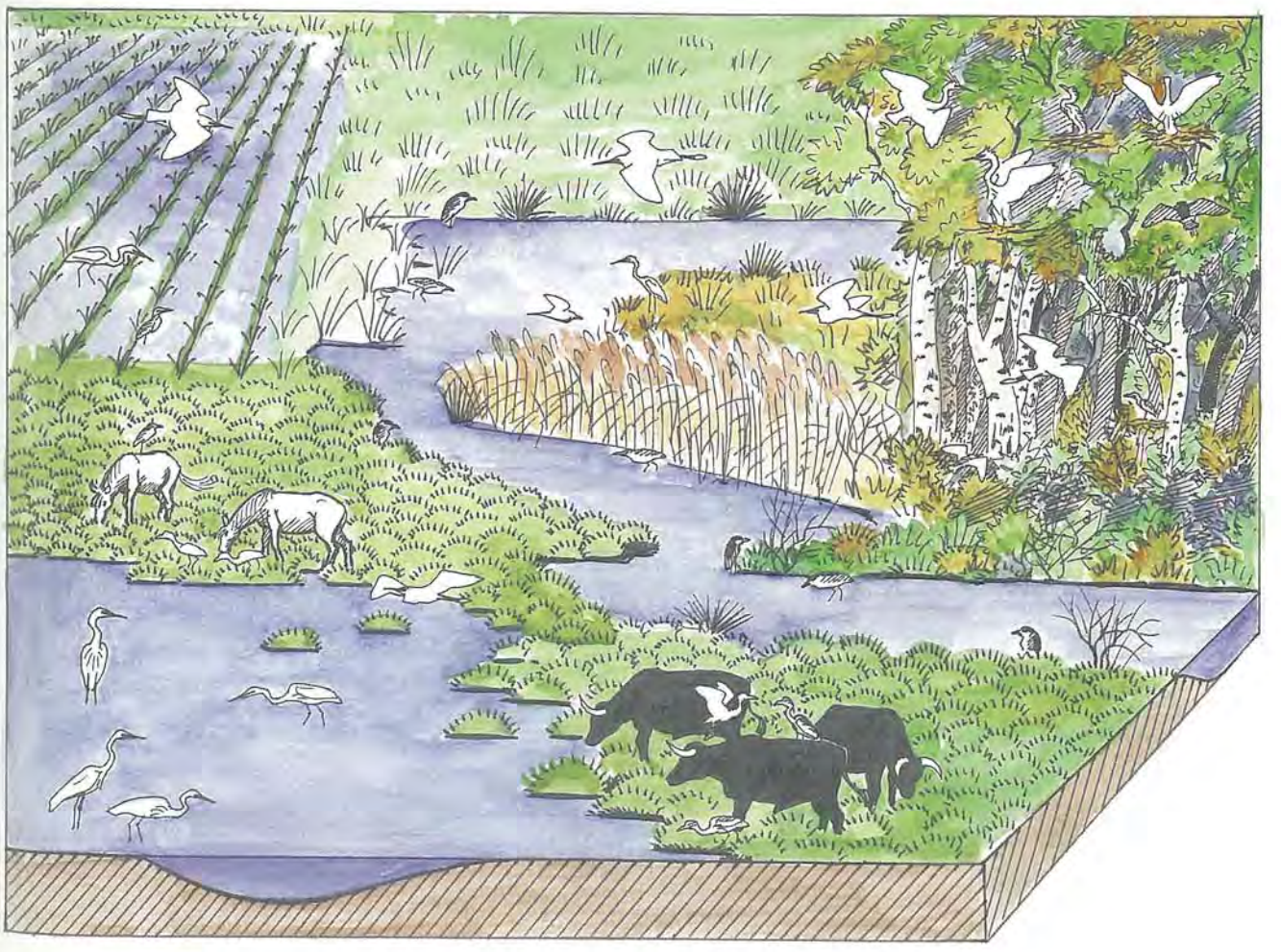
Characteristics and functioning of a breeding colony

Yellow-legged and black-headed gulls are opportunists that can be found in most of these habitats, as well as in neighbouring rubbish dumps.

Similar examples of co-existence of various species of tree-nesting herons, each of them specialising in a different feeding habitat, can be found throughout the Mediterranean region (see figure below).

A plurispecific colony of tree nesting herons, in which each species feeds in a specific habitat.

Drawing by Serge Nicolle



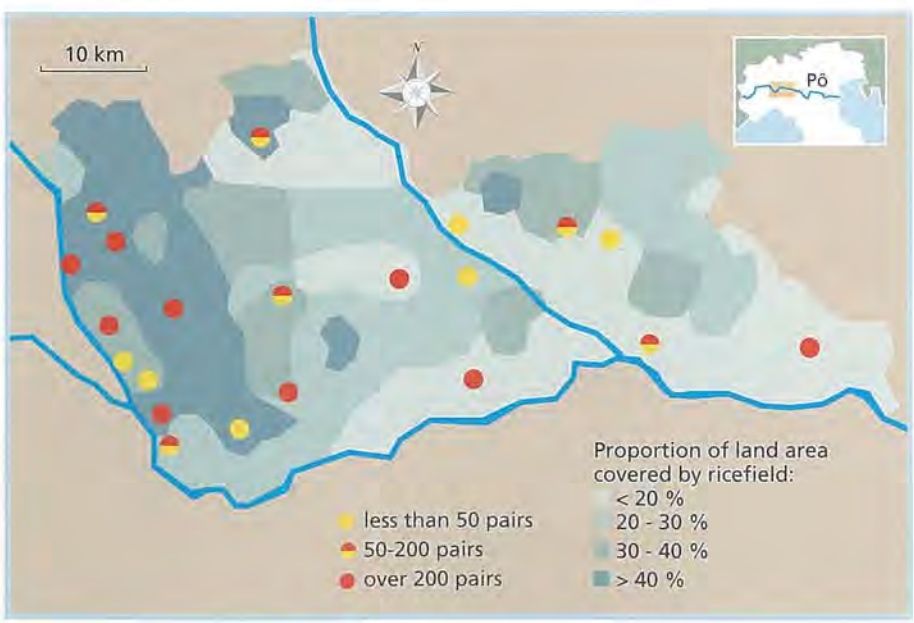
Colony size and competition between colonies

Resource partitioning, through interspecific competition, can occur between individuals of different species settled in the same site. However, competition between individuals of the same species (intraspecific competition) appears to be even stronger, individuals having the same requirements.

Both colony sites and nest sites within colonies may limit numbers at a local level. Food availability during the breeding season may be reduced by intraspecific competition, thereby reducing breeding success or leading to poor body condition in chicks. This in turn regulates colony size and overall populations.

In seabirds, the size of the colony decreases in proportion to the number of other colonies of the same species within the feeding range. In herons, in large wetlands where several colonies of the same species exist, a minimum distance between colonies often exists, presumably as a way of reducing competition between colonies.

In Northern Italy, a major breeding ground for Mediterranean herons[1], colonies are located an average 5.7 kilometres away from each other (ranging from 4 kilometres in areas with rich feeding habitats to



Colonies of tree-nesting herons in the upper Pô valley are more numerous where the density of ricefields is higher.

Source: Fasola & Barbieri (1978)

1 - Fasola & Barbieri (1978) ; Fasola & Alieri (1992)

10 kilometres in areas with less rich habitats), although potential breeding sites lie closer to each other. This suggests that the colonies deliberately maintain a certain distance between themselves.

In regions and species where a minimum distance does exist, the practical implication is that it is probably of little short-term use to try and create an artificial site near an existing, natural one, unless there is a clear threat to that site and the intention is to provide birds with an alternative for the future.

Site tenacity and group adherence

Each spring, newly arriving birds appear on the nesting area and begin to form a colony. Colony formation moves through a series of stages, from pair formation and development of the nest site to the period of stable colony structure when pairs may initiate social relationships and start to breed. Social interactions are very important throughout.

Where their main habitat is stable, species will show greater site tenacity to their traditional colony sites. In unstable habitats (e.g. islets in rivers or lagoons, sand bars), site tenacity is a poor strategy because the colony site is not available permanently.

Species adapted to these unstable habitats (e.g. terns, greater flamingoes, Mediterranean and slender-billed gulls) tend instead to increase their fidelity to the group of birds with which they are used to nesting.

When conditions in the old site deteriorate as a result of environmental change or predation, such group adherence, by preserving social relationships within the group, enables the birds to quickly colonise a new site without delaying reproduction. Thus, in these species, disturbance in the early stages of colony formation (e.g. nest building or the start of egg-laying) will often lead to desertion of the colony and to tentative recolonisation elsewhere.

The dynamics of colonies

Breeding success in a given year is a key factor in colonial waterbirds using the same site in the following year; good breeding success usually leads to attempts to use the same site again if it is still suitable.

Breeding success and colony persistence

Some species tend to return to the colony where they were born (so-called "philopatric" species, such as pelicans) or where they had their first breeding success (e.g. yellow-legged gull). This fidelity to the breeding site is related to its stability. The more stable a site is, the more site fidelity is a guarantee for the future. Other species, such as terns, Mediterranean and slender-billed gulls and greater flamingoes, are overall less attached to a specific site and are in general more adapted to unstable habitat.

The response of colonial waterbirds to a breeding failure tends to be more radical (colony shift) in the following year if the breeding failure has been massive (e.g. colony destruction by predators), than if the breeding success has simply been low, without any great stress or accident occurring. In the latter case, one might witness a mere reduction in breeding numbers, but not necessarily the abandonment of the colony site.

The history of the colony, as well as the degree of philopatry are therefore important factors to take into account if one plans to attract birds to a newly created site. Colonies may be more quickly attracted to a new site from areas where they are often disturbed or predated, than from areas where they have good breeding success.

Similarly, philopatric species may be more difficult to attract to a newly created site, because of their attachment to the previous one.

Characteristics and functioning of a breeding colony

Traditional colony sites as an exception in natural conditions

The Mediterranean region is characterised by large yearly and seasonal variations in rainfall, which makes the hydrological regime of its wetlands highly variable and unpredictable.

A breeding area which is suitable in one year after good rains may become unsuitable the following year; there may be no surrounding water to offer protection to the colony site or feeding areas. The variability in water levels is emphasised in Mediterranean deltas, where the action of both river and sea flooding increases the instability of the landscape and creates a dynamic process where islands, islets and sand bars emerge or disappear, and vegetation changes through natural succession.

The Dalmatian pelican colony in Lake Skadar, on the Albania/Montenegro border, has been known since the second half of the last century, and still exists. However, the birds have used several nesting sites within the wetland, including a ruined castle and an island in the middle of the lake.

In response to these fluctuating circumstances, colonial waterbirds (in the Mediterranean as elsewhere) have developed colony mobility as a major adaptation. Although it is usual for a colony to persist within a given wetland, it may use successive sites depending on their natural evolution, or alternative sites in different years depending on hydrologic fluctuations.

Some colonies, for example of terns, waders and gulls, are able to switch from one island to another, even within the same breeding season, when breeding conditions become unsuitable. Tree-nesting herons prefer an intermediate stage of vegetation succession and tend to abandon woods where the trees have grown too old.

Nesting greater flamingoes in the Camargue

Although nesting in the Camargue by greater flamingoes has been known since 1551, breeding used to be sporadic, occurring only when a potential breeding site was formed naturally through the action of the sea and/or the Rhône river.

Over time, erosion by waves, aggravated by nest-building by the birds, eventually led to the disappearance of the colonies and, unable to find alternative nest sites in the Camargue, the flamingoes either did not nest or instead nested in areas of Spain or North Africa, wherever conditions were favourable.

When a new, suitable site emerged in the Camargue in 1969, the flamingoes returned. Since then, they have bred every year, although they used four different sites in succession, including one created especially for them. So, although this region of 1,450 square kilometres can be regarded as a traditional (although not permanent) breeding area, the "traditional" breeding site currently used is a relatively recent creation.

Colony size and breeding success

Optimal group size can be defined as the size leading to the highest reproductive success. Success will increase with colony size, through social stimulation or group defence against avian predators, but beyond a certain threshold the costs (e.g. competition and disease) will outweigh the benefits. The birds must therefore find the right balance. Environmental factors such as colony site, nest site, predation and food all limit the colony size, with the optimal size for any one species dependent upon its sensitivity to each of these factors.

As social stimulation is essential for colony formation, a minimum group size is a prerequisite for good breeding success; minimum and optimal colony sizes vary considerably between species. A few pairs of common terns may form a mono-specific colony, whilst this is very rare for sandwich terns. Dalmatian pelicans in Greece and Turkey breed just as successfully in small as in large colonies, as apparently do egrets and herons in the Camargue and as greater flamingoes have recently done in Turkey, Italy and Spain.

The slender-billed gull is presently expanding in the Mediterranean, possibly due to increased immigration from the Black Sea.

Characteristics and functioning of a breeding colony

The number of breeding pairs is only one of the parameters of a colony; large colony size does not guarantee good breeding success. In the Camargue, the numbers of colonially breeding gulls, terns and avocets have been quite stable, or even increasing, over 40 years, but the colonies have suffered poor breeding success overall. The changes in numbers may simply be due to external factors such as immigration, and not to local breeding success. Thus, monitoring breeding success is the surest way to measure the real health of a breeding population.

A. R. Johnson

Flamingoes may forage upto 150 km away from their nest, before returning to feed their single chick with a special crop secretion.

A. R. Johnson

Some principles before creating a new colony site

Mediterranean wetlands have long been subject to human influence, especially drainage, canalisation and regulation. Not all man-induced changes in the environment are harmful to colonial waterbirds.

Reservoirs and salinas in the Mediterranean are widely used by waterbirds for feeding, and even for breeding if islands (or rafts) are provided. Some waterbird species breed quite happily in close proximity to man. For example, a census[1] of the white stork population in Spain in 1984 showed that 60 per cent of the 6,500 nests located were on man-made structures (e.g. buildings and electricity poles).

Most species, however, are less trusting and adaptable, and the lack of a suitable nest site can prevent their breeding, and eventually induce a population decline. Habitat modifications wrought by man are too recent, in evolutionary time, for most species to have been able to evolve adaptations.

Heavy machines may be required to create or improve an artificial colony site, as here for flamingoes in the Camargue.

1 - Lazaro et al., 1986

The construction of artificial sites is thus often motivated by the desire to counterbalance the damaging effects of human interference with natural breeding sites by offering birds an alternative, safe breeding site. For such actions to be successful, full account should be taken of the complexities of colonial waterbird ecology, as well as other (e.g. sociological) factors.

To attempt to create an artificial nest site that is successful and brings real conservation benefits requires prior consideration of two key principles: justification for the site, and how to avoid conflicts with human interests and activities. Only then should the practicalities of building an artificial nest site be considered.

In the Camargue, the degradation of large reedbeds managed for shooting caused many breeding sites of purple heron to disappear.

When is creating an artificial nest site justified?

The reduction in the number or quality of natural sites is the main, but not the only, justification for creating an artificial site. Throughout the Mediterranean, human activity has drastically reduced the number or quality of breeding sites, or even worse, affected the natural processes that enable the natural development of new ones.

Reedbeds and woodlands

In Mediterranean France, reedbeds are increasingly managed for hunting and large openings are created which, in the process, destroy the dense structure required, for instance, by purple herons. Moreover, because the hunting season opens in mid-summer, hunters manage the water levels in a way that is catastrophic for breeding purple heron: marshes dry up too early compared to the natural Mediterranean cycle, resulting in increased predation or disturbance by terrestrial animals, and eventually to desertion of the colony site.

Woodlands are no better off. Their loss through cutting removes potential nesting sites for tree-nesting species, while human activities and disturbance reduce breeding success and justify some form of artificial management, as at lake Kerkini in Greece.

In the Camargue where such management is recent, the population of purple herons declined from ca. 400 pairs to fewer than 40 between 1980 and 1993, whereas in the adjacent Petite Camargue where reedbeds have been much less affected, breeding numbers remained constant. However, despite this evidence, a causal link between these observations has not yet been demonstrated.

To counterbalance such trends, the restoration or creation of colony sites (woods or reedbeds) is justified, provided that no other factors (food, hunting, disturbance) limit the birds. For woodlands, even small areas a quarter of a hectare in size can host hundreds of breeding pairs, but their creation is a long-term process. On the other hand, the creation of reedbed requires much larger areas but is a faster and simpler process. Many other species can benefit in the process, for example bittern, rails and marsh warblers.

Artificial platforms for colonial waterbirds at lake Kerkini, Greece[1]

Lake Kerkini is an irrigation reservoir in northern Greece. Its water level, dictated by human use, fluctuates by up to five metres. Mixed colonies of 10 waterbird species (two cormorants, glossy ibis, spoonbill and six heron species) are established on trees in the lake. The fluctuating water level constitutes a major threat and floods many nests every spring.

In 1989, artificial, open nest platforms were built; fixed structures that were placed beyond the reach of high water levels. In the second year, cormorants colonised the platforms and successfully raised chicks, their breeding success matching those of cormorant colonies established in trees.

This was a case of justified active management, to counteract negative (although in this case involuntary) human impacts. Sadly the platforms were destroyed by local people during the following winter.

Artificial sites for species that require cover overhead (i.e. pygmy cormorant, little egret, squacco and night herons) have not yet been tested at Kerkini.

G. Magnin

Artificial platforms for breeding pelicans at Manyas Lake, Turkey.

1 - After T. Nazirides & E. Tsachalidis, pers. comm.

Some principles before creating a new colony site

Any decision to build an artificial nest site must result from careful analysis of the situation – for colonial waterbirds such action may not be the panacea it seems.

Islands and islets

In many Mediterranean deltas, the natural process of island formation and erosion, brought about by the opposing influences of sea and river and by the rivers' sediment load, has been much reduced through the creation of dykes and dam building. This retains the sediment upstream and reduces the volume and weight of water flowing into the delta. This in turn creates problems for colonial waterbirds that nest on unstable islands, for while the natural process of island formation has been stopped, erosion through wind and wave action continues.

As a result, the number of potential colony sites has gradually decreased to the point of being a key limiting factor for populations of mainly, terns, gulls and greater flamingoes. In such cases the provision of artificial breeding sites may be the only way to retain breeding colonies in particular regions.

Priority to conserving existing colony sites

In all cases, existing colony sites deserve the highest conservation priority. If the birds find them suitable, even for only occasional use, it is better to conserve them than to risk attempting to create a new site. The creation of new, artificial nesting sites, particularly those requiring large-scale management, should only be considered as a last-resort solution, when other options have been ruled out.

Other reasons

Active management is justified where man's influence has had a detrimental effect on the natural processes that form new breeding sites.

In some cases, the aim of creating an artificial site is to displace a colony, either because the birds are unwanted in a particular locality, such as airports, electricity pylons (popular with white storks), urban areas, private houses (where the smell and noise of a colony may be resented) or fish farms, or because they have, or may, become vulnerable at the old site.

Attracting an existing colony to a site offering long-term protection is then justifiable from a conservation point of view.

Greater flamingo colonies in the Camargue

In the Camargue, both the Rhône river and the sea have been contained by dykes since the mid-1800s, and the natural process of island creation has ceased. In the mid-1960s, it was feared that no new suitable nesting island would re-emerge naturally and that the greater flamingo might not breed again in the Camargue.

Restoration of the existing but damaged site was considered but rejected because another location, sheltered by a dyke, would provide much better protection from wind and erosion. Unlike the original site, it would also dry up in winter, enabling heavy machinery to be used for island-building and future restorations.

A new island was built in 1969-70 and decoy nests built in subsequent years so as to attract flamingoes. They occupied the site in 1974., and the island has been used every year since.

The old site still used by part of the colony until 1975 was subsequently abandoned by the birds.

The main reasons behind the decision to build an artificial site were that:

- unless some active management was undertaken, there would be nowhere for the flamingoes to nest and they would have been lost to the Camargue ;
- restoration of the existing site would have been impractical (e.g. no access for bulldozers) and ineffective in the long term due to continuing erosion.

The decision to proceed with the creation of an artificial nest-site proved, in this instance, to be correct, but might not have been wise under other circumstances.

The former nesting island, heavily eroded by waves.

A. R. Johnson

After building a new island with heavy machines, decoy nests are a strong incentive for flamingoes to breed.

Avoiding potential conflicts with man

Colonial waterbirds are sometimes accused, and rightly so, of being harmful to human interests. For example, cormorants, grey herons and even black-headed gulls can take fish from commercial fish-farms.

In south-east Europe, some fishermen regard pelicans as a threat to their livelihood, although in most areas they exist quite happily side by side. The greater flamingo in the Ebro delta and the Camargue has been accused of trampling, or even eating, rice seeds and seedlings; studies have shown that it can be a real problem on some localised fields. Yellow-legged gulls, which have proliferated with the help of open-air rubbish-tips, are regarded as a dangerous nuisance around airports, where they pose a threat to flying aircraft. They are even considered a nuisance by conservationists, since they may affect the breeding success of other colonial waterbirds through predation (e.g. of flamingo eggs and chicks) or competition for nest-sites with other gulls and terns.

J.F. Noblet / Bios

The proximity of roosts or colonies of fish-eating water birds locally lead fish-farmers to protect themselves against potential predation, without killing the birds.

Artificial nest-sites should not be developed without serious consideration of the potential for conflict with man. Ignoring this may initially lead to increased bird populations but increased damage (real or perceived) may eventually prove detrimental to the long-term conservation of a species or a site.

It is often irrelevant to argue that damage caused by birds is small or unproven; perceived damage is just as serious a threat, because of the resulting negative perception of nature conservation.

Any plans for an artificial nest site should therefore consider the local human context, and good communication with local people must be established.

How large should an artificial colony be?

In the Camargue, the artificial flamingo-nesting island has been saturated with birds since 1983 as the population has increased. Two strategies presented themselves: either to build a second island to enable the population to increase further, or to allow the flamingoes to adapt to the existing situation.

Adoption of the first strategy would probably have led to more flamingoes feeding in rice-fields in years when low rainfall obliged them to do so, further aggravating the conflict with rice-growers and eventually harming nature conservation interests in the Camargue. As a result, the second strategy was adopted.

Since 1993, new nesting sites, such as those in the Ebro delta (Spain), Molentargius lagoon (Sardinia) and Orbetello lagoon (Italy), have been colonised.

The Camargue origin of some of these pioneers has been shown from their leg-rings; indeed, some birds which tried to breed (unsuccessfully) in the Camargue, tried again a few weeks later in Sardinia.

It can be assumed that the decision not to create a new site in the Camargue probably forced western Mediterranean flamingoes to colonise new nesting sites, an option which is safer for them in the long term. Likewise, the conflict with human interests in the Camargue has remained limited.

Methodological principles

Creation of artificial sites usually fails if the essential requirements of the birds, such as food, are not taken into account.

Stating the objectives

Various objectives may justify the creation of a new nest site. Whatever the objectives, they should be spelt out clearly from the outset and, where there is more than one, an order of priority should be placed on them. This will assist the wildlife manager if he is later faced with a difficult choice between, for example, conservation, research or education activities, all of which may imply a certain level of disturbance.

Taking biological requirements into account

The Mediterranean region provides examples, both successful and unsuccessful, of artificial nest sites for colonial waterbirds.

There are two probable reasons for those that fail:

- insufficient knowledge of and respect for the ideal characteristics of nesting sites (geographical location, vegetation or shingle cover); however, knowledge of these aspects has improved considerably of late, but its application on the ground still lags behind

- feeding requirements are still not sufficiently known or taken into account. It is essential to bear in mind not only the need for tranquillity, nest sites and nest material, but also the considerable demand for food resources.

Long-term planning...

Although creating a nest site may be an emergency solution, the likelihood of the long-term survival of the colony must be evaluated as early as possible. Ignoring the long-term planning aspect may lead to big efforts – and large amounts of money – being poured into actions that will result in little benefit to colonial waterbirds. Long-term planning needs to be addressed on both a local (single-site) and regional (multiple site) scale.

- ...at single-site scale

It would for example, be nonsense to build an artificial site in an area where there are plans to divert water for irrigation, drinking purposes or industrial developments which will lead to a predictable drying-up of potential nest or feeding sites.

Possibilities to maintain long-term, vital nest site characteristics need to be critically examined. A freshly created site will not retain its original features: an island may erode, a plantation may become too dense or tall for herons, or a reedbed may be gradually invaded by shrubs. These natural processes are well documented and need to be considered at the outset. In addition, periodic restoration of an island (including seasonal access by heavy machinery), wood coppicing and light grazing to control shrubs etc will need to be addressed and must be included at the planning stage.

Finally, planning must include the level of protection afforded to the site. Obtaining formal protection, for example as a nature reserve, must be a long-term goal.

One of the artificial woods, surrounded by water, that was planted in 1970 on Tour du Valat, Camargue, for tree-nesting herons.

Some principles before creating a new colony site

• ...and at multiple-site scale

Planning at a single-site scale is not always sufficient, as in the case of species that require a particular stage in the natural evolution of a site (wood, island, reedbed) in order to breed. Hence, regional planning is necessary as well. This can include, for instance, planting woods in stages that will later provide a succession of optimal nest sites for herons.

For species adapted to unstable habitats, a multi-site approach may allow the creation of some variability within a controlled, stable habitat.

For species that nest in unstable habitats, several potential colony sites could be managed so as to provide nest sites in different years, rather than all simultaneously. The system would in fact mimic natural variability, which is needed to avoid colonisation by competing stable-habitat species such as the yellow-legged gull. This can be obtained by using either floating rafts placed in different locations each year, or by forcing the birds to use different islands in successive years, e.g. through controlling access of predators by removing bridges. Such a management strategy has been tested in the field[1] and seems beneficial to the birds.

Artificial breeding sites for tree-nesting herons: strategic aspects

An analysis of the distribution of tree-nesting herons in the Camargue between 1948 and 1970 suggested that there was a lack of suitable breeding sites, with many sites being abandoned due to human disturbance or destruction, for example by owners who did not like the noise and smell. As there was no lack of feeding areas nearby, it was decided to increase the availability of nest sites through artificial plantations on Tour du Valat estate[2].

Since herons prefer a particular stage of woodland growth (10-15 years), three artificial sites were created over 25 years, within 6-8 kilometres of each other: in 1970 (used by herons from 1981 to 1984), in 1978 (not yet used), and 1994-1995. A fourth site lies in a natural woodland, occupied between 1985 and 1994, with some shifts occurring from year to year within the wood.

Such multiple-site planning, taking into account both the natural evolution of nest-sites and the birds' needs, will ensure that whatever happens elsewhere, there will always remain at least one suitable breeding site in the middle of this traditional breeding area. Whether target species nest or not in these artificial sites is of less relevance; it is the persistence of the colony in the area which is the ultimate measure of success, with artificial sites temporarily contributing to it (e.g. between 1981 and 1984).

1- After N. Sadoul, pers. data
2 - Hafner (1982)

The gull-billed tern island, Camargue

In the Camargue, an island created for gull-billed terns in 1979 was used, with good breeding success, within months by large numbers of these and other terns, as well as gulls and avocets. However, during the next ten years it was not used again as a nesting site. It was thought that the island's surface should be gravelled and after completion of this work in 1989, gull-billed terns and other species immediately came back to breed in 1989 and 1990, albeit with low success. From 1991 onwards, yellow-legged gulls colonised the island, occupying it year-round and excluding all other breeding species either through competition for space and/or by predation. Nowadays, no gull-billed terns nest on the island.

This illustrates the difficulty for a wildlife manager who has to take everything into account – there will always be the unknowns and the only way to proceed is by trial and error. Seventeen years after the island was built, we now know that terns, waders and smaller gulls avoid competition by rapidly colonising recently created islands, but that they are unable to compete with yellow-legged gulls on stable islands.

The yellow-legged gull is only a recent threat, being absent from the Camargue as a breeding species 50 years ago. Its expansion has undoubtedly been made possible through dyking of the delta, which has made it a more predictable environment, and by the nearby, huge, open-air rubbish tip of Marseille.

Given this new constraint, the solution might lie in reintroducing a degree of unpredictability in the nesting islands, or in eradicating the unwanted gulls as soon as they colonise an islet preferred by other species.

H. Hafner

Nesting gull-billed terns.

Long-term monitoring

As with all management processes, results should be closely monitored and, if necessary, the operation reoriented. Ideally, monitoring should encompass the following factors:

- the site and its evolution: size, structure, negative factors (e.g. erosion or invasion by shrubby vegetation in the case of islands; serious tree parasites);
- the size of each waterbird population, and its evolution in time;
- the breeding success of each species.

Monitoring is the tool by which the wildlife manager can assess and then react as necessary to the birds' use of the new nesting site, as well as forecasting the future to some extent. In the Camargue, populations of most gulls, terns and avocets have been stable or increasing for 40 years, and a very basic monitoring (e.g. of the number of pairs present) would conclude optimistically on their future. However, detailed monitoring has actually revealed very poor breeding success, which suggests that increasing numbers may be due to external factors such as immigration[1]. Should this immigration stop, these apparently healthy populations could possibly collapse.

Thus, monitoring the breeding success of colonies appears to be the best way to measure the real health of a breeding population, to make reliable predictions, and to help choose an appropriate management strategy. Care should be taken, in implementing the monitoring process, to ensure that the monitoring itself does not become a cause of breeding failure.

1 - After N. Sadoul, pers. data

Synthesis: a planning checklist before creating an artificial nest site

A detailed feasibility study should be carried out before any implementation, ensuring that a review of key issues has not been omitted. A list of the questions that should be critically assessed for each planned site follows.

- Are there any natural colony sites in the neighbourhood whose protection would deserve higher priority than the creation of a new one?
- What are your objectives? Are you targeting one species, or a whole community?
- Is human activity preventing the natural formation of new sites?
- Is there sufficient food around the planned colony site?
- Can predators and human disturbance be easily excluded from the planned site?
- What is the likelihood of the colony's long-term survival?
- Are there any risks of colonisation by an unwanted species (e.g. yellow-legged gull), and if so have you already prepared a solution to this?
- Does your planning take into account multiple-site aspects, especially if the targets are "shifting" species (e.g. terns, waders)?
- What is your target colony size? Is the planned site large enough?
- Are there any plans by local or national authorities to divert or use surrounding water, which would lead to the area drying up? And are there any other plans which would affect nesting or feeding sites?
- Is the planned site under any form of protection, legal or otherwise (e.g. sympathetic owner)?
- Is there any risk of the colony causing disturbance to local people, or harming economic activities (e.g. fish-farms, rice-fields, location close to an airport) ?

Some principles before creating a new colony site

- What type of regular or periodical maintenance (wardening, monitoring etc) will be necessary for the future colony site?
- Will there be sufficient resources in the long term to manage and maintain the site?
- Is the location chosen the most adequate compromise between the birds' requirements and the practical aspects (e.g. access for the maintenance machinery)?
- Are any aspects of the biology of the target species insufficiently known and which might pose a real risk of failure? (It is vital to be aware of this, although it should not deter possible action.)
- Have you consulted specialists in the group of birds you plan to attract to the colony site?

You are now ready to start work on creating an artificial nest-site for colonial waterbirds.

Good luck!

Technical Fact-Sheets

Before doing anything, you should think carefully about all the aspects described in the first two chapters of this guide and summarised at the end of the second chapter (pp 58-59).

The technical fact-sheets presented in this chapter are grouped into three sections : "Breeding structures", "Attracting birds to the artificial site", "Management for specific purposes".

In the first section, general information is provided on how to build each of the artificial breeding structures (islands, rafts, platforms and wooded areas).

In the second, the methods used to attract birds to these artificial structures are described (artificial and living decoys, artificial nests and recordings of bird calls).

Finally, more detailed specifications are provided for each species are included in the section "Management for specific purposes".

Cattle egret.

Generally, any such management project implies drawing experience from these three sections or at least the first and third of them (type of structure and species).

Because there is little experience of such practices in the Mediterranean region, two principles must be kept constantly in mind:

- If a particular method hasn't been attempted with a particular group of birds (e.g. using live decoys in an aviary to attract ibises or spoonbills) this doesn't mean that it won't work. Common sense and experience acquired on taxonomically related species (in this case, herons) or on the same groups in other countries or other continents (northern Europe, North America) can be used to advantage.

- In this chapter, the materials mentioned were those used in actual situations to create artificial breeding sites (e.g. marine plywood for making rafts, polyurethane foam for making artificial decoys). It is obvious that these are just one solution among many. In practice you show inventiveness and flexibility: if you don't have any plywood, bundles of reeds could also be used to make rafts and decoys could be carved out of cork.

It is vital to keep in mind the possible negative visual impact of some materials (e.g. old tyres), and to remember that they are not all biodegradable (e.g. polystyrene). Any structure built with such materials should be removed as soon as it is no longer used, so as to avoid pollution.

1. Designing and building islands

Species concerned

Flamingoes, Charadriiformes, Pelicans (also benefits ducks).

Advantages and disadvantages

Advantage: Long-lasting.

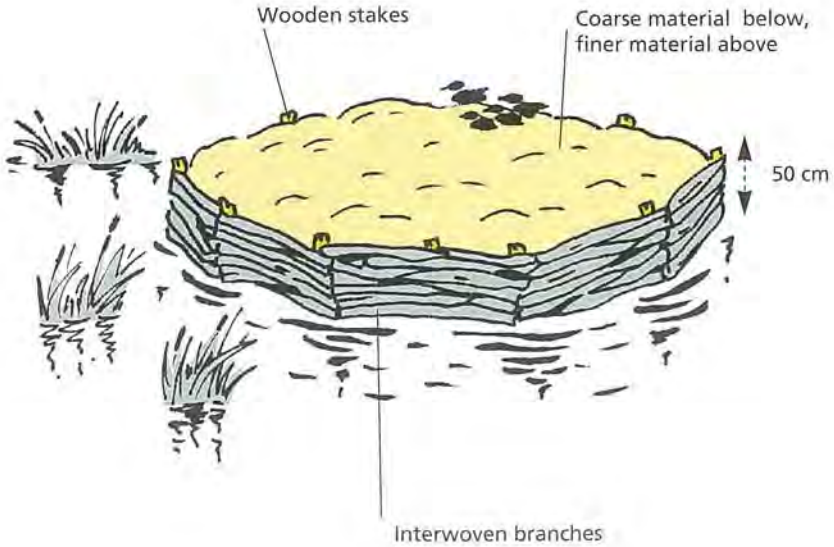
Disadvantage: Heavy initial investment and more expensive than other structures. Islands can be submerged if the water level rises.

Construction

This will depend on whether the water body already exists or has to be created.

If the water body already exist:

- Working when dry
  - Drain the water body or wait until it dries out naturally.
  - Build up the earth to a height of about 50 centimetres above maximum water level (protection against waves). Pile up coarse material at first (stones, concrete, rubble, etc.) and then put finer material on top (gravel, sand, earth). This technique has proved to be very easy for building ideal islands.



Working in water : a "dyke" is built using stakes and interwoven branches and then the centre is filled with various materials.

- Working in water

  There are three possible methods, but none is capable of making an island of a given shape or with a perfect finish:

  - At the desired spot, build up material by dredging a canal or channel around it, until the earth is about 50 cm above water level.

  - Build a dyke out into the water by constructing two lines of stones, rubble or stakes. Fill out the centre at first with coarse material and then with progressively finer material (see figure on previous page).

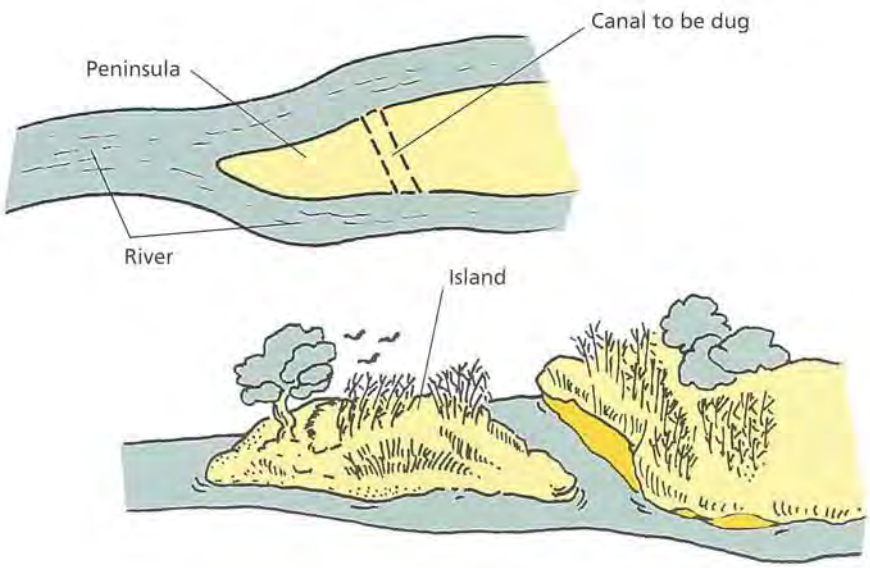
  - Pile up the material needed to construct the island on the ice of a frozen water body, at the site where you want the island. This material will then sink to the bottom at ice melt. This method can only be used if the ice is thick enough to support an earth-moving machine. There are few sites in the Mediterranean where it could be used.

- Change a peninsula into an island

  Depending on the situation:

  - Isolate an existing peninsula from the land by digging a separating canal (see figure below).

  - Dig channels across an existing dyke to create a string of islands.



By digging a canal a peninsula can be turned into an island.

If the water body does not yet exist

There are two possible solutions:

- If the wetland has to be excavated, simply avoid excavating where you want the future islands to be.

- In other cases dig a fairly deep canal 10 to 50 metres wide around the chosen site, piling the dredgings inside the canal to form an island, then flood.
  You have to be aware however that the invasion of the surrounding canal by aquatic vegetation may in the long term stop the island being isolated. This vegetation should therefore be controlled outside of the breeding season by grazing, water level manipulation, or burning.

Area

This depends on the species that you want to attract and the size of the wetland. It can vary from a few tens of square metres for terns or avocets, to several thousands of square metres for tree-nesting herons or flamingoes.

Shape

Irregular shapes have been used to create sheltered bays and increase the area of shallow margins where birds can feed. The shores are always gently sloped to make it easier for adult and chicks to come ashore.

Location

Islands are more attractive if they are:

- Closer to the leeward rather than the windward shore, which will not only reduce erosion but also provide the birds with some protection against the wind.

- Located at a distance putting the birds out of reach of terrestrial predators (10 to 50 m from the shore).

Island habitat management

Different species have differing nesting habitat requirements. Some like to nest in the shelter of vegetation, others in the open. Depending on the species to be attracted the island should either be vegetated or kept bare.

- Gulls (except the slender-billed gull) and ducks prefer islands covered with vegetation. To speed colonisation, they should therefore be seeded or planted with species, such as *Salicornia* spp. and *Salsola* spp. in saline areas. The species planted should be suited to their new environment. Only salt-tolerant species should be planted in brackish or saline environments. Birds that nest under plants can also nest in or under artificial structures such as rubble, tyres, or tiles in the case of terns. For reasons of visual pollution, one should use these materials as rarely as possible.

- For the slender-billed gull, terns and waders such as the avocet, the breeding sites should be maintained free of vegetation. For example, two to three layers of thick plastic sheeting (greenhouse sheeting, or fertiliser sacks) can be laid down on the island and held in place by a covering of sand or gravel. Each year before the breeding season, weed clearance can be undertaken, either by hand or using a weed killer. Glyphosate for example is probably subsequently harmless for the birds.

  Some shelter does however need to be provided for the chicks of these species in the form of stones, tiles, tree trunks, or scattered clumps of vegetation, to provide protection during bad weather (wind, rain) or to offer shade.

  Trees and shrubs should not be planted on islands intended for ground-nesting birds, as these will be used as observation perches for predators such as crows.

Protection against erosion

Various methods can be used to combat this serious threat:

- Build wave breaks around the island or place verticale stakes, large pebbles, etc.
- Provide a gently sloping shore on the island: 1:10 is relatively stable.
- Plant emergent vegetation around the island and particularly on the windward side.

A. R. Johnson

This island is protected from erosion by a belt of large stones.

- Cover the island with plastic sheeting held down at the edges with large rocks or pebbles.
- Shape the island in the form of a U with the convex side into the wind, or make it elongated along the direction of the prevailing wind.

Cost

An island of 6,200 square metres built in the Camargue in 1970 required 61 hours of work with a bulldozer and 1,500 litres of diesel.

The cost of building an island in an existing wetland (1 to 2 m deep) in the United Kingdom was 2 - 4 US $ per square metre in 1992. If a wetland has to be excavated, reserving a place for an island does not cause any additional costs, unless the material excavated has a market value (agglomerates).

References

Johnson *et al.*, 1978 ; Parnell and Soots, 1978 ; Buckley and McCaffrey, 1978 ; Giroux, 1981 ; Payne, 1992 ; Dwernychuk and Boag, 1972 ; Burgess and Becker, 1989 ; Burgess and Hirons, 1992 ; Pienkowski and Evans, 1985 ; Soots and Landin, 1978 ; Swift, 1982.

2. Raft construction

Rafts are floating nesting structures that are smaller than islands. They can last for one breeding season or many, depending on the materials and building methods used.

Species concerned

Pelicans, terns
(N.B. ducks, coots and grebes may also benefit).

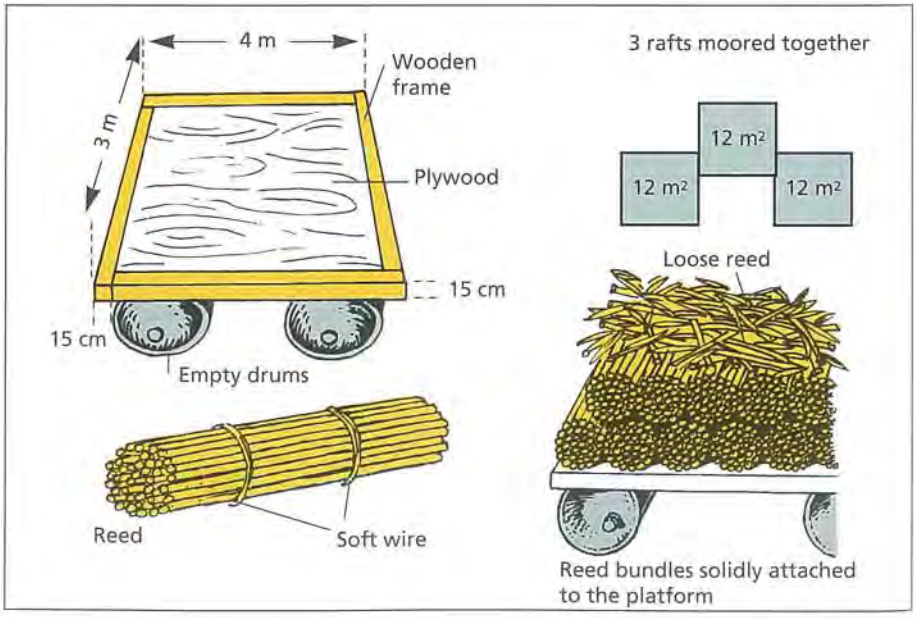
Advantages and disadvantages

Advantages: rafts float on the water, so a sharp rise in water level does not adversely affect breeding birds already installed. It is cheaper to build rafts than islands. They are a suitable alternative when the water is too deep and can even be installed in very deep water. The smaller rafts can be stored on dry land in the winter.

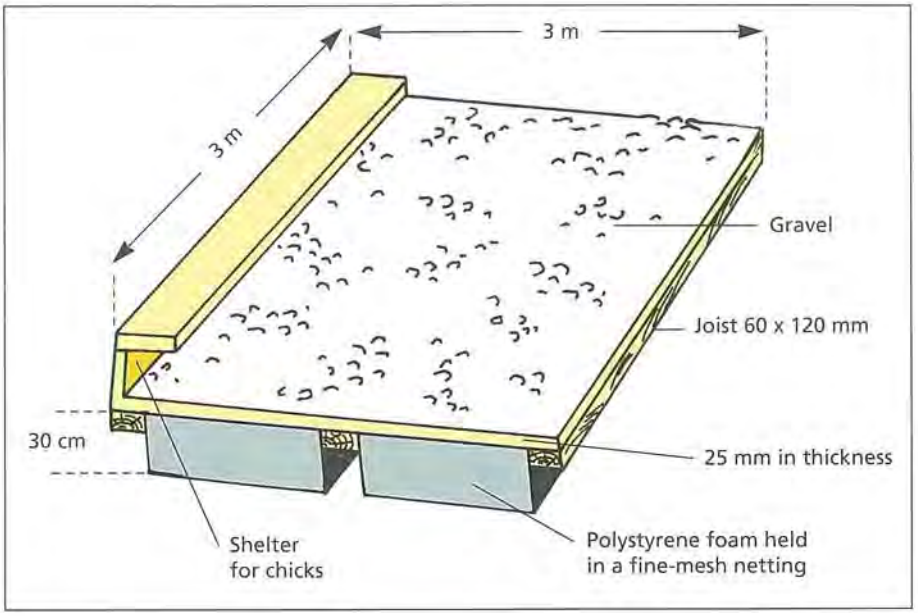
Disadvantages: Rafts have a shorter life than islands, they are necessarily smaller and are unsuitable for some species.

Materials

The platform must be made of rot-resistant material such as marine plywood (whose thickness depends on the weight of the species to be attracted) or treated wood, etc.



Pelican raft used in Greece and Turkey.



Example of a 9 square metre raft, created by the French bird protection society (LPO) for common terns

Source: Doumeret *et al.* (1994)

The most rustic and cheapest rafts are made from bundles of *Phragmites* or *Typha* tied side by side on poles; but they last only one breeding season. Polystyrene foam can also be placed between two layers of material.

Floats costing little or nothing can be made from discarded plastic drums (e.g. 3 to 6 drums of 100-200 litres capacity), attached to the edges of the raft. They can last up to about ten years after which they must be replaced. Other materials can also be used (oil drums, polystyrene foam) but they last only three or four years. Drums that contained oil, pesticides... should be carefully cleaned before use.

Alternatively, the floats can be made of polystyrene foam, contained in a fine-mesh netting to prevent disintegration and placed under the raft.

Construction and setting up

The drums have hoops fitted round them to attach them to the raft and are then partially filled with water so that the platform floats 20 to 40 centimetres above the water surface.

The rafts are anchored to the bottom using a rope long enough to take account of fluctuations in water level, or they can have rings on their ends that slide up and down stakes driven into the bottom. In both cases at least two anchoring points are needed to prevent the raft swinging about. In regions where lakes freeze, they can be carried to their destination on the ice, making transport easier.

Size

From 1 to 30 square metres depending on the species[1]. Several rafts can be moored together to increase the total area.

Shape

Rafts are usually square or rectangular, since these shapes are easiest to build. Triangular or diamond shaped rafts may be more suitable in windy sites, with one of the points facing the prevailing wind.

Location

Rafts can be installed in the same sorts of sites as islands, if possible close to a place where adult birds roost or loaf. In windy areas, rafts must be placed in the shelter of a bank or reed bed. If the site is really too exposed to the wind, a platform may be preferable.

Fitting out

For terns, rafts should be covered with gravel which stays in place better than sand, or for pelicans and marsh terns with reeds. Shelter should be provided for tern chicks in the form of roof tiles, stones or planks of wood.

Maintenance

When the rafts are small in area and are intended to last, they can be dragged onto dry land in the winter and put out on the water just during the breeding season.

Time required to build

This can vary from a few hours for reed rafts with a simple framework to more than a day for large and more sophisticated rafts.
The LPO tern raft (Figure p. 69) required four days to build and install.

References

Doumeret *et al.*, 1994 ; Burgess and Becker, 1989 ; Burgess and Hirons, 1992 ; Dunlop *et al.*, 1991 ; Hoegers, 1988 ; Houbart and Ruwet, 1987 ; Lumsden, 1982 ; Payne, 1982 ; Swift, 1982.

1 - See fact-sheets section "Management for specific purposes"

3. Building platforms

These are fixed installations intermediate between islands and rafts, supported by one or more stakes driven into the bottom or placed on dead trees in the water. In the exceptional case of storks, they are carried on a solid mast, located for example in a wet meadow[1].

Species concerned

Pelicans, cormorant, (white stork), great white egret, terns.

Advantages and disadvantages

Advantages: Cheaper to build than islands; more stable than rafts in windy sites.

Disadvantages: Platforms last less time than islands, and their smaller size only makes them suitable for some species.

Materials

The platform can be made of any locally available materials such as plywood sheets (e.g. 1 cm thick for terns), planks screwed onto railway sleepers or rafters, wattle fencing, bamboo, reeds, etc. Wood lasts longer than other materials such as reeds, but must be treated with fungicide.

Construction

The platform is attached to stakes driven into the bottom. When it is small a single stake may be sufficient. When the platform is fixed it must be above the maximum water level. Some can even be installed several metres above the water level.
If the platform is made of plywood, holes must be drilled through to allow rain and spray to drain away.

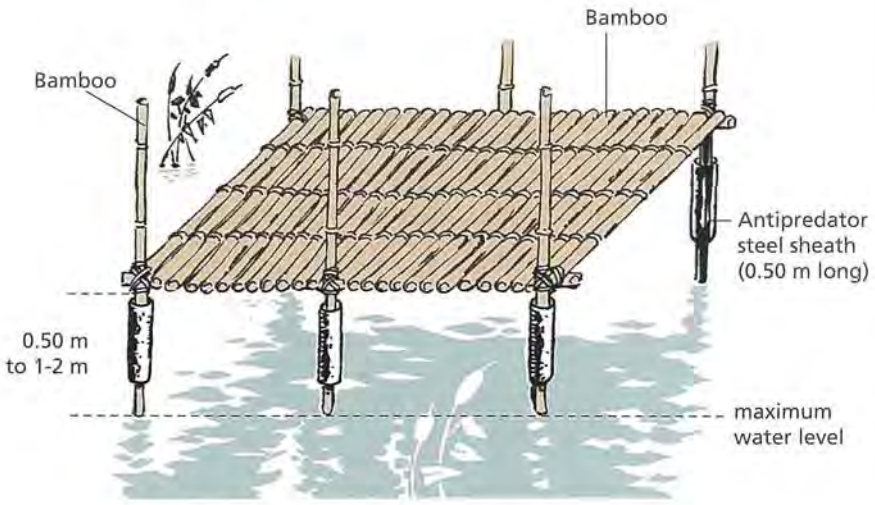
Size

Platforms are of the same size as rafts (1 square metre to 30 square metres), depending on the species to be attracted[2].

Location

Platforms can be sited in the same places as rafts, but always in shallower water bodies. Being more stable than rafts, they need less protection from the wind.

1 - see fact-sheet 17
2 - See fact-sheets section "Management for specific purposes"



A bamboo platform, with a steel sheath around the exposed part of the stake to deter predators.

Shape

Birds do not have a preference for shapes; square or rectangular platforms are easier to make.

Fittings

The species that is to be attracted dictates the nature of the platform covering[1]. Because of the location of the platform, the covering should be heavy or attached to the platform, to prevent it being blown or washed away during storms.

To protect the platforms against predators capable of swimming, any suitable method of dissuasion can be used, such as covering the exposed part of the stake with a sheet iron sleeve.

References

Lumsden, 1982 ; Meier, 1981 ; Payne, 1992 ; Vinogradov *et al.*, 1982 ; Weise, 1976.

1 - See fact-sheet 3

4. Planting a wood

Planting a wood is a costly and time-consuming operation (you must own or have a secure lease on the property, buy trees, and conduct long-term maintenance involving much work) which will only bear fruit ten to fifteen years later. Much thought must therefore be given, and you should only act after all other solutions have been studied and rejected.

Species concerned

Tree-nesting herons, spoonbill, glossy ibis and cormorants.

Location

Herons and cormorants are very faithful to their traditional nesting sites, so the future colony must be sited not too distant from a former abandoned site. As these birds are very timid, the new colony must provide a maximum of security, by means of fencing, dense undergrowth (e.g. brambles) or a canal around the future site.

Size

The area is related to the number of trees to be planted, which is itself dictated by the number of breeding pairs you want to attract. A quarter of a hectare can support several hundred pairs of tree-nesting herons.

Shape

The shape of the wood is not of great importance, unless the site is very exposed to the wind. In this case it is best if it is orientated in the direction of the prevailing wind. Similarly, an elongated shape should be chosen if the wood is established along a water course.

Planting

Several local species of tree can be used (ash, alders, white poplar, and some willows such as *Salix caprea*, etc.), the choice depending on their ecological requirements compared to the selected site, and on the local nesting traditions of the bird species in question (which vary from one region to another). Plant the trees 5 metres apart to allow forking and horizontal branches to develop, these being very favourable for birds. Closer planting leads to the development of a forest of straight trunks that is unattractive. If needed the trees can be pollarded to make them more attractive to birds.

A site for the installation of an aviary for live decoys should also be planned. The construction of artificial nests and the supply of nesting material in the form of twigs placed on the forest floor will also make the wood more attractive. A wood should remain suitable for ten to fifteen years.

Cost

It is expensive to create a wood. Trees cost 6 US $ a plant in France and 5,000 trees were planted in the Camargue experiment (see box). To this must be added the cost of earth moving and for maintaining the plantation over several years.

References

Hafner 1982, Sandilands 1980; Fasola and Alieri 1992

Artificial nesting site for tree-nesting herons: practical aspects.

The strategic aspects of this project carried out in Tour du Valat, in the Camargue, were described in the previous chapter[1].

In 1970 an artificial island of about 2,500 square metres was created and surrounded by a ditch that could be filled with water. At the same time, 5,000 young trees (mostly ash and alder, but also white poplars and a few willows) were collected from various natural forests. These plants were kept for a year in greenhouse and in the following autumn (1971) the artificial island and the land surrounding the ditch (security zone) were densely planted. Ten years were needed before the plantation achieved the desired appearance.

Three methods were used to attract the birds: live decoys in an aviary, artificial decoy egrets placed in the trees and on the artificial pond surrounding the island and the provision of artificial nests and nesting material.

In 1981 the captive birds bred successfully and their activity attracted wild birds. In that year 56 pairs of night-herons, 225 pairs of little egrets and 35 pairs of cattle egret bred on the island and reared 900 young.
Large mixed colonies were established on the site in the following three years.

1 - see page 55 - Hafner (1982)

5. Manufacture of artificial decoys

Social stimulation is fundamental for the breeding of colonial-nesting birds. This stimulation can be visual (artificial decoys, false nests), auditory (recordings of breeding birds) or both (captive live decoys).

Artificial decoys are only available commercially for game species (ducks, waders). Moreover, they are expensive. You therefore have to make artificial decoys of colonial nesting water birds yourself. Decoys can be carved (wood, cork, etc.) or moulded in series. Details will only be given of the latter.

In all cases, two-dimensional shapes (simple outlines in plywood) are useless. These appear to flying birds as a simple line, and never look like a bird; they have no value as decoys.

Species concerned

Terns, gulls, egrets and small heron species.

Materials

For making the moulds: Plaster of Paris, plasticine, an aerosol can of polyurethane foam, a wooden box 4 cm larger than the model to be made (width, length and height of the moulded bird; for example a 30 cm box for a 26 cm tern).

Construction

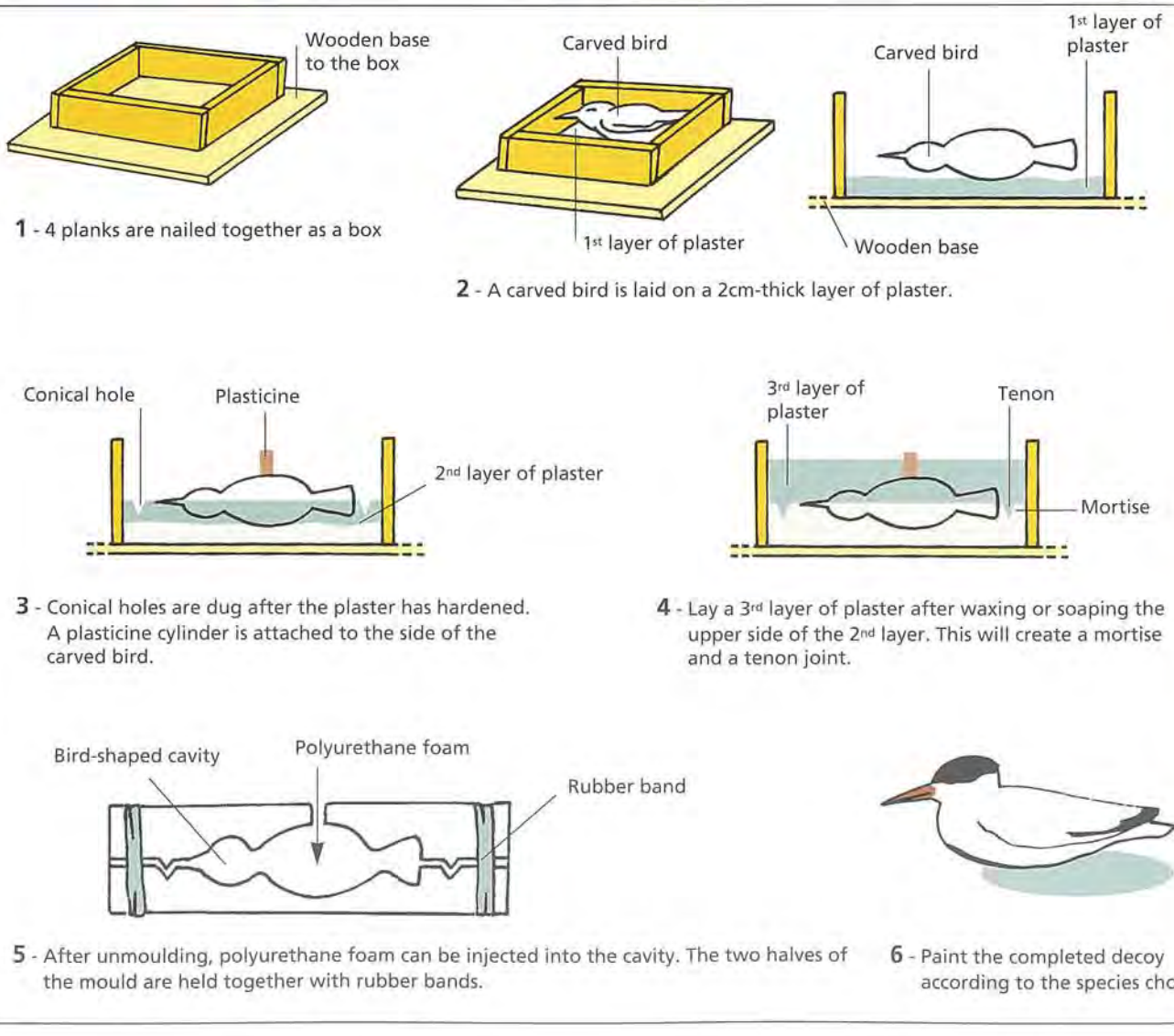
- Carve the required shape out of wood, cork, plaster or polystyrene. Be careful not to choose as model a bird in an alert or alarmed position (head raised, neck stretched, plumage flattened). Chose instead the shape of a bird brooding or resting.
- Spread soap or wax over the shape and over the inside of the box.
- Pour 2 cm of plaster into the bottom of the box.
- When the plaster has set, place the carved model on its side, horizontally and pour plaster in to come half-way up the body. Leave to dry thoroughly.
- Drill two conical holes 1 cm in diameter and 1 cm deep into the surface of the plaster on either side of the model. These holes are used to ensure that the two halves of the mould fit perfectly together. Place a cylinder of plasticine 0.5 cm in diameter and 2 cm long above the model; this will form a channel through which the polyurethane foam will be later be poured into the mould.
- Wax or soap the surface of the dry plaster and then pour the rest of the plaster into the box, so that it just comes up to the top of the plasticine cylinder.

- Leave to dry, remove the upper half of the mould, withdraw the plasticine and the model, then remove the lower half of the mould. Scrape away any excess plaster that has run. Wax inside the mould, then place the two halves together and hold together with a string or large elastic band.
- Fill the mould with polyurethane foam via the chimney formed by the plasticine. Leave to dry then remove from the mould. This will enable you to make large numbers of decoys.

References

Peterson and Fisher, 1955 ; Dusi, 1985.

Successive transverse sections of the model during production.



1 - 4 planks are nailed together as a box

2 - A carved bird is laid on a 2cm-thick layer of plaster.

3 - Conical holes are dug after the plaster has hardened. A plasticine cylinder is attached to the side of the carved bird.

4 - Lay a 3rd layer of plaster after waxing or soaping the upper side of the 2nd layer. This will create a mortise and a tenon joint.

5 - After unmoulding, polyurethane foam can be injected into the cavity. The two halves of the mould are held together with rubber bands.

6 - Paint the completed decoy according to the species chosen.

6. Using live captive decoys

First make sure that you are legally allowed to use live decoys of the species in question and remember that keeping live decoys in captivity is a time-consuming operation, since captive birds need almost daily attention.

If a species is in need of special protection it is inconceivable to capture wild birds. Injured birds or those bred in captivity may be available from rescue missions or zoos, and are entirely suitable.

Species concerned

Small tree-nesting heron species, grey heron, potentially glossy ibis and spoonbill (never attempted in the Mediterranean).

Technical specifications

The aviary must be big enough for the birds to move around freely and even make short flights. For example, for ten egrets or other small heron species, the aviary must not be smaller than 10 m x 12 m and 2 m high. The netting must provide the captive birds with adequate protection from outside predators, particularly small predatory mammals; use small mesh wire-netting (e.g. 2 cm) and not nylon or fabric netting which is too delicate.

Attracting birds to an artificial breeding wood using live decoys[1]

The best example of this method – the celebrated "bird city" – is not in the Mediterranean, but was created in the Mississippi swamps at the start of the century by Edward McIlhenny. A few live decoys kept in an aviary led to the establishment of a small colony of five nests of snowy egret in the vicinity. The number of birds in the colony increased within a few years and soon numbered thousands of snowy egrets and other species of heron.

In Germany, the installation of a colony of grey herons on an artificial site was crowned with success by building seven artificial nests and by placing artificial decoys nearby.

1 - Source: Mc Ilhenni (1934)

The aviary should be fitted with sufficient perches, and places where the birds could nest and with nesting material (twigs). Water must be provided in abundance and the drinking sites should be of a shape that prevents any risk of drowning (e.g. 20 to 30 cm maximum depth, with gently sloping margins).

Feeding

The captive birds must be provided with fresh food such as fish or crustaceans every day. Herons require 10 to 20 per cent of their body weight per day (more if they have nestlings), and the food will need supplementing with mineral and vitamin additives (for further details consult rescue missions, zoos or veterinarians). Most frozen cyprinid fish are unsuitable when given raw as they develop an enzyme (thiaminase) that destroys their nutritional value. Dried or canned dog food makes an ideal dietary supplement (not more than 50 per cent of the total in a zoo in the Camargue), if it is incorporated with the normal food. Feeding time should be adapted so as to disturb wild birds as little as possible; for example immediately after dark if wild birds do not roost at the site, otherwise in the morning after these birds have left. In an experiment conducted with herons in the Camargue[1], the birds were fed once every other day.

References

Armistead, 1987 ; Finskenstaedt and Heckenroth, 1974 ; Hafner, 1982 ; McIlhenny, 1934 ; Peterson and Fisher, 1955.

The aviary used in the Camargue to attract a colony of tree-nesting herons.

1 - Hafner, 1982, see also fact-sheet 4.

7. Using sound recordings

This very sophisticated technique is generally superfluous, and there is little experience up to present. It implies a thorough knowledge of the calls of the species in question, so that socially stimulating calls are played, rather than distress calls.

Equipment

A tape recorder with a loop cassette should be used, so that the recording can be played indefinitely without having to rewind and should be equipped with a timer so that the calls can be played for short periods (e.g. 10 minutes per hour). Calls played continuously are likely to have the opposite effect from that desired.

The calls can be recorded for example from an already existing colony, taking great care because of the risk of disturbance.

References

Kress 1983 (Terns), Dusi 1985 (small species of tree-nesting heron).

8. Making artificial nests

Artificial nests suggest to birds that are about to nest that the site is potentially suitable, since others of their species have seemingly already attempted to breed there.

Species concerned

Flamingoes, herons.

General principles

The nests should be placed as far as possible in the shelter of the wind. Do not place plaster eggs in them as these are bound to attract the attention of predatory birds such as yellow-legged gulls and crows.

Construction

Artificial nests for tree-nesting herons can be made of twigs piled into old baskets. These should be fastened to a tree or placed in a fork. They can also be placed on trays made of wire netting or wood, fixed by their base to a tree or pole.
For flamingoes see Fact-sheet 18.

9. The Dalmatian pelican and great white pelican

The following guides describe techniques for favouring individual species or groups of species having similar requirements. These descriptions, which supplement the more general guides on artificial breeding structures, are not exhaustive; they should in many cases be modified to suit local conditions (e.g. site, species, availability of materials).

Characteristics of natural breeding sites

These two species breed on low-lying islands in the middle of lakes or lagoons, or islands of floating vegetation or in the middle of reed beds. In the first case the nest is a large pile of twigs, reeds etc. It is sometimes cemented together with excrement. The nests of the great white pelican are simple scrapes in the ground lined with a thin layer of vegetation.

Suitable management

Rafts and platforms fixed to posts from 0,5 to 3 metres above the water surface have been successfully used by pelicans in Greece and Turkey. The rafts were made of a framework of poles and the platforms of rafters, on top of which were placed two to three layers of reed bundles, plus loose reeds for use as nesting material.

Artificial islands have also been built at Lake Kerkini (Greece). The birds colonised these sites and laid eggs, but the breeding attempt failed. The reasons for this failure are unclear.

Size

A raft of 12 square metres, two or three rafts 12 metres square assembled together, rafts of 15 square metres and platforms of 15 to 30 square metres have all been used. In Greece at Prespa, colonies were installed on rafts with a total area each of 38 square metres and included

A. Crivelli

Raft used for pelicans in Prespa Lake (Greece).

19 pairs of great white and 6 pairs of Dalmatian pelicans, 19 pairs of great white and 13 pairs of Dalmatian pelican and 12 pairs of Dalmatian pelicans alone. Four pairs of Dalmatian pelican also nested on a single 12 square metre raft.

Shape

Square or rectangular.

Location

In shallow water, or in clearings in reed beds to gain shelter from the wind. In the case of floating rafts, an area of open water must be close nearby to serve as a take-off and landing area for the adult birds. In Turkey, at Lake Manyas, platforms were installed in dead trees in a flooded forest, several metres above the water level. The pelicans were able to land and take off from these platforms without any problem.

Installation dates

The installation works should preferably be completed before December, so that the structures are available at the start of the breeding season.

Experience already gained

Vinogradov *et al.* 1982 (Volga Delta), Catsadorakis and Crivelli, pers. comm. (Prespa, Greece), Crivelli *et al.* 1991 ; DHKD (Kus Kucenneti National Park, Turkey).

1 - see "Contact addresses", page 107

10. The cormorant

The subspecies *sinensis*, which breeds at inland sites, seems to be easily attracted to artificial nesting structures. However, cormorants are blamed for damage at fish farms and because of the fast increase in the population in western Europe, the decision to favour or not their breeding success by artificial management should be considered carefully. It is not recommended at present.

Characteristics of natural breeding sites

The cormorant breeds in trees (especially dead trees), in reed beds or on the ground on islands. The nest is a solid structure of twigs, lined with leaves, grass or aquatic vegetation.

Suitable management

Platforms and reed rafts have been used in the Volga Delta. Other artificial structures should also be suitable for this species. In principle, they should also profit from woods planted for herons. A related North American species, the double-crested cormorant has nested on artificial platforms placed near its colony.

Size

Rafts and platforms of 15 square metres.

Shape

Rectangular or square.

Location

In shallow water and in reed beds, provided they are sheltered from the wind.

Experience already gained

Vinogradov *et al.* 1982 (Volga delta), Meier 1981 (related species).

11. The pygmy cormorant

Characteristics of natural breeding sites

This species breeds on the banks of freshwater bodies bordered by extensive reed beds or dense riverine vegetation. The nests are sited overhanging the water in trees or reeds or on the ground in reed beds. In captivity, pygmy cormorants always nest among the foliage, on the inner branches of trees. In contrast to the common cormorant, it does not nest in dead trees. The nests are built from reeds or twigs.

Experience already gained

There are no data on attempts to improve existing breeding sites or create new sites for this species.

M. Gunther / Bios

Greece and Turkey are the two most important countries in the Mediterranean for breeding pygmy cormorants.

12. The spoonbill and glossy ibis

Characteristics of natural breeding sites

These species usually nest in trees or shrubs on the water margin or in dense reed beds. The nest is a cup formed of twigs or reed stems.

Experience already gained

There are no published accounts of specific management intended to favour these birds. In the areas where these species nest in trees, management suited for small species of tree-nesting herons[1], with which they often nest, would in theory also be suitable for them.

M. Gunther / Bios

Breeding spoonbill in Greece.

1 - See Fact-sheet 16

13. The grey heron

Because of the damage that it is claimed to cause at fish farms and the increase in its population in western Europe, the decision to promote the breeding success of the grey heron by artificial management, should be very carefully considered beforehand. It is not currently recommended. However, management may be appropriate for displacing a colony; for example a colony of grey herons that caused a nuisance at an airport in Germany was moved from one wood to another.

Characteristics of natural breeding sites

The grey heron normally nests in trees near water, but sometimes in bushes, on the ground or in reed beds. When built in a tree, the nest is a platform of twigs, whereas in reed beds it is a cup-shaped structure of reeds.

Suitable management

In the example mentioned above, a colony of grey herons that hindered the activities of an airport was simply moved towards another already-existing wood. The birds were attracted by artificial nests placed in the trees and by a few captive herons in an aviary.

The related North American species (the great blue heron) has been attracted to artificial structures.

Location

Flooded woods and parks close to natural breeding sites.

Site improvements

Live decoys in an aviary, artificial nests and nesting material (twigs spread on the colony floor).

Experience already gained

Armistead 1987, Behlert 1977, Finkenstaedt and Heckenroth 1974 (Germany), Sandilands 1980 (related species, United States).

14. The purple heron

The distribution of breeding sites of the purple heron is currently highly fragmented and the numbers have decreased in the last fifteen years. The purple heron has become a vulnerable species needing increasingly active management to reverse this trend.

Characteristics of natural breeding sites

- Nest sites

The nests are usually sited in the middle of mature reed stands, but other sites have been recorded, such as in low willows *(Salix caprea)* in Italy and among reedmace at Lake Tonga, Algeria.

- Nesting material

The purple heron builds its nest in the spring before the new reed shoots have completed their growth, using dead reeds from the previous season. Mowing or burning the reeds therefore destroys this essential material and prevents breeding, unless intact areas are left. Intensive grazing and repeated mowing prevents the species from breeding, because of the major structural changes they cause to reedbeds.

- Flooding

The reed beds must remain flooded (minimum depth 40 cm) throughout the breeding season, i.e. from March-April to about 10 July. These dates vary little since these long-distance migrants occupy their breeding sites around the Mediterranean almost as soon as they arrive. Drying out of the reed bed leads to desertion of the nests or heavy predation by mammalian predators such as wild boar and foxes.

Suitable management

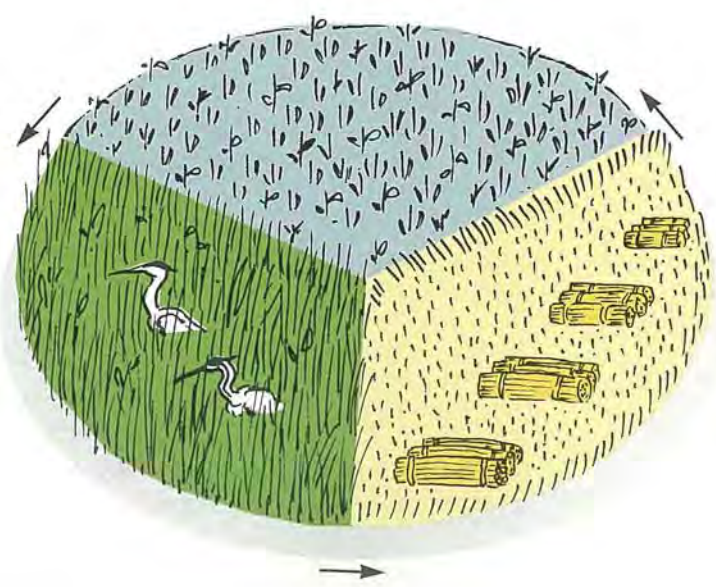
The best management is to retain an intact area of at least 10 hectares in a known natural breeding site. No grazing or mowing should be undertaken in this area, which will be protected from any human incursions. An area of more than 30 hectares can support large colonies of up to several hundred nests.

In large reed beds, a rotation can be installed between successive nesting sites, to allow the reed bed to regenerate and also allow human exploitation of the reed. Empirical observations, not yet scientifically validated, strongly suggest that ideally reed beds should possess clearings (of a few square metres) or narrow canals (up to 2 m wide) providing good feeding habitats for the birds. The opening up of large clearings should however be avoided.

Purple herons are particularly sensitive to disturbance when establishing their colony. This species is less tolerant of human activities than any other heron. This highly sensitive nature can make reed beds unsuitable, even though they are of the right size and structure for breeding.

Experience already gained

There is no known experience of artificial management for this species. The breeding requirements have been described by Moser (1984).



In theory, rotation could allow purple herons to breed while continuing traditional human activities such as reed harvesting. Each portion of the reed bed would be mown alternately every three years.

15. The great white egret

Characteristics of natural breeding sites

The great white egret normally nests on a cup-shaped nest of reeds in the middle of a reed bed, but also in trees in flooded forests.

Suitable management

There is apparently no experience in the Mediterranean for this species. In North America, it has nested on bamboo platforms placed in the middle of large reed beds.

Size

4 m x 20 m et 7 m x 35 m.

Experience already gained

Weise 1976 (North America).

A. Fatras / Bios

Thanks to effective protection, numbers of the great white egret are on the increase in eastern Europe, and the species is colonising the western Mediterranean.

16. Small tree-nesting heron species (Little egret, cattle egret, squacco heron and night heron)

Characteristics of natural breeding sites

These species usually breed in woods, close to water, and sometimes in reed beds or on low vegetation on an island. The nest is a more or less concave platform of twigs, or more rarely of reed stems when the nest is in a reed bed.

Suitable management

Planting a wood surrounded by a canal to isolate it from terrestrial predators. A dense understorey of brambles is also favourable for this purpose.

Do not use very tall species of tree, especially in windy areas. In the Mediterranean, trees 6 to 12 metres high are usually preferable, and sometimes tamarisks only 2 to 3 metres tall are sufficient. Trees more than 20 metres tall are only used exceptionally. In the Camargue, elms, ash and alder have proved very effective and could be tried elsewhere. Commercial plantations of poplars have been used in Italy. In young woods, nesting material has to be provided since there is naturally little in the way of dead wood.

O. Pineau

Squacco herons grow spectacular plumes for the short period of courtship and display.

Size

An area of a quarter of a hectare (80 m x 30 m) has proved sufficient to attract up to 500 pairs, during a successful attempt at attracting birds in the Camargue[1], even so, only part of the island was occupied.

Shape

This is not of importance; some colonies are compact, others can stretch out along nearly a kilometre of canal.

Location

Close to natural breeding sites (if you want to move an existing colony), or in the centre of an area with at least 800 hectares of freshwater wetlands within a radius of 5 kilometres and visited by the species in question.

Site improvements

Live decoys in an aviary and artificial decoys placed in the surroundings, artificial nests, recordings of bird calls.

Experience already gained

Hafner 1977, 1980, 1982 (Camargue), Fasola and Alieri 1992, Fasola and Barbieri 1978 (Italy), Dusi 1985, McIlhenny 1934 (United States).

1 - See fact sheet 4

17. The white stork

Suitable management

Platforms on which a rough nest is built out of dead branches and fixed to the wire netting.

M. Gunther / Bios

White storks sometimes place their nests of top of electricity pylons, thus increasing their risk of mortality through electrocution.

Location

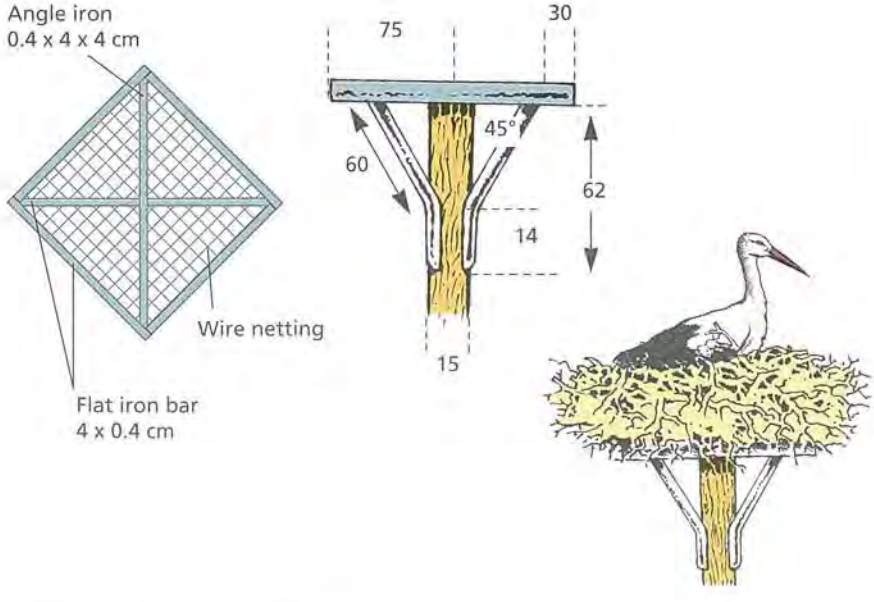
Because of the attraction that the species has for tourists and walkers, the tranquillity of the site has to be carefully studied to prevent disturbance. The platform should be placed on top of a 9 to 10 metre high pole situated in a damp meadow or on a metal base placed on the ridge of the roof of a building, in regions where storks are known to nest on buildings.

Site improvements

Some of the branches in the nest can be splashed with white paint or plaster to simulate bird droppings and thus increase its attractiveness.

Experience already gained

Martinez Rodriguez 1993 (Spain), Doumeret and Sériot 1994, LPO[1].



An example of a white stork platform.

modified after Doumeret and Sériot 1994.

1 - see "Contact addresses", page 107

18. The greater flamingo

Flamingoes usually nest in large dense colonies at a few traditional nesting sites. Most of the sites are only used if the water level is suitable, which in most natural situations depends on the amount of rain falling in the wetland catchment (e.g. Fuente de Piedra in Spain, the North African chotts).

In the world as a whole only a few sites provide regular and predictable hydrological conditions where colonies can form every year, these include: artificial salines (Camargue), a permanent salt lake (Iran) and coastal islands (Banc d'Arguin, in Mauritania).

Characteristics of natural breeding sites

Flamingo colonies are usually installed on low-lying isolated islands with a substrate of mud or sand. Dykes are also sometimes used in salines. The flamingo builds a mound around the site chosen for egg laying by scraping the sand or mud towards it with its beak. Colonies usually contain several thousand pairs and thus require very large breeding sites.

Suitable management

Creating, renovating and repairing islands to replace those eroded by waves or by the nest-building activity of the flamingoes.

New breeding islands can be created using a bulldozer or earth grader, but a mechanical excavator is unsuitable as this will form a deep channel around the island and steep banks. Breeding islands must have gently sloping shores to allow the flamingoes to wade ashore. The island must be raised well above the water to prevent it from being flooded by high water levels or storms; 20 cm above the maximum water level is sufficient.

Successful attempts at artificial flooding around the colony have been conducted at the Fuente de Piedra colony in Spain, in years when early drying out threatened the survival of chicks still in the nest.

Size

Two thousand flamingo pairs can nest on an island of 1,000 square metres (100 m x 10 m). There are therefore, on average, 2 nests per square metre. The artificial islands in the Camargue and at Fuente de Piedra measured 6,200 and 3,600 square metres, respectively.

Sometimes, the same nest can be occupied successively by two different pairs in the same year. The total number of breeding birds occupying the site is then higher. It is useless building very large islands in regions where feeding habitat is likely to be a limiting factor. Erosion of the island must be taken into account in long-term planning, as this will progressively reduce the island's area.

Shape

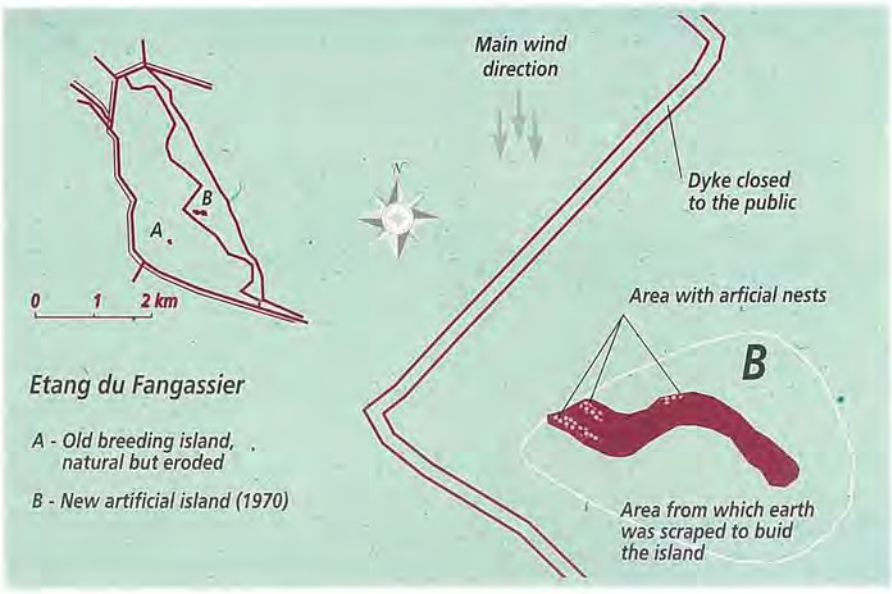
An elongated rather than round shape makes access easier for birds with nests in the centre of the island. It also makes observation easier. Colonies may only occupy a small proportion of a large island such as that in the Ebro Delta.

Location

The artificial sites in the Mediterranean region (in the Camargue, France and Fuente de Piedra, Spain) were built near traditional breeding areas, that no longer possessed suitable nesting sites, but still had extensive feeding habitat.

As flamingoes are very sensitive to disturbance by people on foot or low-flying aircraft, the new sites should be installed away from flight corridors and in areas where they can be wardened effectively.

The further the island is from the shore, the more secure the birds will feel. In the Camargue, the island is 100-150 metres from the nearest dyke, which is closed to the public, and 800 metres from the closest track open to vehicles and pedestrians.



The Camargue colony site

source: A.R. Johnson

At Fuente de Piedra the island is closer to the shore, but a fence around the entire wetland protects it against mammalian predators and human disturbance.

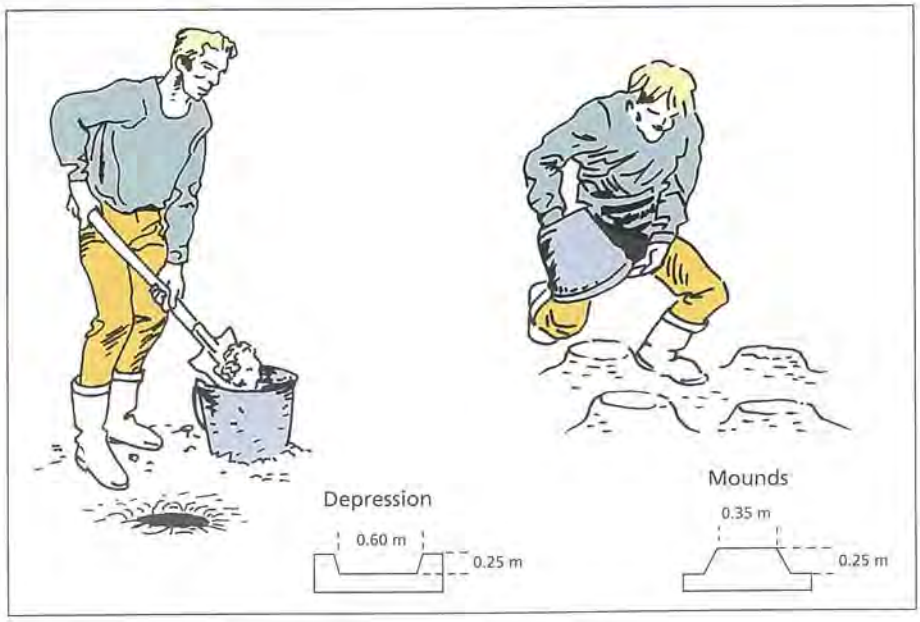
Site improvements

False nests, made by moulding mud in buckets, have helped attract flamingoes, as do mounds and artificial depressions, which retain water and supply mud for nest building, and broken chicken eggs to simulate previous nesting.

If there is vegetation cover on the future nesting site, this must be suppressed. For example the cover of halophytes at Fuente de Piedra was reduced from 65 to 10 per cent.

Experience already gained

Johnson 1982 (Camargue), Rendon and Johnson in prep. (Andalucia, southern Spain), see also A. R. Johnson, M. Rendon and N. Bacetti.



Artificial nests for flamingoes at Fuente de Piedra, Spain.

source: Rendon and Johnson (1996)

1 - see "Contact addresses", page 107

19. Terns

The rehabilitation of former sites should be considered before creating new ones. For example fencing off a coastal spit to prevent dogs and terrestrial predators from gaining access can allow terns to reinstall. If this is accompanied by information notices, human disturbance can also be reduced.

Characteristics of natural breeding sites

Open sites, on islands or coastal spits covered with pebbles, gravel, shells or a carpet of very short and scattered vegetation (a few centimetres). The nest is a simple scrape in the ground and most species use no lining material. The site of the colony on the island is generally protected from the dominant wind by the shelter provided by taller plants, such as *Salicornia* or *Salsola*, which also allow the chicks to hide from bad weather and avian predators.

Suitable management

Platforms, rafts, artificial islands, artificial beaches.

Size

From 3 to 30 square metres for platforms and rafts. Islands can cover a few square metres (common tern) to 1 hectare (sandwich tern). Even if the entire area is not used, a large area is a good guarantee against wave erosion.

Shape

The shape is not important. On natural islands, promontories and the margins of the island protected from the prevailing wind are the most frequently used. Islands with gently sloping shores are recommended.

Location

Close to natural breeding sites. In especially windy sites, if it is situated close to the windward shore the island will be subject to the most spray and erosion. On the other hand if it is situated close to the lee shore in a very shallow lagoon, it is likely to become high and dry during strong winds and thus accessible to terrestrial predators. Rafts are best placed in positions sheltered from the wind.

Site improvements

Whatever the form of the nesting support chosen, it must be covered with pebbles, pea gravel (particularly for the little tern) or cockle shells (sandwich and gull-billed terns). For little terns, elongated strips of gravel (e.g. 30-110 m^2) can be laid at various points on a large island. Shelter for the chicks in the form of tiles, planks, vegetation or old tyres is useful.

In the case of rafts or platforms, planks can be nailed around the edges to prevent chicks from falling into the water. A taller plank on the side exposed to the wind provides better wind protection. A strip of plastic netting 1 m wide could be stapled around the margins of the raft to prevent chicks from passing underneath. Floating wood planks arranged around the raft or platform would allow chicks that fall into the water to regain dry land. Plastic or wooden decoys have been placed on artificial sites and recordings of the calls of the species in question have also been played.

Nylon threads were stretched over former common tern breeding sites in Canada, which had become colonised by undesirable ring-billed gulls, the spacing of the threads being such that the larger gulls were unable to land, but terns were still capable of doing so.[1]

Experience already gained

- Non-Mediterranean species of tern: Kotliar and Burger 1984, 1986, Rimmer and Deblinger 1992, Swickard 1974 (United States).
- Sandwich tern: Nairn 1987 (Ireland), Veen 1977.
- Common tern: Budde 1992 (Germany), Birch 1984, Norman 1987, Burgess and Hirons 1992 (United Kingdom), Dunlop *et al.* 1991, Morris *et al.* 1992 (Canada), Kress 1983 (United States), Vinogradov *et al.* 1982 (Volga delta, Russia), Doumeret *et al.* 1994, LPO[2] (western France); see also fact-sheet 21.
- Roseate tern: Spendelow, 1982.
- Little tern: Burgess and Becker 1989, Burgess and Hirons 1992, Haddon and Knight 1983 (United Kingdom), Fasola and Canova, in press (Italy), LPO[2].
- Gull-billed tern: A.R. Johnson, N. Sadoul, LPO[2].

J. L. Gonzalez Grande / Bios

Little terns nest on sand banks or islands with a low and sparse vegetation.

1 - Morris et al. (1992).
2 - see "Contact addresses", page 107

20. Marsh terns

Characteristics of natural breeding sites

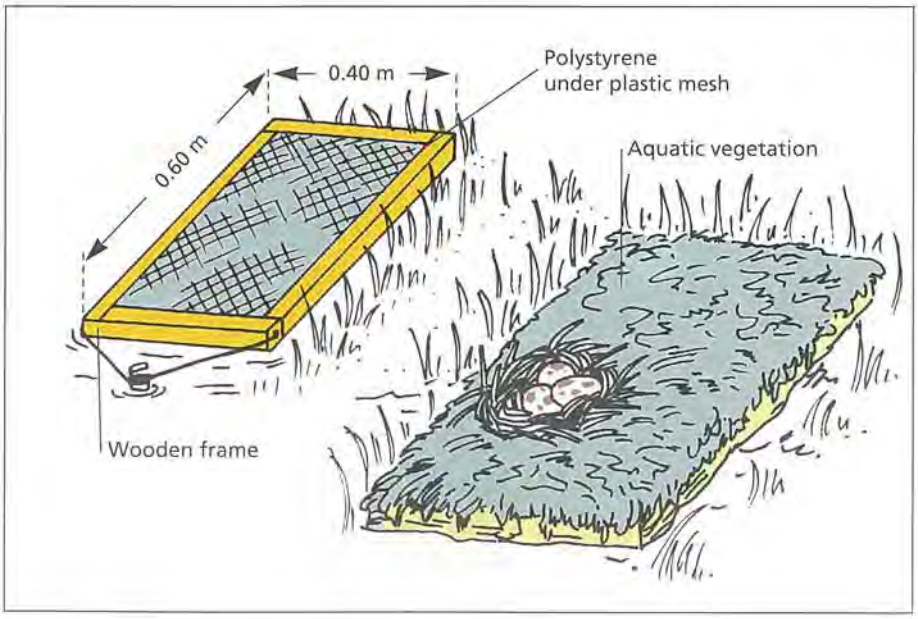
Marsh terns (black and whiskered terns) build a nest made of aquatic plants, usually sited on floating vegetation such as water lilies.

Suitable management

There is apparently no experience of management for these species in the Mediterranean region. However, rafts either covered with aquatic vegetation or not, have been used successfully by the LPO for black terns in western France. Measuring 40 x 60 cm, they were made of polystyrene covered by plastic mesh and surrounded by a wooden frame.

Experience already gained

Sériot *et al.* 1994, LPO[1]



LPO raft for black terns

Source: Sériot *et al.* (1994).

1 - see "Contact addresses", page 107

21. Gulls

Characteristics of natural breeding sites

These species nest on the ground near water, usually on islands but sometimes on artificial structures such as buildings, wrecks and bridges. The nests are piles, sometimes scanty sometimes huge, of living or decayed vegetation. Black-headed gulls build their nests among shrubby or short emergent vegetation, such as *Salicornia*.
Often the colonies are multispecific, with this species in the centre of the islands where the vegetation is denser. Terns are often attracted by the presence of the smaller gull species. On the other hand, the yellow-legged gull which is also a predator competes directly with other gulls, terns and waders for breeding sites. It can displace these species if measures are not taken to prevent it from nesting.

Suitable management

Mainly artificial islands. As they use the same types of breeding sites as terns, gulls can benefit from management intended for the former. Black-headed and Mediterranean gulls do however require denser and taller vegetation, whereas the slender-billed gull prefers open habitats similar to terns.

Experience already gained

Anonymous, 1994 (Audouin's gull) ; see also G. Alvarez[1] and the box below.

A new island in Camargue[2]

In 1995 a newly constructed island was immediately colonised by 770 pairs of colonial waterbirds. The most abondant species was slender-billed gull (390 pairs) followed by common tern (200 pairs), avocet (122 pairs), little tern (48 pairs) and black-headed gull (10 pairs).

The island covered 1,610 square metres and lay only 10 metres away from the dyke.

Composed of mud built up with a bull-dozer, 17 per cent of its area was covered by broken shells and small gravel. The island was devoid of all vegetation.

1 - see "Contact addresses", page 107
2 - after N. Sadoul, unpublished data

22. The avocet and black-winged stilt

Characteristics of natural breeding sites

These species breed in open areas on islands, sand banks or flooded meadows on the borders of saline or brackish lagoons. The stilt also breeds in shallow freshwater marshes with sparse vegetation. The nest is a shallow cup lined with a little vegetation.

Suitable management

The avocet, which uses the same sites as terns, can benefit from management intended for these[1].
Islands 50 to 150 metres long by 10 to 20 metres wide located in artificial wetlands 15 cm deep, have been used successfully by both species in sites close to the Atlantic coast of France.

Cost

Once the initial management works had been conducted, the management of a 15 hectare wetland comprised of 6 ha of lagoons with breeding islands, required 20 man/days work per year for maintaining water levels, site maintenance and monitoring.

Experience already gained

Delaporte and Blanchon 1995, LPO[2].
Avocet: Cadbury *et al.* 1989 (United Kingdom) - Also see the Camargue tern islands, p. 56 and 99)

F. Cahez / Bios

Black-winged stilts from the north Mediterranean spend the winter in northern or tropical Africa.

1 - See fact sheet 19
2 - see "Contact addresses", page 107

23. The common pratincole

To our knowledge no specific management intended for pratincoles has been conducted in the Mediterranean region. However, a recent study has provided basic data for managing the breeding sites of this species and therefore for creating such sites if need be.

Characteristics of natural breeding sites

Pratincoles nest on the ground in areas with very scattered and low vegetation, not necessarily close to water.

Recommendations for managing breeding sites

Grazing seems to have a positive impact on breeding sites, provided it takes place outside the breeding season or during the breeding season at low densities.

Furthermore, if colonies are established on cultivated land, delaying agricultural practices (whose timing varies depending on whether the year is dry or wet) can greatly improve breeding success.

Experience already gained

Calvo 1994 (Andalucia).

J. Walmsley

Common pratincole nest on bare ground, or in areas with very sparse vegetation, e. g. *Salicornia*.

M. Gunther / Bios

Conclusion

The creation of artificial breeding sites can be a very useful conservation tool for colonial-nesting aquatic birds. However, as with any tool, it must be used with discretion.

Such management is not automatically the correct solution for overcoming the decline in a population of birds such as herons, pelicans or terns.

If the principles described in the second chapter such as the biology of the species in question, the local context (hydrology, socio-economic aspects) and predictable medium-term changes are taken into account, such a management project has a good chance of succeeding in the long term. However, current experience is still scattered and scanty, and can in no way guarantee absolute success, even if the basic principles are complied with.

Although we are gaining an increasingly better understanding of the key factors determining the choice of breeding sites by colonial nesting birds, it is certain that other factors are still beyond our grasp. There will always be, for us humans, a degree of uncertainty concerning the final choice made by the birds.

The rafts provided for Dalmatian pelicans on Lake Mikri Prespa (Greece) are no longer sufficient to host their increasing population.

Glossary

Avian: Relative to birds

Biotope: The natural environment in which a species lives

Coloniality: The tendency for some species to nest in groups. These are called "colonial species".

Creche: Gathering of large chicks under the vigilance of a few adult birds.

Grégarious: Species that tend to live in large groups

Mobbing : aerial attacks by a group of birds on a predator (fox, bird of prey...)

Nidifugous: Species whose chicks spend only a very short time in the nest after hatching, e.g. avocets. Other species (e.g. herons) are called "nidicolous".

Pelagic: That lives mainly offshore

Philopatric: A species in which individuals tend to breed close to where they were born.

Trophic niche: The place "niche" that a given species occupies in an ecosystem, as a result of its food preferences.

List of species mentioned in the text

Birds

Audouin's gull: *Larus audouinii*
Avocet: *Recurvirostra avosetta*
Bittern: *Botaurus stellaris*
Black swan: *Cygnus atratus*
Black-headed gull: *Larus ridibundus*
Black tern: *Chlidonias niger*
Black-winged stilt: *Himantopus himantopus*
Caspian tern: *Sterna caspia*
Cattle heron: *Bubulcus ibis*
Common Pratincole: *Glareola pratincola*
Common tern: *Sterna hirundo*
Cormorant: *Phalacrocorax carbo*
Dalmatian pelican: *Pelecanus crispus*
Double-crested cormorant: *Phalacrocorax auritus*
Glossy ibis: *Plegadis falcinellus*
Great white Egret: *Egretta alba*
Great white pelican: *Pelecanus onocrotalus*
Greater flamingo: *Phœnicopterus ruber*
Grey heron: *Ardea cinerea*
Gull-billed tern: *Gelochelidon nilotica*
Lesser crested tern: *Sterna bengalensis*
Little Egret: *Egretta garzetta*
Little tern: *Sterna albifrons*
Mediterranean gull: *Larus melanocephalus*
Night heron: *Nycticorax nycticorax*
Purple heron: *Ardea purpurea*
Pygmy cormorant: *Phalacrocorax pygmaeus*
Roseate tern: *Sterna dougallii*

Sandwich tern: *Sterna sandvicensis*
Shag: *Phalacrocorax aristotelis*
Slender-billed gull: *Larus genei*
Snowy egret: *Egretta thula*
Spoonbill: *Platalea leucorodia*
Squacco heron: *Ardeola ralloides*
Western reef heron: *Egretta gularis*
Whiskered tern: *Chlidonias hybrida*
White stork: *Ciconia ciconia*
Yellow-legged gull: *Larus cachinnans*

Other animals

American crayfish: *Procambarus clarkii*
Mosquito fish: *Gambusia affinis*
Pumpkinseed fish: *Lepomis gibbosus*
Fish *Pseudorasbora parva*

Plants

Alder: *Alnus* spp.
Ash: *Fraxinus* spp.
Bramble: *Rubus* spp.
Cane: *Arundo donax*
Cork oak: *Quercus suber*
Cornel: *Cornus* spp.
Elm: *Ulmus* spp.
Glass wort: *Salicornia spp., Arthrocnemmum* spp.
Juniper: *Juniper* spp.
Olive: *Olea* spp.
Pine: *Pinus* spp.
Poplar: *Populus* spp.
Reed: *Phragmites australis*
Reedmace: *Typha* spp.
Seablite: *Suaeda*
Seapurslane: *Halimione portulacoïdes*
Tamarisk: *Tamarix* spp.
Willow: *Salix* spp.

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The **Station biologique de la Tour du Valat** was established in the Camargue (France) in 1954 by Dr. Luc Hoffmann as a private research institute, primarily for field ornithological studies.

In 1993 the estate consists of 2500 ha of land belonging to the Fondation Sansouire, created under French law in 1976. The estate is one of the few in the eastern Camargue on which extensive areas of near-natural landscapes have survived the post-war expansion of arable agriculture. Funding for the research and conservation programme of the Station comes from a variety of national and international organisations, but the major part of the core funding is provided by the Fondation Tour du Valat, a foundation under Swiss law.

The scientific programme of the station has evolved over the years, and has included programmes on the management of vegetation using domestic herbivores, fish ecology, optimal foraging strategies, behavioural studies, and migration and breeding success of colonial waterbirds. Most of these studies have been undertaken in the Camargue, but the Station has increasingly worked in collaboration with other scientists in the Mediterranean region.

This programme has provided the Station with a fundamental understanding of Mediterranean wetland ecology which can be applied to wetland management problems in the region.

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