Manual for monitoring seabird colonies in West Africa

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Contents

1 Introduction

Why this manual?

This manual was written in the framework of the project *Monitoring fish bio-diversity along the coast of Northwest Africa using seabirds as indicators*. It is meant to be a practical tool for African conservationists participating in the monitoring of seabirds, and their food, in breeding colonies along the Atlantic coast of Northwest Africa.

Oceanic currents along the Atlantic coast of Northwest Africa give rise to upwellings, which bring cold and nutrient-rich water to the surface. As a result, the area is extremely rich in fish. Traditionally, this resource is exploited by a large number of artisanal fishermen. During the past decade, the intensity of artisanal as well as industrial coastal fishing has enormously increased. There is great concern that over-fishing takes place, with negative impacts on local fishing economy and nature values. Accordingly, there is an urgent need for information about the development of fish populations and their possible impacts on nature.

In the period of 1998-2001, on the demand of the ministry of Agriculture, Nature Management and Fisheries (LNV) of the Netherlands in co-operation with Senegalese partners, a project was carried out to study possibilities for monitoring the well-being of West-African seabird species and, more importantly, to study whether these seabirds could be used for monitoring fish abundance and fish bio-diversity. For practical reasons, the project focused on a number of colony breeding species, among which were the Grey-headed Gull, Slender-billed Gull, Caspian Tern, and Royal Tern. Each year the size of the breeding populations was determined. In addition, the following breeding parameters were measured that can be expected to react to changes in food abundance: clutch size, egg size, and chick condition. Because breeding parameters may inform us about food abundance in general, but fail in giving information on the availability of food on the fish species level (unless the bird eats only one species of fish) it was felt necessary to study the diet of the birds as well. The results of the project carried out in 1998-2001 are described in detail in Veen *et al*. 2002 and 2003.

Changes in fish populations and their effects can be expected to play a role in the long term. Therefore, the present project was started (2003-2005) which aims at implementing the monitoring in a network of sites along the Northwest African coast. This manual will be used as a reference for African colleagues, mostly employees of organisations managing the breeding sites, which will be trained in order to carry out the field observations.

Seabirds as indicators of fish abundance

Fish stock size is usually measured with standard catching techniques, involving expensive research vessels. Indirect information can also be obtained by analysing catches landed at markets and fish-auctions. A completely different, but relatively cheap way of obtaining information is based on studying the ecology and feeding behaviour of fish-eating birds, which can relatively easily be done in breeding colonies. These birds "sample" the marine environment in a "standardised" way, depending on their species-specific feeding strategy.

Studying seabird-food relationships in breeding colonies has two main advantages. Firstly, breeding birds come ashore and are present at the same place for a relatively long period. This makes it relatively easy to study them. Secondly, breeding birds can spend only part of their time foraging, whereas food requirements are high because chicks have to be fed. This means that food shortage will easily be detected, because it has immediate consequences for the survival of the brood. Working in breeding colonies has a disadvantage as well, since relationships between breeding performance and food are restricted to the (relatively) small foraging area around the breeding colony.

Relationships between breeding parameters and food availability

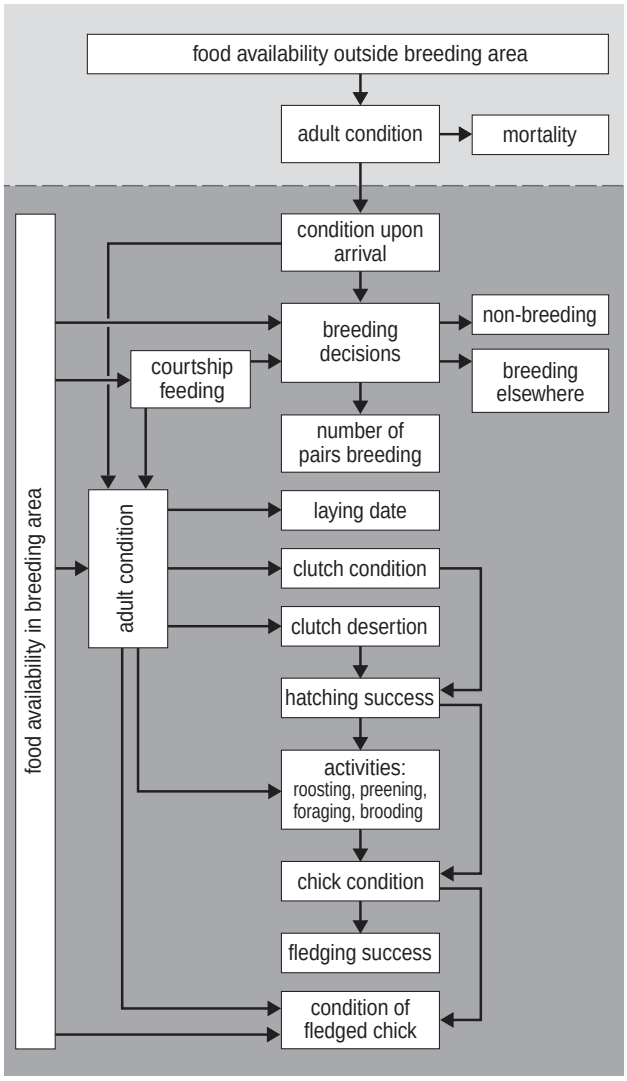
There is a wealth of literature describing the results of studies focusing on breeding parameters in relation to food abundance. The general picture of how seabirds react to changes in food availability can be described as follows (see also figure 1.1):

As a rule, seabirds spend most of their life at sea. In order to survive, they are constantly seeking for food. Food shortage influences the birds' condition and may ultimately lead to starvation. However, only few cases of mass starvation of seabirds are known, which may be explained by the birds' ability to quickly move from one foraging area to another.

As the breeding season approaches, seabirds concentrate in the breeding area. A good physical condition is a prerequisite for breeding: it has been shown that the body condition determines whether an individual bird "decides" to breed or not. Food availability around the breeding site is another factor underlying this decision. In the pre-laying period the birds collect information about food availability and are thus capable to "predict" whether the breeding attempt is feasible in view of the local situation. As a result, the size of the breeding population may be an important indicator of food availability.

In order to lay the eggs, the female bird needs extra energy reserves that are often obtained in the foraging area near the breeding site. In many species, the male plays an important role in this process by feeding the female. Seabirds which are in a good condition often lay their eggs relatively early in the season. They may also have a larger clutch or some of their eggs may be of higher quality in terms of total volume or protein content. If the feeding conditions are good, there is a greater chance that the incubation proceeds without interruptions: one bird sits on the eggs while the other forages at sea. The male either

Figure 1.1. *Relationships between breeding parameters and food availability. The arrows indicate causal relationships based on examples from the literature for different seabird species (after Veen et. al. 2003)*



feeds the female on the nest or incubation is shared. If food is abundant, one may even see many non-incubating birds in the colony, resting, preening or sleeping. They simply have time left over for a rest. Uninterrupted incubation of the eggs contributes to hatching success, because it minimises the chances that eggs are taken by predators or die because of exposure to extreme heat or cold.

When the eggs hatch, the breeding birds enter a critical period of their life. Food caught at sea has to be brought to the colony, which means spending more time and energy for flying. Foraging also becomes more specific, because different-sized chicks need fish of different sizes. If food is abundantly available, chicks grow well and losses to starvation are low. Chick condition, therefore, is one of the best indicators of food availability. Chick condition does not only determine the chances to survive until fledging, but has also proved to be related to first-year survival as well as the timing and probability to return to the colony as a breeding bird in later years.

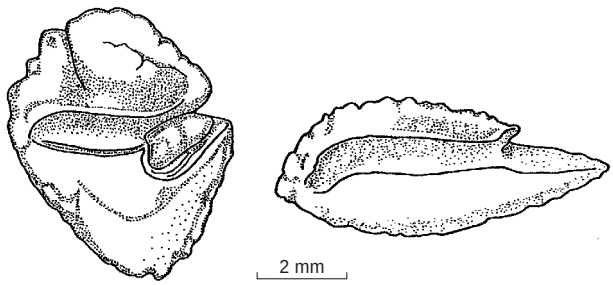
Diet composition

Breeding parameters can give information about food availability in general. It can answer the question, whether the breeding birds get enough food to start the breeding process, to lay eggs, or to raise healthy chicks. If the birds under study eat only one species of fish, the information can also be used as an indicator of changes at the level of the fish population. However, if we deal with bird species that have a varied diet, as it is with the Grey-headed Gull, Slender-billed Gull, Caspian Tern, and Royal Tern, breeding parameters do not say anything about the abundance of particular fish species as long as we do not know which species have been caught.

Several techniques are available for studying the diet composition of breeding seabirds. In terns, data on the number, size, and species of fish fed to the young can be obtained through direct observation from a hide. This appeared to be very difficult in the West African colonies because of the large number of similar looking fish species brought to the colony. Moreover, direct observations are not possible in gulls, as they swallow their prey. As a rule, the remains of such prey are unidentifiable when regurgitated during chick feeding.

In several studies, the information on the diet composition of fish-eating seabirds was successfully obtained through analysing otoliths found in regurgitated pellets and faeces. Fish otoliths are highly species specific, as shown in figure 1.2. They are also very durable and are not much affected when passing the bird's gastro-intestinal tract. It has been shown that this method can be used for all species that produce regurgitated pellets and defecate from the nest, such as the Slender-billed Gull (faeces), Royal Tern (pellets and faeces), and Caspian Tern (pellets and faeces). In case of the Grey-headed Gull, the method could not be applied, because this species neither defecates from the nest nor leaves regurgitated pellets on the territory.

Figure 1.2. *Two otoliths showing morphological differences enabling species identification: Antigonia capros (left) and Trachurus trachurus (right) .*

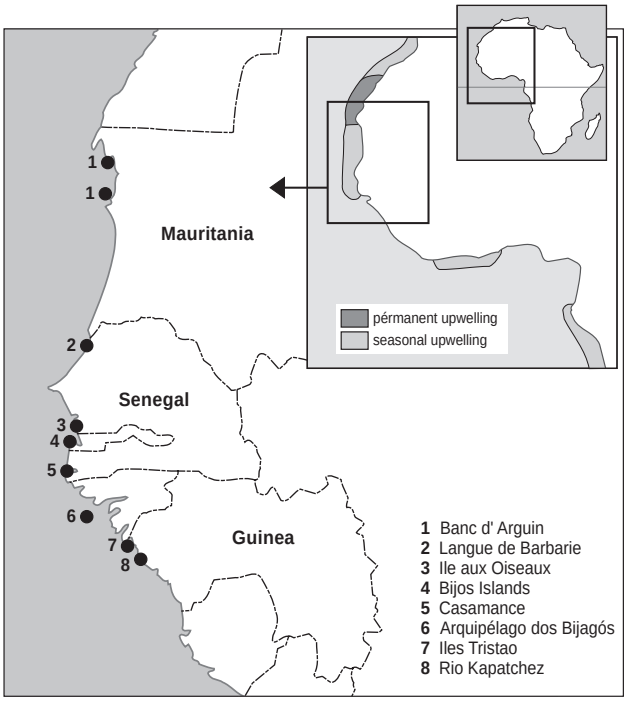


2 Important seabird and waterbird colonies in West Africa

The energetic requirements of birds are especially high during the breeding season. As a consequence, large breeding colonies of fish-eating seabirds are found in places where fish is abundant. One of such places is the Sahelian Upwelling Marine Ecoregion (SUME) off the Atlantic coast of Northwest Africa.
However, there is another factor that is equally important for breeding: a safe site. Most fish-eating seabirds breed on the ground, concentrate in colonies and have a conspicuous plumage pattern. Such colonies are easily found by predators. As a rule, the birds can cope with most aerial predators, but the occurrence of mammalian ground predators can make successful breeding impossible. For this reason, seabirds prefer to breed on isolated islands or peninsulas out or reach of the predators.

Figure 2.1 gives the position of the upwelling zone along the West African coast (insert) and of the most important colony areas. Islands suitable for breeding are few and mainly available in the southern part of the upwelling area. There is great variation in protective status of the different areas as well as in our knowledge regarding numbers and distribution of different bird species. A short description of each site is given below (see also table 2.1):

Figure 2.1. *The situation of the most important colonies of fish-eating seabirds and waterbirds along the Atlantic coast of West Africa. The map on the right (insert) shows the upwelling zone. (After Veen et al. 2003)*



1. Parc National du Banc d'Arguin (Mauritania)
This is a 1,500,000 ha large national park, half of which lies in the Sahara desert. The marine section includes a large part of the relatively shallow Banc d'Arguin, with highly productive tidal flats that are a winter home of some two million Palearctic shorebirds. The park is extremely rich in fish and thought to be a nursery area for many fish species. Large seabird colonies are present on islands in the northern and southern part of the park. There are significant breeding numbers of the Greater Flamingo, Great Cormorant, Long-tailed Cormorant, White Pelican, Grey Heron, Reef Heron, Eurasian Spoonbill, Caspian Tern, Royal Tern, and Slender-billed Gull. The colonies on the Banc d'Arguin are of great international importance. The sub-species of the Grey Heron *Ardea cinerea monicae* and the Eurasian Spoonbill *Platalea leucorodia balsaci* are endemic breeding birds to the park; moreover, roughly 20% of the sub-species of the Royal Tern *Sterna maxima albidorsalis* breed there. The total number of breeding pairs (all species together) is estimated between 45,000 and 55,000 pairs. The park is a Ramsar site and is managed by the Parc National du Banc d'Arguin. For more information see Campredon 2000 and Ens et al. 1990.

2. Parc National de la Langue de Barbarie (Senegal)
The site (2000 ha) stretches along the Atlantic in the north-western part of Senegal and covers part of the estuary of the Senegal River. It consists of a large sandy peninsula (la Langue de Barbarie), part of the river and some salt plains. A small island in the river (Ilot aux Oiseaux, 1.5 ha) is a traditional breeding place for Reef Herons, Caspian Terns, Royal Terns, Slender-billed Gulls and Grey-headed Gulls. In the period of 1998-2001, breeding numbers (all species together) varied between 6,000 and 7,000 pairs. In 2003, a channel was cut mid-way the long sandspit separating the Atlantic Ocean from the river, which will have implications on the ecology in the Senegal delta, and potentially on the breeding islands. The park is managed by the Direction des Parcs Nationaux du Sénégal. For more information see Veen *et al*. 2003.

3. Parc National du Delta du Saloum (Senegal)
This large national park (73,000 ha) is situated at the Atlantic coast of Senegal, just north of the Gambian border. The park is formed by the delta of the rivers Saloum, Diombos and Bandiala and consists of numerous mangrove-bordered waterways, islands, lagoons, and tidal flats. A number of isolated sandy islands are situated in the ocean, a few kilometres away from the nearest mainland. One of them, Ile aux Oiseaux, is a traditional breeding place for colonial seabirds, among which are Reef Herons, Common Terns, Caspian Terns, Royal Terns, Slender-billed Gulls and Grey-headed Gulls. Between 1998 and 2001, the breeding numbers varied between 40,000 and 60,000 pairs. Royal Terns are by far the most numerous (maximum 42,000 pairs in 1999). The island is of great international importance for this sub-species, as it harbours up to 80% of the total population. The park is a Ramsar site and is managed by the Direction des Parcs

Nationaux du Sénégal. For more information see Schepers *et al*. 1998 and Veen *et al*. 2003.

4. Bijol Islands (The Gambia)
The two small sandy islands (1.5 ha), at low tide connected by a small sand bar, are situated roughly 3 kilometres off the coast of The Gambia, south-west of Banyul. One of the islands is partly covered with vegetation. There are breeding colonies of the Grey-headed Gull, Caspian Tern and Royal Tern. Between 2000 and 2003, the total numbers varied between 5,000 and 10,000 pairs. The islands are part of the Tanji Wildlife Reserve and are managed by the Department of Parks and Wildlife Management of the Gambia.

5. Réserve Ornithologique de Kalissaye, Casamance (Sénégal)
This small ornithological reserve (16 ha) in southern Senegal consists of a sandy peninsula at the Atlantic coast situated within the delta of the Casamance River. In the past, breeding colonies of the White Pelican have been recorded here. There are also records of a large tern colony (10,000 pairs), but it is uncertain whether this concerns Royal Terns or Caspian Terns. Because of the political situation in the area, ornithologists have not visited the reserve for a long time, and no recent data on the occurrence of breeding seabirds are available. The area is managed by the Direction des Parcs Nationaux du Sénégal.

6. Arquipelago dos Bijagos and other coastal islets (Guinea Bissau)
The area (roughly 500,000 ha) includes an important part of the coastal area of Guinea Bissau. It consists of 88 islands and the adjacent mainland with open water, large channels, river estuaries, inter-tidal sand and mudflats, and mangrove vegetation. It is an important wintering area for one million migratory Palaearctic shorebirds. Information on breeding birds is scanty. Breeding colonies of the Western Reef Heron, African Spoonbill, Grey-headed Gull, Caspian Tern, and Royal Tern have been recorded, the latter being situated on some westernmost sandy islets. The area is a Man and Biosphere Reserve and contains the Orango National Park. For more information see Dodman *et al*. 2004 and Wolff 1998.

7. Iles Tristão and Ile Alcatraz (Guinea)
Iles Tristão (85,000 ha) are located at the Atlantic coast of northwestern Guinea, just south of the border with Guinea-Bissau, at the mouth of the Cogon River. It is an estuarine complex with extensive mangrove forests and sandy inter-tidal zones. There are two large mangrove dominated islands, and smaller sandy islands nearer the ocean. The main sandy island, Pani Bankhi, supported some waterbird breeding colonies including African Spoonbill, Grey-headed Gull and Caspian Tern. However, it would appear that the island was washed away in recent years.
Ile Alcatraz (1 ha) is a rocky island situated in the Atlantic about 60 km southwest of Iles Tristão. Brown Boobies (3,000 pairs) nest on the island, forming the largest colony for the species in western Africa. A neighbouring sandbank, Ile du Naufrage, is a resting place for thousands of terns, notably the Royal Tern, but also the Black Tern, Caspian Tern, Little Tern, and Sandwich Tern. Reliable data are lacking.
Iles Tristão and Ile Alcatraz are Ramsar sites managed by the Direction Nationale de l'Environnement de Guinea. For more information see Altenburg & Van de Kamp 1991.

8. Rio Kapatchez (Guinea)
The site (20,000 ha) is located at the Atlantic coast just north off Cape Verga, between the Nunez and Koumba rivers. It mainly consists of marshy freshwater coastal plains bordered by sand dunes and inter-tidal sand/mudflats. On the north-western boundary of the site, there is a tidal creek with mangroves and a small sandy island at its mouth. The area is an important wintering site for migratory Palearctic shorebirds. Other waterbirds recorded here include Greater and Lesser Flamingos and Long-tailed Cormorant. Royal Tern and Caspian Tern have been recorded to breed on a small sandy islet in the area (Khoni Banki). No recent data are available on numbers. The area is a Ramsar site managed by the Direction Nationale de l'Environnement of Guinea. For more information see Altenburg & Van de Kamp 1991.

Table 2.1. The occurrence of the Grey-headed Gull, Slender-billed Gull, Caspian Tern and Royal Tern in colonies along the coast of Northwest Africa. Numbers vary from year to year and have been (roughly) indicated as follows (breeding pairs, situation 1980-2002): x=tenths, xx=hundreds, xxx=thousands, xxxx= ten thousand or more, ? numbers unknown. In many cases the data in the table are based on occasional observations. Source: Wetlands International 2002 and personal observations.

Site	Country	Grey-headed Gull	Slender-billed Gull	Caspian Tern	Royal Tern
Banc d'Arguin	Mauritania	x	xxx	xxx	xxxx
Langue de Barbarie	Senegal	xxx	xxx	xx	xxx
Ile aux Oiseaux, Saloum	Senegal	xxx	xxx	xxx	xxxx
Bijol Islands	The Gambia	xxx		xx	xxx
Kalissaye	Senegal			?	?
Arq. dos Bijagos	Guinea-Bissau			xx	xxx
Iles Tristao	Guinea	?		xx	xxx
Rio Kapatchez	Guinea			?	?

3 Identification of species included in the monitoring programme

The monitoring programme behind this manual concentrates on the Grey-headed Gull, Slender-billed Gull, Royal Tern and Caspian Tern. Therefore, identification, numbers, distribution and ecology of these species is described in detail. In a number of colonies, some additional information (mainly the number of breeding birds) is collected on other species as well, such as the Greater Flamingo, Great Cormorant, Long-tailed Cormorant, White Pelican, Grey Heron, Reef Heron, Eurasian Spoonbill, African Spoonbill, Common Tern, and Kelp Gull. These species are described briefly at the end of this section.

Grey-headed Gull (*Larus cirrocephalus*)

Identification
Medium-sized gull with white underparts and darkish-grey upperparts. In breeding plumage has characteristic grey hood. Bill and legs red, eye pale yellowish. In flight shows grey upperwing with white "mirror" and black wing-tips. Underwing is uniformly dark grey with small white tip at end. Eggs usually have a brownish or greenish ground colour with many grey, brown or black spots. Dark spotting may be concentrated at the blunt side of the egg. Downy chicks are cinnamon-buff, marked with black or dark brown spots, bands and mottles, except on belly. Emerging feathers (larger chicks) above dark-brown with cinnamon-buff edges; primaries with black distal part and edges, but white central parts.

Numbers and distribution
The Grey-headed Gull breeds in South America (*L. c. cirrocephalus*) and in South, East and West Africa (*L. c. poiocephalus*). The African breeding population is estimated at 75,000-150,000 pairs (Wetlands International 2002). No detailed information is available on the breeding distribution in West Africa. The species breeds in colonies along the coast from Mauritania till Guinea and probably more southward. The main part of the West African population is concentrated in Senegal with ca. 3,000 pairs in the Langue the Barbarie and ca. 7,000 pairs in the Delta du Saloum. Outside the breeding season, the West African population probably spreads along the Atlantic coast and along coastal rivers.

Ecology
Grey-headed Gulls nest along the coast, estuaries, rivers, and lakes. Sometimes colonies are located close to human habitation (harbours). Nests are usually built in vegetated areas, but may also be situated on bare ground. Colonies vary in size from a dozen to several thousand of nests. Inter-nest distances vary between 2m and more than 10m. The timing of breeding varies from colony to colony and may extend over a period of six months or more (see annex 11). A complete clutch usually consists of 3 eggs (range 1-3). Incubation takes 22-26 days (Peeters 1999), whereas chicks fledge after about 35 days. In case of disturbance chicks may leave the nest, but they usually return shortly afterwards. As a rule, chicks remain in the neighbourhood of the nesting territory until fledging. Grey-headed Gulls have a varied diet consisting of fish, fish offal, marine invertebrates and insects. Certain individuals may specialise in taking eggs and small chicks (for instance, Royal Tern eggs on Ile aux Oiseaux, Delta du Saloum). Foraging activities take place close to the shore.

Slender-billed Gull (Larus genei)

Identification
Medium-sized gull with white underparts, neck, and head. Long sloping forehead with long dark-red bill. Upperparts pearl-grey; legs orange-red. In flight shows light grey upperwings with white wing-tips tipped black. Pale underwing with black and white at tips. Eggs have a white or whitish ground colour with many small brownish, grey or black spots. Downy chicks are variable. Ground colour usually is greyish-white, but may also be greyish-brown or pinkish-buff; marked with dark-brown to black spots and blotches except on chin, breast and belly. In larger chicks, emerging feathers above wood-brown with light terminal edges; primaries with black distal part and edges and white central parts. Head and neck white or yellowish with brown blotches. The bill is relatively long.

Numbers and distribution
Slender-billed Gulls nest in West Africa, around the Mediterranean, the Black and Caspian Seas and the Persian Gulf. The world population is estimated at 100,000-135,000 pairs (Wetlands International 2002), of which 7,500 pairs nest in West Africa. West African colonies are situated in Mauritania (ca.1,500 pairs, Banc d'Arguin), Senegal (ca.1,000 pairs Langue de Barbarie and ca. 5,000 pairs Delta du Saloum). It is assumed that the West African breeding birds spend the northern winter along the West African Atlantic coast, but no detailed information is available.

Ecology
Slender-billed Gulls nest in dense colonies (inter-nest distances often less than 50 cm), varying in size between a dozen and several hundred nests. Nests are constructed of plant material, and the nest rim is covered with faeces in the course of the season. Colonies are usually situated along the coast, but inland colonies have been recorded as well. Breeding mainly takes place in April-June (see annex 11), with egg-laying being highly synchronised within colonies. A complete clutch usually consists of 3 eggs (range 1-4), which are incubated for a period of 22-28 days. Chicks fledge when 30-40 days of age. In reaction to disturbance, several-days-old chicks may leave the nest. When growing older, chicks become more and more mobile. However, they normally return to the nest to be fed by the parents. Chicks of a few weeks old may concentrate in crèches outside the colony area. Slender-billed Gulls mainly occur along the coast and forage at sea. Their diet consists of fish and crustaceans. Occasionally insects and fish offal are eaten. Certain individuals may prey upon eggs and small chicks of terns and gulls, including their own species.

Royal Tern (*Sterna maxima*)

Identification

Relatively large tern (but notably smaller than Caspian Tern), with white underparts and neck. Upperparts grey. In breeding plumage has black cap with crest. Conspicuous orange bill and black legs. Wings long, pointed and narrow with dark primary wedge on underwing (but less conspicuous than in Caspian Tern). Eggs are extremely variable. Usually they have a white or creamy ground colour with a large number of grey, brown or black speckles and (sometimes very large) dots. Speckles and dots may be concentrated at the blunt side of the egg. Downy chicks have a whitish or creamy ground colour and may have dark freckles (amount variable) on head, back and wings. The colour of the bill is usually orange, but may also be greenish or yellowish. The legs may be black, yellowish or orange. In larger chicks emerging feathers above cream-grey with dark spots on mantle. Black crown-cap usually first develops as a dark spot around the eye. Dark grey lesser coverts show as a bold line across folded wing; dusky-brown band across secondaries.

Numbers and distribution

There are two sub-species of the Royal Tern which both have different breeding ranges. The North American population of the sub-species *A. m. maxima* is estimated at 60,000 pairs, whereas the West African population of *A. m. albidorsalis* is estimated at 45,000-55,000 pairs (wetlands International 2002). Important West African breeding colonies are found in Mauritania (ca.15,000 pairs, Banc d'Arguin), Senegal, and The Gambia (ca. 30,000-40,000 pairs, Langue de Barbarie, Delta du Saloum, Bijol Islands and Kalissaye). Outside the breeding season, the West African Royal Terns spread along the entire Atlantic coast from Morocco to Namibia.

Ecology

Royal Terns breed in large colonies that may consist of several thousand of nests. Inter-nest distances are small (mean 36 cm) and surprisingly uniform. Colonies are situated on islands or peninsulas, on bare sandy soil, occasionally bordered by sparse vegetation. In Senegal and The Gambia, breeding is concentrated in the period April-June (see annex 11). Egg-laying is highly synchronised within each colony (hundreds or even thousands of eggs laid within a few days). A clutch typically consists of one egg. Two-egg clutches (a few percent) probably always originate from two females laying in one nest. The incubation period varies from 25 to 31 days; chicks are able to fly when about 30 days of age. In reaction to human disturbance, chicks of a few days old may leave the nest. Chicks ageing one week or more often leave the colony area and concentrate in groups (crèches) on the beach where they are fed by their parents. Royal Terns typically occur along the coast. They forage individually or in small groups and almost exclusively catch marine fish. In the breeding season, the foraging area may extend up to 50 km from the colony.

Caspian Tern (*Sterna caspia*)

Identification

Very large tern with white underparts and neck. Upperparts grey. In breeding plumage black cap with crest, cut off square at back of head. Diagnostic heavy red bill. Black legs. Wings long and broad, held relatively straight. White underwing contrasts with large dark wedge on primaries. Eggs are large and variably coloured. They usually have a light sandy-brown ground colour with small grey, brown or black dots. Downy chicks are uniformly light coloured, varying from whitish to creamy, greyish or brownish, often with a few darker freckles on the back. Down on lore and throat usually darker grey. Bill apricot-orange with black extreme tip. Emerging feathers above (larger chicks) vary from white to greyish buff with dark wedge-shaped markings. Black crown-cap of large young reaches far below eye.

Numbers and distribution

The Caspian tern *S. c. caspia* breeds in North America, Europe, Africa, the Middle East, Central Asia, North and South America, whilst the subspecies *S. c. strenua* occurs in Australia. The world population is estimated at 65,000-110,000 pairs, of which 25% breed in West Africa (Wetlands International 2002). The most important West African colonies are found in Mauritania (up to 11,000 pairs, Banc d'Arguin) and Senegal (up to 9,000 pairs, Delta du Saloum). Caspian Terns breeding in West Africa probably winter along the West African Atlantic coast.

Ecology

Breeding colonies of the Caspian Tern show great variations in size (between a few pairs and several thousand of pairs) and density (inter-nest distances from 50 cm to several meters). The nest is no more than a shallow depression on bare sandy or rocky soil. In Senegal and The Gambia, breeding is concentrated in the period March-July (see annex 11). Clutch size varies between 1 and 3 eggs, incubation lasts 26-28 days and chicks fledge when 35-45 days old. Caspian Terns occur on large freshwater lakes, in estuaries and along the seashore. However, the species is rarely observed far away from the coast. Foraging takes place individually or in small groups, up to 60 km from the colony. The diet consists of a variety of fish species (freshwater and marine).

Grey-headed Gull: adults in breeding area (1), nest in typical habitat (2), eggs and small chick (3). Slender-billed Gull: adults incubating (4), Nests with eggs (5 and 6), chick of a few days old (7), adult with chicks of 3-4 weeks of age (8).
Photo's by: J. Peeters 3, 8; J. Veen 1, 2, 4, 5, 6, 7)

Royal Tern: adults incubating (9), nests with eggs (10), adults with chicks of about one week of age (11), adult with chicks of about 4 weeks old (12). Caspian Tern: adults in breeding colony (13), nest with eggs and regurgitated pellet on right (14), adult with chick of about one week old (15), adult with chick of four to five weeks of age (16).
Photo's by: J. Peeters 3,7,11,13,15; J. Veen 1,2,4,5,6,8,9,10,12,14,16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Some other colonially breeding seabirds and waterbirds along the West African coast

A number of species breeding in the colony sites mentioned in chapter 2 are briefly described below. The species mentioned all find their food, either exclusively, or partly, in the marine environment. Many of them also eat marine invertebrates, in addition to fish. In several sites more colony breeding species are present. A selection has been made here, based on the presumed suitability of the species to be included in a monitoring programme which aims at obtaining information on marine food resouces. Numbers, distribution and data on whether the species is monitored mainly refer to the sites earlier mentioned.

1. Brown Booby (*Sula leucogaster*)
Large seabird, brown above, on head and neck; white below (see Barlow et al. page 18 and 118). Pelagic offshore feeder. Colony of approx. 3,000 nests (Altenburg & Van de Kamp 1991) on rocky substrate on Alcatraz Island, Guinea. Not regularly monitored.

2. Great Cormorant (*Phalacrocorax carbo*)
Large cormorant. Adults with black plumage except for white throat and breast (see Barlow et al. page18 and 118). Coastal feeder, also in freshwater. Nests on ground (sand or rocky substrate) and in trees. Breeds on Banc d'Arguin, Mauritania, (max. 8190 pairs in 1997) and along the coast of Senegal. Not regularly monitored.

3. Long-tailed Cormorant (*Phalacrocorax africanus*)
Smaller cormorant species with all black plumage when adult (see Barlow et al. gage 18 and 119). Coastal feeder, also in freshwater. Nests on ground (sand or rocky substrate) and in trees. Breeds on Banc d'Arguin, Mauritania, (max. 2883 pairs in 1997), in Senegal (Saloum and Casamance) and in Rio Kapatchez, Guinea. Not regularly monitored.

4. Great White Pelican (*Pelecanus onocrotalus*)
Large, white pelican with black flight feathers (see Barlow et al. page 18 and 120). Favours coastal and riverine habitats for feeding. Nests on ground. Large colonies in Djoudj and (formerly?) Kalissaye, Senegal, with thousands of pairs. Regularly monitored in Djoudj.

5. Western Reef Heron (*Egretta gularis*)
Medium-sized heron with all blue-black plumage except for white chin. There is an all-white morph that is far less numerous (see Barlow et al. page 20 and 125). Favours saline and brackish coastal waters for feeding, often near mangroves. Nests in trees (often in mixed heronries) or on ground. The species breeds widely along the West African coast. Colonies are present on the Banc d'Arguin, Mauritania, (max. 1897 pairs in 1997), Langue de Barbarie (355 nests in 2002) and Ile aux Oiseaux and Ile aux Diables, Delta du Saloum (5000 pairs in 2000), Senegal. The Senegalese colonies have been regularly monitored since 1998.

6. Grey Heron (*Ardea cinerea*)
A large heron, mainly grey above and white below, with black supercilium, black 'epaulettes' on wings and black primaries (see Barlow et al. page 20 and 127). Favours coastal (tidal flats, mangroves) and freshwater habitats for feeding. Nests in trees or on ground. Colonies of the pale-grey African race are present on the Banc d'Arguin, Mauritania (max. 2400 pairs in 1984-85). Not regularly monitored.

7. Eurasian Spoonbill (*Platalea leucorodia*)
Large all-white spoonbill with spatulate bill (see Barlow et al. page 22 and 133). The European-breeding sub-species *P. l. leucorodia* has a black bill with prominent yellow tip (adults), whereas the somewhat smaller African sub-species *P. l. balsaci* has an entirely or almost black bill. The latter is an endemic breeding bird of the Banc d'Arguin, Mauritania, where it nests on the ground and forages on the tidal flats (max. 2001 pairs in 1997). Regularly monitored (numbers and breeding success) since 1997.

8. African Spoonbill (*Platalea alba*)
Large all-white spoonbill with bare red face and long blue-grey spatulate bill (see Barlow et al. page 22 and 133). Favours open water, both fresh and saline. Nests in colonies, in trees, often in mixed heronries. Breeds in Arquipelago dos Bijagos, Guinea-Bissau, and Iles Tristão (Guinea) but numbers are unknown. Not monitored.

9. Greater Flamingo (*Phoenicopterus ruber*)
Unmistakable large wading bird with long neck and legs and white to pink plumage (see Barlow et al. page 22 and 133). Feeds in open water, salt or brackish. Nests on the ground. There is a large colony (max. 12,940 pairs in 1984-85) on the Banc d'Arguin. Regularly monitored on the Banc d'Arguin.

10. Kelp Gull (*Larus dominicanus*)
Large gull with black mantle and olive-green legs (see Barlow et al. page 56 and 210). Marine species, usually seen along coast. Nests on the ground in loose colonies. Species from the southern hemisphere which occurs in very small numbers in western Africa. Only breeding place on Ile aux Oiseaux, Delta du Saloum, Senegal (14 pairs in 1999). Numbers, hatching success and some other breeding parameters have been monitored since 1999.

11. Common Tern (*Sterna hirundo*)
Medium-sized tern with grey mantle and, in breeding plumage, black cap and red bill tipped black (see Barlow et al. page 58 and 215). Mainly offshore feeder. Nests on ground, on bare sandy soil or in low vegetation. Large numbers of Palearctic migrants winter along the West African coast, whereas small numbers (usually tens to hundreds) belong to the local breeding population. Known to breed regularly on Ile aux Oiseaux and Ile Senghor, Delta du Saloum, Senegal (110 pairs in 2000), where numbers, hatching success and some other breeding parameters have been measured since 1999.

Table 3.1. *Population and breeding data for some colonial seabirds and waterbirds breeding along the coast of Africa from Mauritania to Guinea. Population size is given for West Africa (WA) or West and Central Africa (WCA) as defined by Wetlands International (2002). M, S, GB and G refer to Mauritania, Senegal (and The Gambia), Guinea Bissau and Guinea. Usual clutch size is given, with extremes between brackets. Egg size is given by means of mean length and width. Data derived from Cramp & Simmons 1977-1983, Veen et al. 2003 and Wetlands International 2002.*

Species	Population size (individuals)	Breeding countries	Clutch size (n eggs)	Egg size (mm)
Brown Booby	?	G	1-2 (3)	60x61
Great Cormorant	35 000 WA	M S GB G	3-4 (-6)	66x41
Long-tailed Cormorant	100 000 WCA	M S GB G	4 (3-5)	46x31
Great White Pelican	60 000 WA	M S G	2 (1-3)	94x59
Western Reef Heron	?	M S GB G	2-3 (4)	47x34
Grey heron	10 000 WA	M	4-5 (1-10)	61x43
Eurasian Spoonbill	6 500 WA	M	3-4 (-7)	67x46
African Spoonbill	?	GB G	?	?
Greater Flamingo	40 000 WA	M G	1 (2)	90x55
Grey-headed Gull	30 000 WA	M S ? ?	1-3	50x36
Slender-billed Gull	22 500 WA	M S ? ?	1-3 (4)	53x38
Kelp Gull	30 WA	S	1-3	41x31
Caspian Tern	45-60 000 WA	M S GB G	1-3	65x45
Royal Tern	135-165 000 WA	M S GB G	1 (2)	61x42
Common Tern	1 200 WA	M S ? ?	1-3	41x31

4 Working in a seabird colony

When you want to do observations in a breeding colony you have to approach the breeding birds and, in many cases, you have to enter the colony area. This will disturb the birds, which involves certain risks for the eggs and chicks. When doing your work, always remember that you collect information to be used for nature conservation purposes. Always keep in mind that the welfare of the birds comes first. This means that you always carefully judge the situation in order to keep disturbance to a minimum. Special attention must be given to the following:

1. Always minimise the time spent in the colony
This can be achieved by knowing what to do and by working together. It is of crucial importance to plan your activities in advance. Give everybody a clear task (counting, measuring, making notes). A well-trained team knowing what to do can work very quickly.

2. Concentrate disturbance in one place
When working in a group, you should stay together and concentrate disturbance in one place. If you want to move to another colony area, do it in a disciplined way and again keep together. Always avoid spreading over the colony.

3. Avoid that eggs and chicks are exposed to high temperatures
Birds brood their eggs and small chicks in order to keep them at the right temperature. In tropical regions, eggs and chicks may easily die when they are exposed to the heat of the sun for a long period. Therefore, only enter the colonies in the early morning and late afternoon, when temperatures are low. In West Africa, as a rule, observations inside a colony are only made before 10.00 hrs. and after 17.00 hrs. But even so it is necessary to keep an eye on the situation. At 7.00 hrs in the morning you can stay longer in a particular place than at 10.00 hrs.

4. Do not disturb settling birds
In seabird colonies egg-laying is often highly synchronised and all pairs in a particular part of the colony may lay their eggs in a period of only a few days. In the egg-laying period severe disturbance may cause the birds to desert their clutches. Therefore, try to avoid disturbing settling birds. Do not count nests, but make an estimate of the number of pairs present. You can enter the colony and count the nests at a later stage of the breeding cycle.

5. Do not disturb small chicks
Chicks of the Caspian Tern, Royal Tern, and Slender-billed Gull usually stay in the nest for about a week. When getting older, they become more mobile and voluntarily move around in the vicinity of the nest. As a rule, chicks of the Caspian Tern and Slender-billed Gull return to the nest to be fed, but Royal Tern chicks gradually move away from the nesting area and concentrate in groups on the beach where they are fed by their parents. In reaction to human disturbance, small chicks may leave the nest walking away from the human intruder. Such chicks may have difficulties in finding their way back to the nest. It is especially a problem in the dense colonies of the Royal Tern where breeding adults behave aggressively towards any chick apart from their own passing the territory. This may cause serious injury or even death of such chicks. Therefore, avoid disturbing Royal Tern colonies with small chicks and always keep an eye on how chicks (small and larger ones of all species) react to your presence. Chicks should never end up in the middle of a dense colony far away from their place of birth.

6. Do not chase large chicks over long distances
Medium-sized and large chicks that have left the colony area may concentrate along the beach. When walking along the beach, especially at high tide, such chicks tend to run away from a human observer following the coastline. Avoid chasing such chicks over long distances. They may get exhausted and overheated. Leave the beach for a while by moving inland, thus giving way to the chicks.

7. Avoid being the cause of predation
Grey-headed Gulls and Slender-billed Gulls are opportunistic foragers, with eggs and chicks forming part of their diet. As a rule, only a small number of gulls tend to steal eggs and chicks from temporarily unattended nests of other gulls (including their own species) and terns. However, certain gulls may specialise in robbing eggs or chicks in parts of the colony disturbed by human observers. Always keep an eye on (potential) predators, which try to land in your working area. (Non-predators behave differently. They show alarm behaviour or attack the intruder in order to defend their own brood.) The problem can be partly solved by staying together and thus minimising the area of disturbance (see 2). Sometimes it may be necessary to leave the area and choose another part of the colony for doing your research.

5 Measuring the breeding population size

Introduction

Determining the number of breeding pairs is the first thing to do when monitoring seabird colonies. The size of the breeding population is basic information in planning protection and management of the area. Changes in breeding population size may be related to changes in food availability and, thus, they indicate the abundance of fish in the neighbourhood of the colony. A variety of methods can be used for determining the size of the breeding population in a particular area. The method to choose depends on:

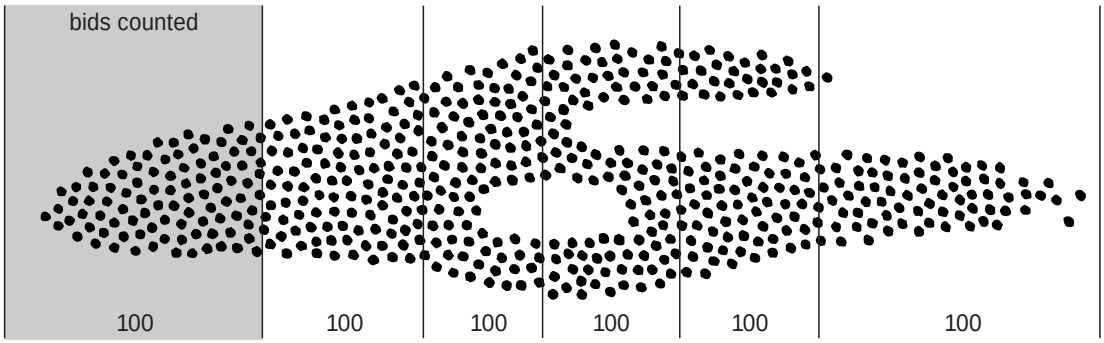
- the species involved;
- the size, location and accessibility of the colony;
- the phase of the breeding cycle;
- the number of persons available to do the observations;
- the level of experience of the observers;
- whether you visit the area only once or at regular intervals.

The methods vary from a rough estimate of the "total number of breeding birds present" to an "exact count of the number of occupied nests". The first method is used when the number of observers is too small, or when other circumstances do not allow to carry out a more precise count. An estimate will also be made when the colony area is visited only once and when eggs, chicks and fledglings are present all at the same time. In the framework of the present monitoring programme it is envisaged to check the colonies on a regular basis. As a rule, colonies will be visited at 30-day intervals (once a month) throughout the breeding season. This frequency is based on the fact that all species included in the monitoring programme have an incubation period between 22 and 30 days long. This means that nests with eggs counted at a particular moment cannot be the same as those counted a month earlier. It also means that the total number of nests with eggs counted during successive months will provide us with a figure that is "the minimum number of clutches laid in a particular year". This figure is not necessarily identical to the total number of pairs breeding. Eggs collected by humans, predation, and high floods may cause egg loss and, possibly, re-laying. The number of breeding pairs may therefore be smaller than the number of nests with eggs counted. When doing observations in the colonies, it is of great importance to try to obtain information about egg-loss and the extent of re-laying. Such information is needed in order to interpret the results obtained from nest counts in terms of the number of breeding pairs.

Estimating the number of breeding pairs (all species)

There may be several reasons for estimating the size of a breeding colony instead of making accurate counts of nests with eggs and/or chicks. As a rule, an estimate concentrates on the number of adult birds present in the colony area. An easy and relatively accurate method for estimating the number of adult birds present is the "block method". It can be used for large or small aggregations of birds that are densely concentrated (Royal Tern) or spread over a large area (Grey-headed Gull). The method involves counting or estimating a "block" of birds within a group. Depending on the group size, the block can include 10, 100, or 1000 birds. The "block" is then used as a model to measure the remainder of the flock. An example is given in figure 5.1. All observers present should make their own estimates. Comparison of the results may show great variations between the observers. Let everybody repeat his or her estimates. Finally, take the average of the estimations made by those skilled in counting birds.
The number of adult birds present is not necessarily the same as the number of breeding pairs. Information on how both relate to each other can be obtained by studying the situation in the colony using a telescope. Try to obtain information on whether there are many non-breeding birds present, whether the birds are incubating their eggs or brooding their chicks and whether there are many large chicks or even fledglings around. Non-breeding or roosting groups should be distinguished from the breeding birds. In the incubation and chick-rearing period, one partner usually cares for the brood while the other forages at sea. However, as the chicks get older, both parents may be off fishing. No strict rules can be given for how to cope with this situation. Very often the total number of adult birds present relates rather well to the number of pairs breeding. However, if many medium and large-sized chicks are present in the area, an estimate of the number of adult birds is nearly always an underestimation of the number of pairs that have bred in the colony.

Figure 5.1. *Estimating the number of birds in a colony using the 'block' method. In this case a 'block' of 100 birds is counted and its size compared with the remainder of the colony. Number estimated 600; real number 562.*



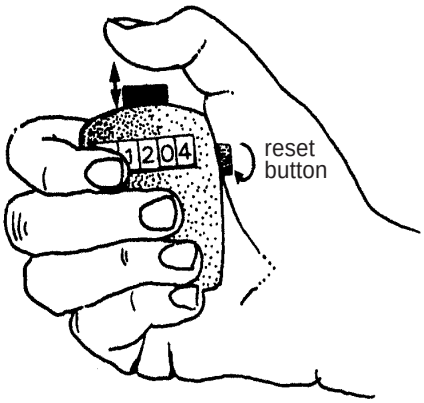
Procedure:
1. *approach the colony as closely as possible without disturbing the breeding birds;*
2. *count/estimate numbers using the block method;*
3. *compare results of different observers;*
4. *count/estimate once more, if necessary;*
5. *observe the breeding birds using a telescope;*
6. *discuss and decide on the final number (take average if necessary);*
7. *make notes on the phase of breeding (part of population with eggs, chicks and fledglings; occurrence of non-breeding birds).*

Materials needed:
1. *binoculars*
2. *telescope*
3. *notebook and pencil*
4. *counter*
5. *map of area*

Counting colonies of Slender-billed Gulls

Slender-billed Gull colonies are usually small, varying in size from a dozen to a few hundred nests, but larger concentrations up to a thousand nests have been recorded (Langue de Barbarie). Colonies are situated on higher parts of the beach, on small dunes or open sandy places, on bare ground or in sparsely vegetated areas. In most cases, the nests of Slender-billed Gulls can easily be counted by one person slowly walking through the colony using natural markings to separate parts of the colony already done from those still to be counted. When dealing with a larger colony, it may be useful to involve two to four people in order to minimise the time of your presence in the colony. It may also be necessary to introduce some extra markings in addition to natural ones. In fact, you can use everything for this purpose (pieces of wood, clothing, binoculars, etc.), but the best way is to bring some large sticks or a long rope, or to divide a large colony into sections by drawing lines in the sand using a stick. In all cases it may be handy to use a tally counter - a small hand-held instrument that records and adds numbers at the press of a button (see figure 5.2). This facilitates fast counting and, if the person counting is distracted, ensures that the number counted will not be forgotten. In case the colony is counted only once, all nests are counted. If counts are carried out each month, only nests with eggs are included.

Figure 5.2. Tally counter used for accurately counting eggs or birds in a colony



Procedure:
1. *watch the colony from a distance and decide how to count and who is doing what;*
2. *collect material for marking (if needed)*
3. *walk through colony from one end to the other counting all nests with eggs*
4. *write down results of count in notebook (make a copy once you are back to camp)*
5. *write down things like: phase of breeding, chicks present (percentage of nests), traces of predation, etc.*
6. *indicate position of colony on map of the breeding area.*

Materials needed:
1. *binoculars*
2. *notebook and pencil*
3. *ropes or large sticks*
4. *counter*
5. *map of the area*

Counting colonies of Grey-headed Gulls

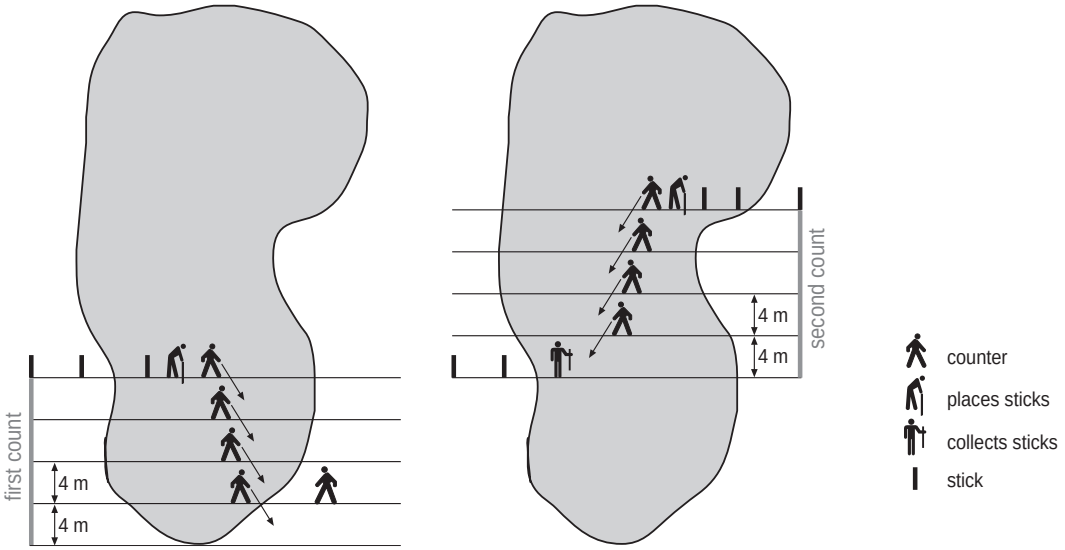
Counting all nests

Grey-headed Gulls breed in colonies sizing from a few to many thousands of pairs. Nests are made in areas with low, sometimes dense vegetation. Inter-nest distances vary between 1 and 10 meters. Large colonies are often composed of several concentrations of nests (sub-colonies) that may be connected by less populated parts of the colony. Large breeding colonies may spread over a very large area, and counting such colonies is very time-consuming. For instance, on Ile aux Oiseaux, Delta du Saloum, more than 5,000 pairs of Grey-headed Gulls are spread over an area of about 4x1 km, so it takes 4 days for a group of 5 persons to count all the nests.

In nearly all cases, large colonies of the Grey-headed Gull have to be divided in well-defined parts (use natural boundaries or sticks to mark borders). Small concentrations of nests (up to a hundred) can usually be counted by one or two persons traversing the area as described for the Slender-billed Gull. However, in most cases, Grey-headed Gull nests should be counted by a group of persons (preferably 4 or more) in the following way:

After the count area has been well defined (use natural boundaries or place sticks), all the observers take position in a line transversely to the direction of movement. They all walk at similar speed in the same direction while distances between neighbouring observers are kept constant (roughly 4 meter). Each observer counts all nests present in his four-meter-wide section, which can be four meter at his right-hand side or two meter at both sides (decide before you start). As a rule, the vegetation makes it impossible to draw lines on the ground and thus to indicate boundaries between sections. Therefore, neighbouring observers must be constantly in contact with each other about who counts nests situated at the

Figure 5.3. *Schematic representation of how large colonies of Grey-headed Gulls can be counted. For explanation see text.*



Procedure:

1. *watch colony from a distance; decide about area to be counted and direction of movement;*
2. *mark boundaries of the area to be counted (if no natural boundaries exist);*
3. *place sticks at beginning and end of colony to indicate line of walking for each observer (not always necessary; depends on colony situation and experience of observers);*
4. *discuss way of working, such as the position of observers in line and distance between them;*
5. *take position in line some distance away from edge of colony;*
6. *start walking and count your section;*
7. *communicate with neighbouring observers about nests at borderline of sections;*
8. *leave colony at other end and move away from area just counted;*
9. *if you placed some sticks to indicate area to be counted, do not remove them if you need them later;*
10. *discuss results and write them down in notebook (make a copy in camp);*
11. *write down things like: phase of breeding, chicks present (percentage of nests), traces of predation, etc.*
12. *indicate position of (part of) colony on map of breeding area.*

Materials needed:

1. *binoculars*
2. *sticks for marking the area*
3. *notebook and pencil*
4. *counters*
5. *map of colony area*

borderline of the sections. Counting ends, when the observers have reached the other side of the colony. Sticks placed at both ends of the colony may be used to ensure that individual observers walk in a straight line. On Ile aux Oiseaux, Delta du Saloum, large Grey-headed Gull colonies have been successfully counted by repeating the above described procedure as depicted in figure 5.3. During such counts one person acted as a co-ordinator, placing sticks to separate the area to be counted from the remaining colony area. Another person removed the sticks. If the colony is counted only once during the breeding season, all nests should be counted, distinguishing between empty nests, nests with eggs and chicks. If counts are carried out on a monthly basis only nests with eggs and small chicks (up to about three days of age) should be included in the count.

Using partial counts for calculating the total number

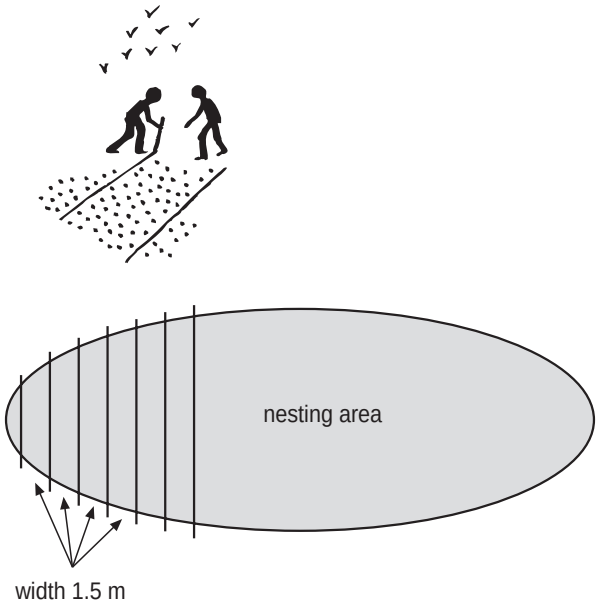
The total number of nests present in a large colony of the Grey-headed Gull can be calculated after all parts of the colony have been counted as described above. However, if time is limited, count results for a part of the colony can also be used to calculate the total number of birds. In this case, the nest density in the counted area should be representative and the size of the counted area and the total area known. However, densities in different parts of the colony being often dissimilar, it is much easier to extrapolate based on the number of breeding birds present in the counted and in the remaining area. Work as follows: count all nests in part of the colony as described above. Additionally, count or estimate the number of adult breeding birds present in this area, which can easily be done as they fly up when you enter the colony. Thereupon, visit all other parts of the colony and count the number of breeding birds in a similar way. If Nc is the number of nests and Bc is the number of birds in the counted area and Br the number of birds in the remaining area, then the total number of nests is equal to Nc x (Bc+Br) : Bc.

Counting colonies of Royal Terns

Counting all nests

Royal Terns nearly always nest in large or very large colonies varying in size between several hundreds and many thousands of nests. Colonies of up to 30,000 nests have been recorded (Ile aux Oiseaux, Delta du Saloum). Because distances between nests are very small (mean inter-nest distance = 36 cm), it is impossible to make a nest count without dividing the colony area into clearly recognisable sections. As the nests are nearly always made on bare sandy soil, it can easily be done by drawing lines in the sand using a stick. In all cases, a relatively large number of observers should be involved in the counting action. The following method has been successfully used for counting colonies of all sizes (see also figure 5.4):

Figure 5.4. *Schematic representation of how Royal Tern colonies can be counted. For explanation see text.*



Procedure:

1. *watch colony from a distance to get an impression of its size*
2. *decide how many persons need to be involved based on the count rate of 80 nests per minute provided by each group of two persons*
3. *plan to be no longer than about 20 minutes in colony*
4. *prepare materials needed during count (stick of about 1 m length for each group)*
5. *discuss division of labour (form groups, appoint marker and counter, appoint co-ordinator);*
6. *decide on where to start your count and in what direction you go;*
7. *carry out counting activities;*
8. *do not hesitate to stop counting, if there are many small chicks in the colony or if you witness many cases of egg predation by gulls;*
9. *leave the colony area and come together to discuss results;*
10. *write down results obtained by different groups in notebook (make a copy in camp);*
11. *write down special things like: phase of breeding, chicks present (percentage of nests), traces of predation, etc.*
12. *indicate position of colony on map of breeding area*

Materials needed:

1. *binoculars (do not carry them while working in colony)*
2. *stick for each group (1 m long, pointed)*
3. *notebook and pencil*
4. *counters*

Persons participating in the count are divided into groups of two: "the marker" and "the counter". Starting at one edge of the colony, the marker of the first group draws a line in the sand, from one side of the colony to the other, thus creating a narrow strip (about 1,5 m wide) that can easily be counted by his/her group mate. The next group begins shortly after the first one has started, and after some time all groups work side by side. After the first group has completed counting the first section, they start anew next to the last group. As a rule, the whole action is co-ordinated by one person who takes care that all sections are properly counted and keeps an eye on predating gulls. In 1998, in the Delta du Saloum, a Royal Tern colony of 16,000 nests was counted in the above-described way by 15 persons in 28 minutes. Based on a number of such counts, it was found that a two-person group on average counts 80 nests per minute.

Measuring colony area using a GPS

In large Royal Tern colonies, the number of nests can be successfully calculated by measuring the surface area of the colony (square meters) and the nest density (nests per square meter). A GPS device appears to be an appropriate tool for measuring the colony surface area. The GPS (abbreviation of Global Positioning System) is a small handheld device that provides information about the geographical position (co-ordinates) of the observer based on satellite bearings. Under favourable conditions, the positions measured can be as accurate as plus/minus several meters. Most GPS's can store positions at given time intervals (for instance, every second). This makes it possible to measure the circumference of a colony as a series of points (co-ordinates) while walking along its borders. Using appropriate computer software, points can be connected and the colony circumference can be converted into the surface area (in square meters). Surface area can then be multiplied by the average nest density (in nests per square meter; see below how to measure) in order to obtain the total number of nests. However, it is also possible to simply plot the co-ordinates of the various points on graph-paper, calculating the surface area by counting squares on paper. Details on how to work out the data age given in annex 1 and Veen et. al. 2004.
Up till now, the GPS method has only been used for determining the size of Royal Tern colonies on Ile aux Oiseaux, Delta du Saloum, and the Bijol Islands, The Gambia. A comparison of the results of direct counts and GPS measurements shows that the accuracy of the GPS-method strongly increases with an increase of the colony size. An error of less than 15% was found for colonies of 5,000 nests or more. Because the GPS method causes little disturbance (one person rather quickly walks around the colony), the method is recommended for all colonies over 5,000 nests. For smaller colonies, especially those having an elongated shape, the method cannot be recommended. More information on how a GPS works is given in annex 1.

Procedure:

1. *watch colony from a distance to get information about its borders;*
2. *check whether your GPS works properly (power supply, right working mode?);*
3. *quickly walk to colony and place stick at starting end;*
4. *walk at constant speed along colony border holding your GPS as much as possible above nests in border;*
5. *proceed along border till you arrive at starting point (stick);*
6. *quickly walk away from colony;*
7. *store data to be processed later (not explained here);*
8. *make notes on situation in colony: phase of breeding, chicks present (percentage of nests), the occurrence of traces of predation, etc.*

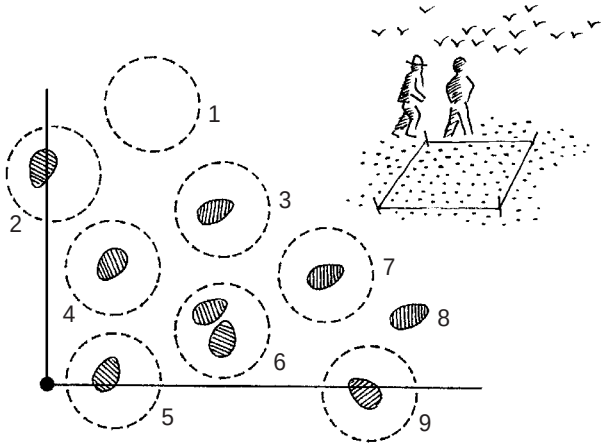
Materials needed:

1. *binoculars*
2. *GPS + batteries*
3. *stick for marking starting point*
4. *notebook and pencil*
5. *for working out the data: computer with appropriate software (Mapinfo), or simply A3 or A4 graph-paper*

Measuring the density of nests

Nest density is measured by counting the number of occupied nests in 2x2 squares at different places (at least three) within the colony (figure 5.5). Avoid areas with vegetation, small dunes, or wreckage, as these might be the cause of non-representatively low nest densities. Squares are easily made by connecting four pegs with 2-meter long ropes (prepare this tool before you enter the colony). Inside each square, the number of occupied nests is counted, i.e. you count all nests with one or two eggs (a two-egg nest is scored as one). However, you should exclude empty nests and deserted eggs (there may be several) that usually lie between nests and are covered with faeces or partly buried in the sand. Should a nest be situated just under the rope, the position of the egg decides whether it is included in your count (at least half of the egg should be inside the square). On having measured a number of 2x2 m squares, the average number of nests per square meter is determined by dividing the total number of nests counted by the number of square meters measured. The total number of nests present in the colony can be calculated by multiplying the colony area (m^2) by nest density (number of nests/m^2).

Figure 5.5. *Nest density is determined by counting the number of nests with 1 or 2 eggs in 2x2 m squares. The picture shows a corner of the square. Nest 3, 4, 5, 6 and 7 are included in the count, whereas nest 1 (empty), 2 and 9 (egg mainly outside) and 8 (deserted egg) are excluded. Further explanation in text.*



Procedure:

1. *prepare the tool for measuring nests in 2x2 m square (4 pegs connected by 2 m ropes);*
2. *discuss way of working and divide tasks;*
3. *watch colony and choose area wherein nest density is representative;*
4. *put pegs in ground (rope should be tightened, forming rectangular corners);*
5. *count nests with eggs apparently incubated;*
6. *quickly leave colony, discuss results and write them down in notebook;*
7. *choose other part of colony for next measurement.*

Materials needed:

1. *binoculars*
2. *tool for making 2x2 square (pegs and rope)*
3. *notebook and pencil*
4. *counter*
5. *map of colony area*

Counting colonies of Caspian Terns

Caspian Terns breed in colonies varying in size from a dozen to several thousands of nests. Inter-nest distances are relatively large (usually between 1 and 5 meter), and colonies can be spread over a large area. Small and compact nest concentrations can usually be counted by one or two persons walking through the colony and counting nests one by one, as described for the Slender-billed Gull. However, if a colony is large, counts should be made by several persons (preferably 4 or more), in order to minimise disturbance. The area to be counted should be divided into sections, in order to avoid overlooking some nests or counting one nest twice. Good co-ordination of the activities is important; tasks should be well-defined. The following method proved to be successful:
Several observers take position in a line transversely to the direction of movement. They all walk at a similar speed in the same direction, while distances between neighbouring observers are kept constant (roughly 3 to 4 meter). Each observer counts all nests present at his/her right-hand side. Holding a stick in the left hand, he/she draws a line in the sand, thus clearly separating neighbouring counting sections. (In case the birds do not breed on sandy soil, neighbouring observers should communicate about nests situated on the borderline of sections.) Counting ends when the other side of the colony has been reached. Sticks placed at both ends of the colony may be used to ensure that individual observers walk in the right direction. The method is largely similar as described for the Grey-headed Gull (see also figure 5.6.)
If the colony is counted only once during the breeding season, all nests should be counted, distinguishing between empty nests, nests with eggs and chicks. If counts are carried out on a monthly basis only nests with eggs and nests with small chicks (up to about three days of age) should be included in the count.

Procedure:

1. *watch colony from a distance; decide about area to be counted and direction of movement;*
2. *discuss way of working, such as position of observers in line and distance between them;*
3. *if regarded necessary, place sticks at beginning and end of colony indicating imaginary line of movement for each individual observer (facilitates walking in straight line);*
4. *take position in line some distance away from edge of colony;*
5. *start walking and count your section;*
6. *leave colony at other end and move away from area just counted;*
7. *if you placed some sticks to indicate area to be counted, do not remove them all, because you may need them again;*
8. *discuss results and write them down in notebook (make duplicate in camp);*
9. *write down things like: phase of breeding, chicks present (percentage of nests), the occurrence of traces of predation, etc.*
10. *indicate position of colony on map of breeding area.*

Materials needed:

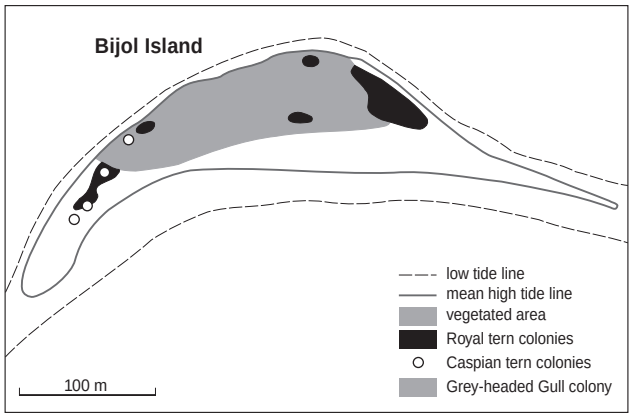
1. *binoculars*
2. *stick for each person*
3. *notebook and pencil*
4. *counter*
5. *map of colony area*

Special methods for making successive counts

Making a map of the area

The above-described census techniques refer to determining the size of a colony at a particular moment. In many cases, the census programme will consist of successive counts made at monthly intervals. In this case, it is necessary to follow the birds throughout the season. In order to be able to clearly distinguish between different concentrations of nests, it is very useful to indicate colonies on a map of the area and number them. This helps to avoid confusion, especially when different people are involved in the census work. The map needs not to be an official one. Any hand-drawn map will do, as long as it includes enough beacons (a ship wreck, a tree, or a stick placed in a certain place), which makes the location of the colonies unmistakable. Preferably, however, a GPS should be used for taking the co-ordinates of a colony or sub-colony which can then be accurately drawn on an official or hand-drawn map. An example of a map with colonies based on GPS-measurements is given in figure 5.6.

Figure 5.6. *Map of the Bijol Islands, The Gambia, with bird colonies indicated, based on GPS measurements taken on 13 May 2003 (by Wim C. Mullié)*



Repeated counts of colonies of the Slender-billed Gull and Royal Tern

If nest counts are made monthly, one concentrates on counting nests with eggs, because clutches counted a month before have either hatched or disappeared (predation). However, one should try to avoid checking colonies for the existence of new nests, if this is not necessary. Slender-billed Gulls and Royal Terns breed highly synchronised, and neighbouring nests are close to each other. Once the area is occupied by these birds, there is no room left for newcomers to settle among the already existing nests. This means that concentrations of nests of the Slender-billed Gull and the Royal Tern counted during one visit usually need not be visited next time. However, it is possible that newcomers have not settled in a new sub-colony, but joined an already existing group at its edges. For instance, Royal Tern colonies may "grow" in a particular direction. In order to minimise disturbance, one should check from a distance whether it has really grown. This can be done on the basis of markings in the field indicating the edges of the colony. If natural markings are insufficiently available, it is necessary to place a few sticks at the ends of the colony to know whether or not new nests have to be counted and where to start. However, be sure to place such markings during the first visit to the colony and to indicate them on your map!

Repeated counts of colonies of the Grey-headed Gull and Caspian Tern

Grey-headed Gulls, and to a certain extent also Caspian Terns, tend to breed rather widespread and new nests may appear amidst the already existing ones. This makes it necessary to check these colonies for new nests during successive monthly visits. As far as large colonies of a thousand or more nests are concerned, it is advised to make a number of study plots or transects to count new nests. The results obtained at the study plots can then be compared with the results of the total count carried out in the middle of the season (during the peak of egg-laying) and the total number of nests calculated. An example is given in table 5.1. It should be noted that this method leads to a reliable figure only if the seasonal pattern of egg-laying in the study plots is representative for the whole colony. In case of very large colonies, a number of study plots or transects should be sampled in order to avoid a non-representative sample. However, one should always compare the laying pattern in the plots with those of the whole population of the species.

Table 5.1. *This example shows (fictive) count results of nests with eggs in a large colony of the Grey-headed Gull. Each month a number of study plots was counted, whereas the total census was carried out on 15/5. The total number of nests for the whole population (Tpop) can be calculated as follows: Tpop = 3200 x 322 : 182 = 5662 nests.*

Nests with eggs present in:	Date of monthly counts 15/4	15/5	15/6	15/7	15/8	Total
Transects or study plots	58	182	47	31	4	322
Whole colony	?	3200	?	?	?	5662

Study plots or transects should preferably include 50 nests or more. Study plots are simply marked with sticks. Transects may be marked with sticks at both sides and counted while walking between these borders. However, a more sophisticated way to count nests in transects is as follows: (1) mark the transect with sticks forming one line; (2) use a "measuring stick" of standard length (for instance 2,5 m) with a rope of 1 m long attached at each end; (3) walk along the sticks (always the same side) keeping the "measuring stick" horizontally and transversely to the direction of movement; (4) count all nests with eggs that are situated between the two ropes at the end of the measuring stick, which should touch the ground. The results to be obtained can be improved if one marks nests that were counted (for instance with a very small stick). In this way one avoids that nests with addled eggs (up to 5% of the eggs is usually rotten or infertile) are counted more than once.

6 Measuring clutch size and egg size

Introduction

In many seabird species, food availability affects body condition of breeding birds, whereas the body condition affects the number of eggs in a clutch and/or the size of the eggs laid. Therefore, by measuring clutch size and egg size, one can obtain information about the feeding conditions. When measuring clutch size and egg size, the following factors should be taken into account:

- Clutch size and egg size tend to decrease in the course of the breeding season, which is mainly caused by differences in the condition of early and late breeders and by an increase of predation later in the season (for details see Veen et al. 2003).
- Within a given part of the colony, clutch size is not always the same. When the birds have just started egg-laying, there may be several nests with incomplete clutches, and by the end of the incubation period eggs may have hatched and chicks left. Besides, eggs may disappear from the nests because of predation throughout the incubation period.
- The effect of predation on clutch size is usually the greatest in small colonies and at the colony edges.

In order to cope with the above problems, clutch size and egg size should be measured:

1. in the beginning or in the middle of the breeding season;
2. in colonies where breeding birds are about halfway done with the incubation;
3. in relatively large and compact colonies.

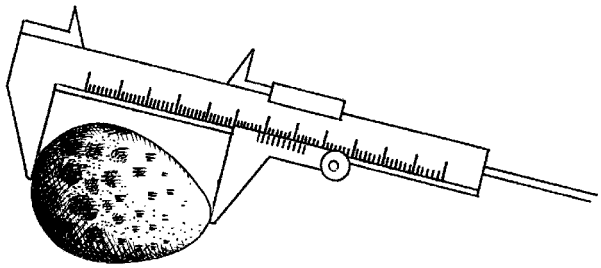
Clutch size

Clutch size is usually measured by two persons. One person mentions how many eggs are present in the nests (like 2, 2, 3, 3, 3, 1, etc.), whereas the other writes down the results. Empty nests are not taken into account. A representative sample is taken with respect to nests situated in the centre and at the edge of the colony. The sample size may vary between 50 and 100 nests. Mean clutch size is calculated by dividing the total number of eggs observed by the number of nests included in the sample. Special data sheets can be used as given in annex 2.
If one wants to work quickly, photographs can be taken and clutch size can be determined by analysing these photos afterwards.

Egg size

Egg size is measured by two persons: one actually measures the eggs, whereas the other acts as an administrator. In a number of randomly chosen nests (clutch size should be representative for the population). the length and width of each egg are measured with an accuracy of 0,1 mm using a pair of vernier callipers (see figure 6.1). At least 50 eggs per species should be measured (can be done in different parts of the colony). In order to minimise the time spent in the colony, it is very important to be experienced in using the callipers. Practice with chicken eggs, until you can accurately measure 15 to 20 eggs in 10 minutes. Results are noted on special data sheets (see annex 4). While working in the colony, the administrator constantly keeps an eye on possible errors being made by checking whether egg measurements are within the normal range for the species (see Veen *et al*. 2003). For details of using vernier callipers see annex 3.

Figure 6.1. *Eggs are measured using a pair of vernier callipers*



Determining egg size in the field is restricted to measuring their length and width. Those who want to compare the results from different years and sites may either calculate mean length and width of the eggs (see table 3.1) or the egg volume using the formula L x B2 x kv (Westerkov 1950), where:
L = length of egg
B = width of egg
kv = 0,51 (constant factor)
The volume is determined for each individual egg. Thereafter, mean values and standard deviations can be calculated (for details see Keijl *et al*. 2000).

Materials needed:
1. *vernier callipers*
2. *data sheets*
3. *notebook and pencil*

7 Measuring chick condition

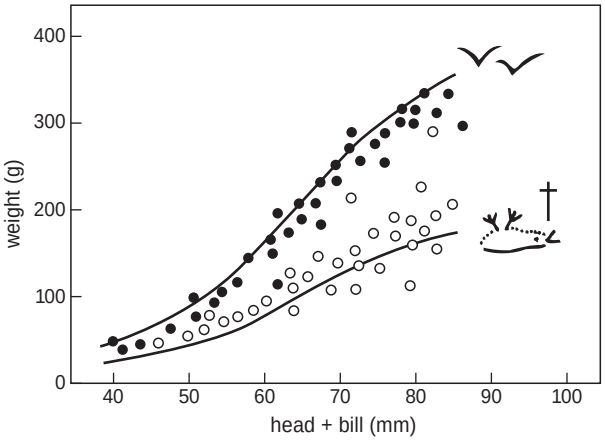
Condition index and condition graphs

The growth of chicks is directly related to the amount of food they get from their parents. Consequently, the body condition of a chick can be used to obtain information about the feeding conditions for the parents at sea. Body condition is also related to survival. Well-fed chicks have better chances to reach the fledging age, and chicks fledged in a good condition have better chances to survive and to return to the colony as a breeding bird in later years.

The weight of a chick is used to measure its condition, but it is evident that the age of the chick should be taken into account as well. Therefore, the chick condition is usually expressed as its actual weight in relation to the expected weight at the given age. However, the age of chicks is often unknown. In this respect it is important to mention that weight strongly reacts to food availability, whereas measures of structural size, such as wing length or head size, are far less affected. If food gets short, weight may even decrease, but the wing length and head size cannot show a decrease. This means that a usable measure of condition can be obtained by relating the weight to measures of structural size (Beintema 1994). Previous research in West African seabird colonies has shown that the length of head+bill is the best measure of size to be used for this purpose (Veen et al. 2003).

If the weight of a chick and the length of its head+bill are measured, they can be related to each other in a graph, as it is done for several chicks in figure 7.1. However, one needs a reference in order to interpret the results. Two lines of reference are given in the figure: the line of maximum growth (upper line) and the line at which chicks die of starvation (lower line). Both lines are averages, so individual chicks may reach weights above and below both lines (see also Veen *et al*. 2003). Condition is now defined as: *condition = observed weight / maximum weight at given length of head+bill.*

Figure 7.1. *Condition graph showing the relationship between length of head+bill and weight for chicks of the Slender-billed Gull. The two s-curves are the means for chicks which show maximal growth (upper line) and chicks which die of starvation (lower line).The black and white dots represent two groups of chicks which are in good and bad condition, respectively.*



This condition index is independent of age and thus can be used for calculating the mean condition for groups of chicks of different age. Condition is given the value of 1,00, if chicks show maximum growth. The starvation line appears to be equal to a condition value of 0,48. Mean condition of groups of chicks can thus be expected to vary between 1,00 and 0,48. High values show that chicks are well fed (black dots in figure 7.1), whereas low values indicate food shortage (open dots in figure 7.1). More details about how the condition index was derived are given in Veen *et al*. 2003.

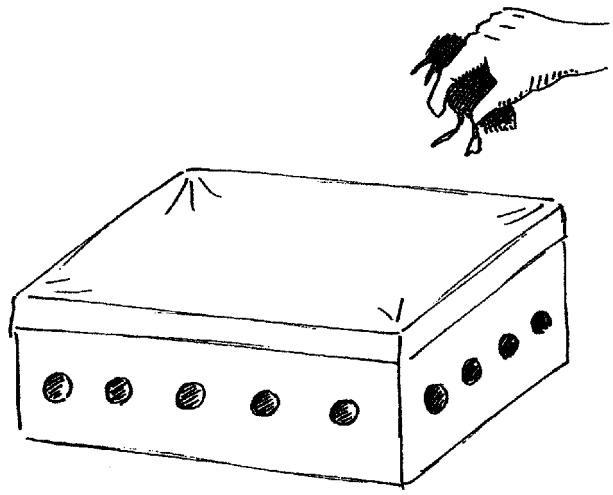
Those who carry out the observations in the field will usually not analyse the data and calculate condition indices. However, field observers will be curious to know whether the condition of the chicks they just measured is good or not. Therefore, forms were developed for the Grey-headed Gull, Slender-billed Gull, Royal Tern, and Caspian Tern, wherein the data can be plotted by hand (see annex 5 and 6). Visual inspection of the data will allow a general interpretation of the results in terms of good, medium or bad condition. It will also allow a rough comparison between sites and between years.

Catching, measuring, and weighing chicks

Small chicks can be measured and weighed in the nest. However, in case of the Royal Tern one should take care that neighbouring chicks do not leave their nests ending up in parts of the colony from where they cannot return (see chapter 4). Grey-headed Gull chicks of all ages can usually be found in the nesting territory and measured at the spot. Medium to larger-sized chicks of Slender-billed Gulls, Royal Terns, and Caspian Terns usually react to human disturbance by walking away and concentrating into groups. In many cases, such chicks stay in crèches outside the nesting area more or less permanently. Chicks in crèches should never be chased over large distances and end up in a colony with Royal Terns still incubating their eggs. The best way to catch chicks is to surround them with a group of people, slowly chase them to an area with low vegetation and quickly catch as many as you can. Do not include in your catch very small chicks that might accidentally be present at the place of catching. They might originate from a nearby nest and should stay where they are.

Chicks caught are stored in well-ventilated boxes with a cover to protect them from the sun (see figure 7.2). Ensure that some space is left in the boxes. Keep the boxes horizontally and avoid that chicks are piled up in one corner. Boxes should be taken away from the colony area and chicks measured in a place where no other birds can be disturbed. On having carried out the measurements, all chicks should be brought back to the place of catching and released together.

Figure 7.2. *Chicks are kept in well-ventilated cages and protected against the sun*



Handling chicks is preferably done by a group of four people. Different persons fulfil the tasks of ringing, measuring head+bill, taking the chicks' weight, and writing down the results. Results should be noted in a special data sheet (see annex 5). Ringing (see chapter 9) is not necessary, but should be done whenever possible.

Head + bill are measured with a pair of vernier callipers or a special ruler. Hold the chick as depicted in figure 7.3 or 7.4. Press the back of the head against one side of the callipers or ruler, ensuring that the protruding part of the skull touches the tool. Then take a reading to the nearest 0,1 mm (callipers) or 1,0 mm (ruler). (For using vernier callipers see annex 3.)

Figure 7.3. *The length of head+bill is usually measured with a pair of vernier callipers*

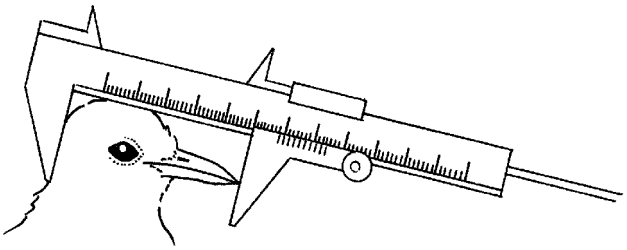
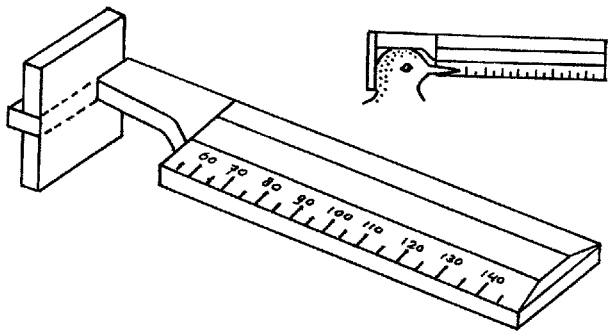
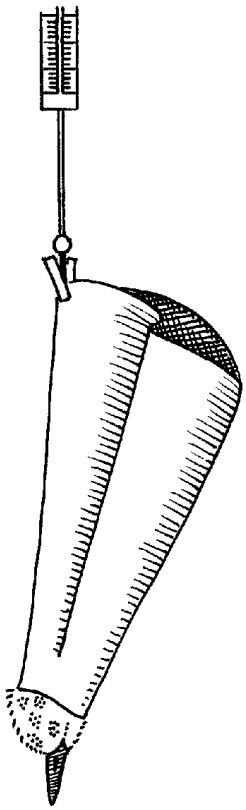


Figure 7.4. *A special ruler may be used as well for measuring head+bill*



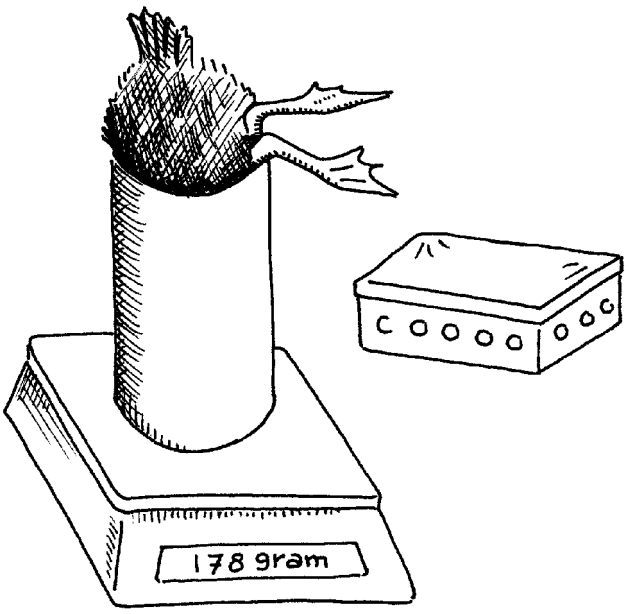
Weight is taken using a hand-held pesola balance or an electronic balance. When using the pesola balance, the chick should be placed in a plastic bag as shown in figure 7.5. Subtract the weight of the plastic bag from the reading; keep in mind that the weight of the bag may change when it is contaminated with faeces.

Figure 7.5. *Chick being weighed with a pesola balance*



A pesola balance has a limited weight range. In order to measure accurately, different balances have to be used for small, medium-sized, and large chicks. Another disadvantage is that reading a pesola is difficult when it is windy. An electronic balance with an accuracy of 1 gram and a range of 1 - 2000 grams is preferred for weighing chicks (figure 7.6). Put the balance horizontally on bare ground and avoid sand to be blown inside it. Whereas very small chicks can be placed on the balance in an open cup (use bottom part of plastic bottle), larger chicks should be placed into a plastic tube for immobilisation. Either subtract the weight of cup/tube from your reading or tare your balance (if your balance has the possibility). In the latter case, put the tube on the balance, press zero, and weigh the chick in the tube. The balance will now show the net weight of the chick. Take care that you apply only one method in order to avoid errors. Always write down the weight of the tube near the weight of the chicks. This makes it possible to correct your data afterwards, should you make a mistake.

Figure 7.6. *Taking the weight of a chick with an electronic balance. The chick is immobilised by placing it in a plastic tube.*



Procedure (for catching and measuring chicks in crèches):

1. *prepare your equipment beforehand and check whether everything works*
2. *check whether those involved in the work are experienced in working with callipers, weighing and ringing*
3. *find group of chicks and watch them from a distance*
4. *decide on how to catch the chicks, discuss plan, divide tasks (who carries boxes?)*
5. *catch chicks as described above*
6. *move away from catching area and settle in a place not to cause disturbance*
7. *settle in group around boxes*
8. *take measurements as described above*
9. *put chicks being handled in special box, separated from the other chicks*
10. *release chicks together at place of catching*
11. *once back in camp: fill in official data sheets, check your data and analyse them using (a copy of) the graphs provided in annex 6. In case you have many data lying far above the line of maximum growth you may have included the tube in your weight measurements.*

Materials needed:

1. *binoculars*
2. *boxes with cover for storing chicks*
3. *bird rings with banding pliers and circlip pliers (only if ringing is included)*
4. *vernier callipers or special ruler for measuring head+bill*
5. *pesola's with plastic bags. In order to be able to measure chicks of all ages of Grey-headed Gull, Slender-billed Gull and Royal Tern, pesola's are needed of 0-100, 0-300 and 0-600 g. For large Caspian Tern chicks an additional pesola of 0-1000 g is needed. If possible use the smallest pesola's in order to have maximum accuracy.*
6. *or an electronic balance with cup and plastic tube. Use a small tube (length 18 cm, diameter 7-8 cm) for chicks of Grey-headed Gull, Slender-billed Gull and Royal Tern and a large one (length 25 cm, diameter 10 cm) for large chicks of Caspian Tern.*
7. *data sheets (see annex 5) and graphs (see annex 6)*
8. *notebook and pencil*

8 Measuring breeding success

Why measure breeding success?

Studying breeding success involves following (part of) the breeding population throughout the breeding process in order to determine the fate of the eggs and chicks. The ultimate goal is to get an insight in the number of chicks fledged per breeding pair. In addition, valuable information can be obtained with respect to environmental factors determining mortality of the brood.
Successful reproduction determines the future size of the population. A population that does not produce any offspring will eventually disappear, unless there is a constant influx of birds from neighbouring populations. Studying breeding success - especially if the results of different years can be compared - can tell us whether the situation is "normal" or something is "wrong" with our birds. In the latter situation, it may lead to the conclusion that action must be taken.
When determining the fate of individual broods, we can obtain detailed information on mortality of eggs and chicks. For instance, if many eggs disappear from the nests and we find empty eggshells near the nests, it is likely that predators are active in the colony. If chicks are in bad condition and many of them dying, it is likely that starvation takes place as a result of food shortage. Information on mortality factors is more specific and may lead to goal-directed management measures.
Information about egg-loss may also give an insight in the extent of re-laying. Such information is indispensable in order to interpret the "total number of nests counted" in a particular season in terms of "number of pairs breeding". Breeding success figures are usually given for different phases of the breeding cycle and can be expressed as follows:

Hatching success, which can be expressed as:
(1) percentage of eggs hatched,
(2) mean number of hatchling per pair,
(3) percentage of nests in which at least one egg hatched (irrespective of the number of eggs laid).

Fledging success, which can be expressed as:
(1) percentage of hatchlings that fledged,
(2) mean number of fledglings per pair.

Breeding success, which can be expressed as:
(1) percentage of eggs that resulted in a fledged chick,
(2) mean number of fledglings per pair.

We prefer to work with "mean number of eggs or chicks per pair" and to give, additionally to these figures, the mean number of eggs laid, and the percentages of eggs and chicks lost. Table 8.1 gives an example by presenting the results of a study on Common Gulls Larus canus in The Netherlands (Veen et al. 2003[1]).

The results show that population size was relatively stable over the years, except for a 25% decrease in 2002. In 1997, 1998, 2000 and 2001 the breeding parameters were rather similar. However, in 1999 and 2002, the clutch size was low, while the egg and chick losses were high. In both years, the breeding success (fledged/pair) was extremely low. Additional information has shown that, in all years, eggs and chicks lost were taken by predators. In 1999 and 2002, however, food availability was low. Birds reacted to this by laying a smaller clutch. Moreover, the breeding birds spent more time foraging and sometimes left the brood unprotected. This resulted in more predation. In 2002 part of the population probably did not breed because of food shortage. In that year, food shortage forced the breeding birds to regularly leave the nest at the egg stage, which resulted in 100% egg loss. The above example does not only demonstrate the indicator value of the breeding parameters "clutch size" and "breeding population size" in relation to food availability. It also shows the importance of the breeding success figures for interpreting of what's going on in a seabird colony.

How to measure hatching success?

Hatching success is usually measured by selecting a number of nests in a colony and marking each nest with a small numbered stick. Sticks should be small and placed in such a way that they neither hinder birds' landing near the nest nor attract predators. As a rule, it is better to choose a part of the colony where all nests – both present at the moment of starting and appearing throughout the season - are studied. Do not select nests scattered over a large area. You will have to search for your nests during every visit, which will cause unnecessary disturbance.

Table 8.1.

Breeding parameter	1997	1998	1999	2000	2001	2002
Breeding pairs	196	170	183	191	209	149
Nests followed	30	30	30	30	30	30
Eggs / pair	3,0	2,6	1,8	2,6	2,6	1,9
% of eggs lost	34%	32%	57%	27%	22%	100%
Eggs hatched / pair	1,96	1,77	0,77	1.90	2.06	0.00
% of chicks lost	30%	23%	48%	26%	21%	-
Fledged / pair	1,37	1,37	0,40	1,40	1,63	0,00

Nests selected for study should be a representative sample of the whole breeding population. Keep in mind centre-edge effects and the possible influence of seasonal timing of egg-laying. Nests should be inspected at regular intervals; the nest contents should be noted during each visit. Ideally, each nest should be marked when the first egg is laid. However, this is often impossible, because it can be achieved only through daily visits to the colony. Such visits may even be undesirable for some species, as they cause too much disturbance. For gulls and terns, visits at 3-day intervals are regarded the best solution. A 3-day interval means that each nest is marked shortly after laying the first egg (on average 1.5 days). Because chicks do not wander away from the nest before they are three days old, it also means that the hatching is rarely missed. A sheet for collecting hatching success data is presented in annex 7. The example, which is based on fictive data for the Caspian Tern shows how the nest contents are noted using special codes. It also shows how the data obtained can be analysed in order to calculate clutch size, hatching success and mortality factors. However, it should be noted that this analysis only leads to reliable results if clutches are checked during the entire incubation period (from the laying of the first eggs till the hatching of the chicks). If clutches are marked halfway incubation one ignores eggs which have disappeared from the nests before marking took place. In the latter case far more complicated calculations have to be made in order to obtain reliable results. See for instance Mayfield 1961, 1975 and Veen *et al*. 2004.

Procedure:
1. *Calculate the census date based on mean date of hatching and fledging period of species*
2. *Visit colony area with at least two persons, with one of them being experienced in counting/estimating*
3. *Count/estimate number of chicks present*
4. *Check with telescope whether part of the chicks have already fledged*
5. *If possible, check in neighbourhood how many fledged chicks already left the colony area*
6. *Make note of all your findings, interpret results, and make final estimate*

Materials needed
1. *Binoculars*
2. *Spotting scope*
3. *Notebook and pencil*

How to measure fledging success?

If we are dealing with chicks that stay in the nest until fledging, the fledging success can be measured by following nests in the above-described way. However, chicks of the Slender-billed Gull, Caspian Tern, and Royal Tern leave their nests long before the fledging age. They often concentrate in large groups, the so-called crèches, mixing up with chicks from other colonies. Thus, it is almost impossible to determine the fate of particular chicks, even if these are individually marked with rings or colour dyes. However, depending on the situation, the following methods can be used:

Following chicks that stay in the breeding territory
Chicks of Grey-headed gulls, at an early age already, may leave the nest and walk away from a human intruder. However, every chick normally returns to the breeding territory, where it is fed by the parents. If the breeding area is covered with vegetation, which is often the case, chicks usually stay in the territory until fledging. In this case, you can ring chicks upon hatching and check their presence afterwards (preferably with 5-day intervals) in order to determine their survival. However, chicks fledge at different ages and thus disappear from our observations at different moments. Therefore, for practical reasons, chicks are assumed fledged, if they have reached an age somewhat shorter than the minimum fledging period. In case of the Grey-headed Gull the age of 30 days could be chosen (actual fledging period varies around 35 days). The method described is not very accurate and should be regarded as a rough estimate of the number of fledglings. Note: For the above-mentioned reasons, the search for chicks should preferably be combined with taking measurements for determining their condition.

Procedure:
1. *Ring chicks as soon as possible after hatching, in all nests under study (see hatching success)*
2. *Check the area for live chicks, every 5-7 days*
3. *Search the area with a group of people in order to minimise time present (=disturbance)*
4. *While searching, keep an eye on predation on eggs and small chicks*
5. *Make note of ringed chicks, dead or alive; determine condition of live chicks (biometrics), if relevant*
6. *Check the surrounding area for the presence of ringed chicks (may give insight in accuracy of method)*
7. *Calculate/estimate fledging success based on the number of chicks having reached the chosen age*

Materials needed
1. *Bird rings, pliers and other ringing materials*
2. *Notebook and pencil*

Counting or estimating groups of chicks (nearly) fledged

If we are dealing with a bird colony where eggs are laid synchronously and which is situated on a relatively small island, it may be possible to count or estimate the total number of chicks in the period they grow up. This involves determining the number of chicks on the island (usually in a crèche or spread along the waterline), shortly before the first birds actually leave the area. Preferably, several counts are made, for instance once a week. Depending on the situation (rate of synchrony and possibilities for making an accurate count), this method can lead to rather good results.

Procedure:

1. *Calculate the census date based on mean date of hatching and fledging period of species*
2. *Visit colony area with at least two persons, with one of them being experienced in counting/estimating*
3. *Count/estimate number of chicks present*
4. *Check with telescope whether part of the chicks have already fledged*
5. *If possible, check in neighbourhood how many fledged chicks already left the colony area*
6. *Make note of all your findings, interpret results, and make final estimate*

Materials needed

1. *Binoculars*
2. *Spotting scope*
3. *Notebook and pencil*

9 Ringing chicks

Introduction

Ringing involves catching a bird, placing a metal ring with a unique number and address engraved on it around one of the legs, and then releasing it. If a ringed bird is recaptured or found dead and the ring number reported to the address on the ring, one may obtain data on the movements and longevity of the bird. In case you find a ringed bird, dead or alive, you should send a letter to the address engraved on the ring, reporting: (1) the number of the ring (and its colours in case coloured rings have been used in addition to a metal one), (2) the position of the ring(s) on the leg, i.e. left or right and above or below tarsus joint, (3) the species of bird, its age, sex and plumage characteristics (breeding- or non-breeding plumage), (4) the date and the place where you found the bird, (5) the possible cause of the bird's death, and (6) your name and full address.

The major aims of bird ringing are:
- to study migratory patterns;
- to identify important areas for a bird (e.g. breeding grounds, non-breeding areas, etc.);
- to study causes of mortality (shot, found dead, caught, etc.);
- to determine the age of a bird.

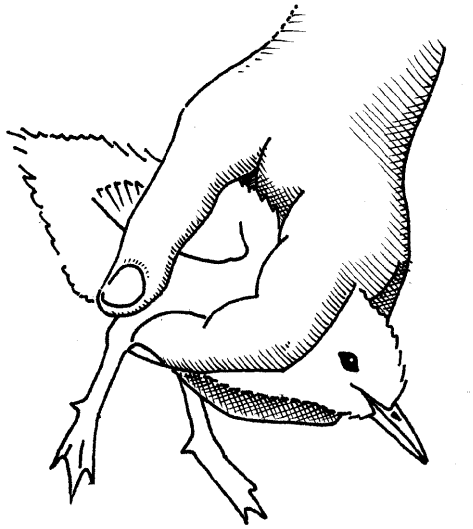
In many countries, bird ringing is organised and co-ordinated by a national ringing centre. The ringing centre acts as the administrative unit for all ringing activities within the country and supplies rings to licensed ringers. To obtain the license, one should normally pass an examination. Not any national ringing centre currently exists in West African countries. Therefore, ringing activities in these countries have been carried out only on a project basis using rings issued in other countries. During the past decades, in Mauritania, Senegal, and The Gambia they used rings from France, Belgium, Germany, Great Britain, and South Africa. A great disadvantage of this situation is that the recovery data are sent to the responsible ringer, which usually means: to a foreign country. Thus, the results of the ringing do not automatically end up in the countries where the birds were ringed.

Between 1998 and 2003, ringing activities were carried out at the Langue de Barbarie and the Delta du Saloum; as a result, more than 10,000 chicks of the Grey-headed Gull, Slender-billed Gull, Royal Tern, and Caspian Tern were ringed. Personnel of both parks were trained using a special ringing manual that was developed for this purpose (Veen & Veen, 2001). In the framework of the present seabird monitoring programme, chicks that are caught and handled (for instance, for the purpose of measuring their condition) will be ringed whenever possible. Therefore, the most important techniques and tools used during ringing will be briefly explained in this chapter. For more detailed information, the reader is referred to the above mentioned manual or to other books describing ringing in detail (Bub 1991, Spencer 1984).

Ringing techniques and ringing materials

Handling a bird correctly
Birds to be ringed should be handled correctly during catching, transportation, and processing, to avoid stress and injury. This is important both from an ethical and a scientific point of view. With respect to the latter: injured birds may behave in an abnormal way, which may lead to abnormal recoveries and thus to wrong conclusions.
It is important to hold the bird around the body and never by a wing, a leg or the head. Figure 9.1 shows the correct way to hold a bird:

Figure 9.1. *The correct way to hold a bird to be ringed*



Curve the four fingers of one hand over the birds back enclosing the birds shoulders and lower neck between the first and second finger. Avoid pressing the lower regions of abdomen. A gentle but firm hold is all that is needed. With small chicks, the hold enables the rest of the hand to assist in supporting the leg to be ringed - between thumb and first finger. When transferring the bird from one person to another, turn the bird on its back, flatten the palm of the hand and transfer by holding the bird at the top of the thighs near the body whilst supporting with the other hand. For smaller chicks, hold a finger between the thighs. Large chicks may be transferred by substituting hands over the back in the holding position.

The actual ringing
Birds of different sizes need different-sized rings. Most ringing centres provide lists with ring sizes for bird species ringed by their co-workers. It is crucially important to follow the instructions of the ringing centres. Rings that are too large or too small may lead to a serious injury, including loss of leg or even death of the bird. If you do not have rings of the right size, simply do not ring your bird. Ring

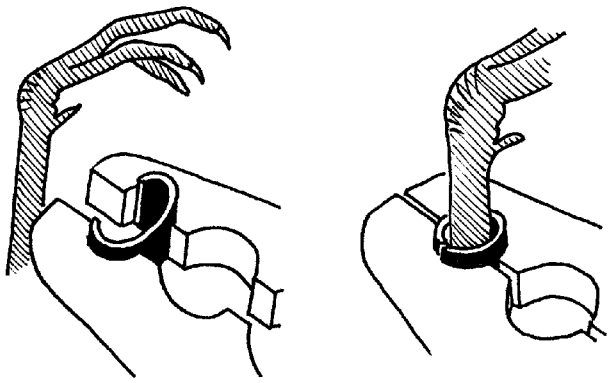
sizes advised by ringing centres should fit both chicks and adults. However, the legs of young chicks may be too small to hold the ring. Also in this case: do not ring. Table 9.1 gives the sizes of rings to be used for the Grey-headed Gull, Slender-billed Gull, Royal Tern, and Caspian Tern. In all cases, some size variation is accepted, provided that you always check whether the ring properly fits your bird.

Table 9.1. *Ring sizes to be used for Grey-headed Gull, Slender-billed Gull, Royal Tern and Caspian Tern*

Species	Ring sizes to be used	
	Range	Preferred
Grey-headed Gull	5.5 - 7.0	6.0
Slender-billed Gull	7.0 - 8.0	7.0
Royal Tern	5.5 - 7.0	6.25
Caspian Tern	7.0 - 9.0	7.5

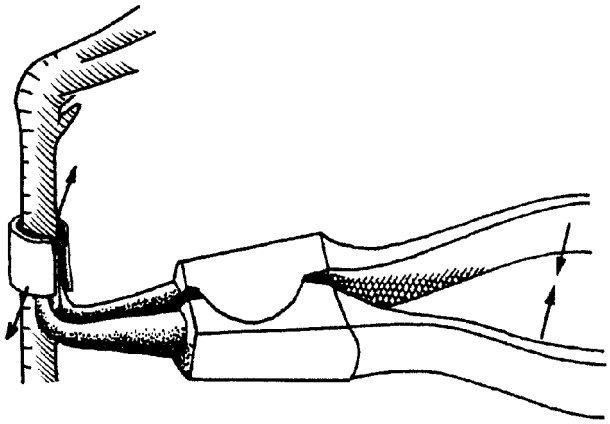
The basic procedure for ringing a bird is as follows:
- check both legs to make sure that the bird is not already ringed, either above or below the tarsus joint;
- select the correct ring size for the species;
- check that the ring number follows in the correct sequence on your data collection sheet;
- select the correct size "hole" on the ringing pliers;
- place ring in correct hole of pliers;
- place ring around the birds leg (see figure 9.2 and 9.3);
- slowly, but firmly squeeze the pliers until the ring closes. Ensure that pliers are kept at 90 degrees to the bird's leg;
- Examine the ring to ensure that it fits correctly, has closed properly (i.e. no gap or overlap) and that the inscription has not been defaced. Adjust or replace, if necessary;
- fill in the number on the condition data sheets, together with other information (when back in camp or office, the official data sheets of the Ringing Centre (see annex 9) should be filled in as well;
- record all details of lost or broken rings on the data sheets too.

Figure 9.2. *The way in which a ring is fitted in the appropriate hole of the pliers and then put around the leg by squeezing gently*



Note: Rings that do not fit well need to be removed. To do this carefully, place the two upward points of the ring remover on either side of the ring and gently squeeze as shown in figure 9.4.

Figure 9.3. *How to remove a ring with special pliers*



Materials needed:
- *materials for catching and keeping the chicks*
- *bird rings of appropriate sizes*
- *ringing pliers with different holes*
- *pliers for removing rings from leg*
- *materials to take morphometric measurements (chapter 7)*
- *data sheets (annex 6)*
- *notebook and pencil*
- *bag for transporting and keeping ringing materials*
- *official data sheets provided by the ringing centre (annex 9)*

10 Collecting pellets and faeces

The various seabird species included in the West African monitoring programme feed almost exclusively on fish. Research carried out in Senegal in the period of 1998-2001 (Veen et al. 2002) showed that information on the diet of such species can successfully be obtained by analysing regurgitated pellets and faeces for the occurrence of the so-called otoliths.

Every fish has three pairs of otoliths, which are small calcareous "hearing stones" located in the head. One pair of otoliths (the so-called sagittae) is relatively large, species specific (see figure 1.2), and to a large extent resistant to erosion within the gastro-intestinal tract of birds. Many of the larger otoliths can be found in regurgitated pellets, whereas smaller ones end up in the faeces. Slender-billed Gulls, Royal Terns, and Caspian Terns all defecate around the nest and deposit regurgitated pellets near the nests as well. In the course of the incubation period, pellets and faeces accumulate on the rim of the nest (Slender-billed Gull) or form a crust in the sand (Royal Tern and Caspian Tern) and can easily be collected. It is assumed that faeces and pellets can give important information on the species composition of fish eaten by the birds during the incubation period. Apart from the mixture of pellets and faeces present near the nests, many fresh pellets of Royal and Caspian Terns can be found spread in the colonies. Such pellets provide additional information (Veen et al. 2003).

The analyses of pellets and faeces as well as the identification of otoliths should be done by specialists (for addresses see annex 8). However, the material to be analysed must be collected in the colonies. The way of how to collect, store, and administrate these materials is given below.

For each species regurgitated pellets are collected as follows:
- in part of the colony where only one species is nesting (do not mix pellets of different species!)
- only fresh pellets (wet, not fallen apart) are taken
- pellets are put together in a plastic bag
- notes are made in triple: (1) with pencil on a piece of paper, (2) with water resistant marker on outside of plastic bag, and (3) in a notebook
- the following notes are made: date, place, species of bird, pellets, number of pellets, special information (collected inside or outside the nesting area, nests with eggs or chicks present, etc.)
- check your notes after the field trip

For each species faeces are collected as follows:
- in part of the colony where only one species is nesting (do not mix faeces of different species!)
- preferably from around nests with eggs shortly before hatching
- do not collect complete nests (Slender-billed Gull) and avoid to collect a lot of sand*
- notes are made in triple: (1) with pencil on a piece of paper, (2) with water resistant marker on outside of plastic bag and (3) in a notebook
- the following notes are made: date, place, species of bird, faeces, number of nests, special information (collected inside or outside nesting area, nests with eggs or chicks present, etc.)
- check your notes after the field trip

Note* - special attention should be given to how the material is picked up from the nest or the ground. Slender-billed Gull nests of different years may be built on top of each other, and Royal and Caspian Terns may breed at the same location year after year. If the faeces are not properly collected, the samples may be contaminated with material from previous years. In case of the Slender-billed Gull: do not collect the entire nest, but collect the faeces from the nest rim. In case of the Royal Tern and the Caspian Tern: only collect the faeces which are on top of the soil, never dig in the sand.

Species	Material to be collected	
	Pellets	Faeces
Slender-billed Gull	no pellets	10 bags each filled with faeces from 3 or more neighbouring nests
Royal Tern	100-200 pellets	10 bags each filled with faeces from 3 or more neighbouring nests
Caspian tern	100-200 pellets	10 bags each filled with faeces from 3 or more neighbouring nests

11 Planning of activities

Introduction

Monitoring activities should be planned each year. The planning should be made well in advance, preferably many months before the first eggs are laid. It should cover the whole breeding season, taking into account methods and materials to be used, human resources, and the budget needed.

Planning should be made in a way to optimise the results to be obtained and to minimise the disturbance. This means that the planned activities should fit in with the birds' seasonal calendar. This is especially important, if visits to the colonies take place at monthly intervals. For instance, if the peak of hatching in a large Royal Tern colony is around the 15th of May, a census of this colony should be carried out well before this date. In this case, 5 May might be the best date for counting the nests. On the 5th of May very few chicks will be present, whereas on the 5th of June (next visit) most chicks can be expected to have left the colony area already. However, choosing the 5th of May for counting this colony means that preceding visits must be planned for the 5th of April and (if necessary) for the 5th of March.
As a rule, the species to be monitored differ as far as their breeding periods are concerned. This means that the planning of visits to the colonies will be a compromise. As a rule, species that breed highly synchronised (Royal Tern and Slender-billed Gull), and in very large colonies (Royal Tern), will be the basis for choosing dates.
It will be clear that any planning is based on experience gained during preceding seasons. At the Langue the Barbarie and in the Delta du Saloum, breeding periods appear to be markedly similar from one year to another. This makes planning of visits relatively easy. However, if this is not the case, try to be flexible and adjust dates on the basis of observations made during first visits to the site.
An example of a planning table as it was used in the past for Ile aux Oiseaux, Delta du Saloum, is given in annex 10. The distribution of egg-laying of the main species to be monitored on this island (basis for planning) can be found in annex 11.

What to consider while making your planning

Defining objectives
Before making your planning, you should know what your objectives are. The objectives of the present monitoring programme are:
- o collect information on the development of seabird populations and its causes;
- to collect information about marine resources using the birds as indicators.
  However, additional objectives may play a role as well, depending on the specific situation at a site. Examples of such objectives are:
- to obtain information about how to develop eco-tourism without disturbing the birds;
- to measure the impact of disturbance;
- to measure the impact of human activities such as mining, oil and gas exploitation, building dams, etc.
- to collect specific information on endangered or rare species.

Choosing the breeding parameters to be measured
For each bird species to be studied, you should select a set of parameters that fits the monitoring objectives. The parameters should be listed in order of priority. All parameters dealt with in this manual contribute in different ways to the objectives defined (see above). This means that, preferably, they should all be measured. However, this is not always possible, because of:
- the nature of the site (size, vegetation, accessibility, etc.)
- disturbance effects
- materials and human resources available

For instance, Ile aux Oiseaux in the Delta du Saloum is a relatively large island (5x1 km). It is possible to camp on the island without disturbing the birds. Moreover, park staff and écogardes are well trained. This makes it possible to carry out a complete monitoring programme, including measuring breeding success (see e.g. Peeters 1999 and Ndiaye 2000). However, circumstances may be completely different, if we deal with a small and inaccessible island, which is completely covered with birds. In such a situation the effects of disturbance may very much limit what we can do.

Breeding parameters to be measured should be selected by a person who has a broad experience with bird monitoring and who knows the site, together with the person who is responsible for the allocation of financial and human resources. The following list of parameters, which is not exhaustive, should be considered for each species:
- date of first egg laid
- date of the "peak" of laying
- development of laying throughout the season
- mean incubation period
- mean fledging period
- distribution of colonies in relation to habitat characteristics (mapping)
- number of breeding pairs
- mean clutch size
- mean egg size
- chick condition
- hatching success (number of eggs hatched per pair)
- breeding success (number of chicks fledged per pair)
- diet composition (collecting pellets and faeces)

Determining the methods to be used
Next step in your planning is to consider how the parameters chosen should be measured in each species. If different methods can be applied, choose the one that may give the best results, however without giving too much disturbance. Take human, material and financial resources

available into consideration and optimise these. Be practical and do not forget the first rule that says that "the welfare of the birds comes first".

Making the timetable
All parameters to be measured should be worked out in activities, which should then be included in a timetable. This should be done for each species and on a daily basis. So activities are not planned for a particular month, but for a particular day in that month. Now you have to consider whether and to what extent observations on different species can be made on the same date. Try to combine activities in order to reduce disturbance effects as well as costs. If it is not possible, for some reason, to carry out all activities, try to find a more efficient method. Ultimately, you might be forced to skip activities, but start doing so at the end of your priority list.
The timetable should not only focus on the work in the breeding colonies; but also include preparatory activities (buying materials, making sticks, copying data sheets, etc.), as well as activities taking place after the breeding season (data analysis, writing report). Finally, human resources must be allocated to different activities on different dates. Be sure that those who are supposed to carry out the work, know about it and are indeed available.

Co-ordination
The monitoring of the breeding colonies at a particular site should be co-ordinated by a person who is well-trained and experienced in doing monitoring work. Preferably, co-ordination is in the hands of one person from the beginning (planning phase) till the end (completing report) of the programme. If no experienced person is available to act as a co-ordinator, the monitoring programme should be simply cancelled. One would run the risk of unnecessary disturbance and the collection of insufficient data. An experienced person is also the only one being able to react properly to unexpected events in the field and to decide about adjusting methods, in order to obtain better results.

Human resources

Human resources needed to carry out the monitoring programme depend on the nature of the site, the number of breeding birds, and various breeding parameters to be measured. For instance, on Ile aux Oiseaux, Delta du Saloum, a complete monitoring programme, including measuring breeding success of six species (Grey-headed Gull, Slender-billed Gull, Kelp Gull, Royal Tern, Caspian Tern and Common Tern), needs the following:
- a scientific co-ordinator, who co-ordinates the whole programme, takes care of training activities, provides data sheets, analyses the data, writes the report, etc.
- a logistic co-ordinator, who takes care of materials to be used in the field, organises transportation, camping facilities, etc.
- group leaders (3 to 5): persons with experience in monitoring breeding colonies, who are responsible for field activities carried out in small groups of 2-3 persons.
- counters (4 to12): persons carrying out field activities under the supervision of a group leader
- one or two persons (up till now from abroad) with a ringing license
- an expert in identification of otoliths (this expert is not part of the local team, but works in a laboratory to which the sampled pellets and faeces have to be sent)

The two co-ordinators are involved in the monitoring programme from the beginning till the end of the season. Group leaders and counters are involved in specific parts of the fieldwork, whereas the ringers play a role only during a relatively small period.

If necessary, training activities can be included in the programme. Preferably, training activities should be carried out as much as possible outside the colony area. For instance, working with a pair of vernier callipers should be trained in the camp and not in the field. Always avoid discussions inside the colony area. Fieldwork should be done as quickly as possible. Therefore, less experienced persons should start with simple tasks, for instance making notes. But even in this case they should be well instructed beforehand.

12 Administration, data analysis and writing a report

Administration in field and office

When working in the field, you concentrate on your work and have the feeling you will not forget what you have seen or done. This is not true at all. If you have visited your colonies a couple of times, you mix up information and you do not remember details from earlier visits. And after a couple of years, no one can remember a date or even a year when observations were made. Therefore, write down as much information as you can - and be complete.
Always write down:
- date, place, and species
- names and addresses of observers
- all relevant data with respect to specific observations as described in this manual
- all other observations that may be important for your study.

With respect to the latter, one may note all kinds of incidental observations, such as the occurrence of predation, human disturbance, high tides, dead chicks, etc. Always try to write down as much as possible. You cannot plan such observations and do not have any format for it. However, they may turn out crucial for the interpretation of your results.

All observations made in the field should be written down in notebooks or on data sheets. However, notebooks and data sheets can get lost; moreover, the latter often get crumpled in the field. In order to assure that your data do not get lost, it is necessary to make a copy once you are back to the office. You can also use the notebook in the field and make a copy by filling in the data sheets afterwards. Do this immediately after the fieldtrip and use this occasion to check your data. Did you make any errors? Have you forgotten something?
Once you are back in the office, it is also useful to compare census results with those of the previous field visit. Are there any special questions that arise from this comparison? Maybe you counted a particular part of the colony twice or you forgot something. Maybe you can solve such problems during the next visit. It's better to compare now than at the end of the breeding season.

Analysis of data and writing a report

Pellets and faeces
Pellets and faeces collected in the colonies should be immediately sent to the African Otolith Expert who will undertake the analysis of the samples and the identification of the otoliths. First of all, the longer the samples are stored in the plastic bags, the smellier they become. Moreover, the expert needs a lot of time to analyse the samples and it is important that the data on the diet of the birds are available at about the same time as the results of the field observations.

Analysis of data
Data collected in the field should be analysed when the breeding season is over. Do this as soon as possible. The results of your monitoring work are important information, also for yourself, as it will help you to even better plan the next year's activities.
In the future, there will be a regional co-ordinator who will gather, store, and analyse the data collected in the different sites included in the West African Monitoring Network. He/she will give you special instructions with respect to how the data should be delivered. In practice you will have most of the work done, if you complete the data sheets. This applies especially to the data on clutch size, egg size, and chick condition. However, the census data need special attention. For each species, the data collected during successive visits should be compared. Use the colony map while doing this. Nests with eggs counted during visits with monthly intervals can be summed, unless there are good arguments to assume that you deal with birds laying eggs for the second time (re-layings). Interpret your final figures and give all arguments in a discussion that is to be included in the report.

Writing a report
Each year, a final report should be produced giving an overview of the data obtained. Some people have pleasure in making an elaborate report giving many details, graphs and pictures. That's excellent. However, a report may also be comprehensive giving key information. In all cases, the report should include:
1. An introduction with a description of the site
2. Monitoring objectives
3. A description of methods used. In many cases you can refer to standard methods as described in this manual.
4. A short description of the colonies per species: temporal and spatial distribution, occupation of the area and the number of breeding birds
5. A table giving, for each species, the census results obtained on different dates as well as the final result in terms of the "total number of nests counted" and the "number of breeding pairs". In all cases it should be made clear how these figures are compiled and to what extent and why corrections were made while converting nest count figures into breeding pairs.
6. Tables summarising data on clutch size, egg size, and chick condition
7. A summary of the results obtained with respect to mortality factors and breeding success. This may be based on incidental observations as well as on data collected as described in chapter 8.
8. A discussion dealing with any subject important for: (a) a good understanding of the results obtained, (b) improving the monitoring work in the coming season, and (3) the welfare and the protection of the bird colonies in general.

More detailed information on the contents of a report is given in annex 12.

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Annex 1

Measuring colony surface area using a GPS

For large colonies of Royal Terns, in particular when many small chicks are present, it is often not possible to carry out a conventional nest count. In such a case, measuring the surface area covered by nests can be done by using a GPS.

Definition and functioning of a GPS

A GPS ("Global Positioning System") is a space-based navigation system that has been developed many years ago by the US military services. It is now used in civil life, for scientific research as well as other, in particular leisure, activities. It enables a person equipped with a receiver (small hand-held device containing an antenna) to know with good accuracy his geographical position on the ground. It is these receivers that are commonly called "GPS" by civil users and several brands are available in the market. The GARMIN 12 XL GPS is one of the models offering the best quality-price-user friendliness ratio for our area of interest. The principles of functioning are as follows:
(1) GPS satellites are in orbit at an altitude of 20.180 km by the US Department of Defence (DoD). Started in the 1970s, the programme ended in 1993 with the setting up of a constellation of 24 satellites. These satellites are in orbit on 6 orbital plans and orbit the earth every 12 hours. The satellites are programmed so that at any place on the earth surface, a simultaneous visibility of 4 to 8 satellites with an elevation of at least 15 degrees is ensured (each satellite has its "almanac", i.e., its timetable of the positions programmed for each time interval).
(2) Each satellite is armed with a high-precision atomic clock and broadcasts a microwave radio signal captured by the GPS receivers.
(3) The receiver includes an antenna, an electric power source, an electronic clock and a system that transforms the signals received from the satellites in geographical location. Each signal received permits the GPS receiver to compute the distance between it and the satellite concerned. As the satellites' position is known, combining the signals received from several satellites is enough to calculate by triangulation the geographical position of the GPS receiver to the earth surface. A minimum of three satellites is needed to calculate the latitude and the longitude, and a fourth is needed to obtain the altitude. If more satellites are received, then the accuracy will be even better.

Projection and coordinate system

The GPS receiver provides data on the geographical positions (latitude, longitude, altitude) following various modes of possible coordinates and projections, chosen by the user. The earth surface is shaped like an oblate sphere called a geoid. Each point located at the surface of the earth can be localised from coordinates (latitude and longitude) that determine the distances (in degrees or in meters) of this point to a defined system of reference. There are many systems of reference, and most countries have developed their owns, but they are not all recognised by the GPSs (like Adindan Senegal, used on the IGN topographic maps of Senegal). The systems of reference given for the whole earth are known as "ellipsoid" and those defined for a country or region as "datum" (the datums of neighbouring countries often pose problems of incompatibility). Therefore, for working with the GPS in West African coastal areas, the international WGS 84 datum is highly recommended, for it is recognized by all GPSs. It splits the globe up into 60 zones, each 6 degrees wide, and projects them onto a flat surface with the Universal Transverse Mercator (UTM) projection. The coordinate system can be in degrees or meters; the metric UTM system is recommended, for it is the easiest to transfer to a map.

Thus, before using your GPS, you must always check whether it is set to work in the "metric UTM WGS84" system (see GPS explanatory leaflet for the methods to follow for these settings). However, if official maps of your site are already available, check whether the projection and coordinate systems of the map (see the latter's caption) are not recognized by the GPS (each GPS recognizes a number of predefined systems). If your GPS recognizes these systems, they will then be used and preferred to the "metric UTM WGS84" system. In any case, you should always indicate on the maps and in your notebook the reference and coordinate systems used.

For reading the positions of points in the colonies, we are only interested in the two figures indicating the latitude (X) and the longitude (Y) (data expressed in meters if the GPS is set to metric UTMWGS84). The altitude given by the GPS is not accurate enough and therefore, is uninteresting on these flat areas.

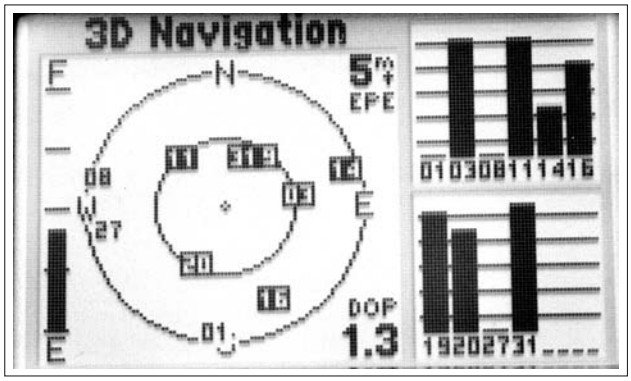
Accuracy of the coordinates calculated by the GPS

Being basically a military system, the accuracy of the signal was intentionally restricted by the so-called Selective Availability (SA) until 1 May 2000 (accuracy was often in the region of 50 to 100 meters). Since then, this SA has been suppressed, allowing now the GPS to calculate with more accuracy the coordinates of the points read (accuracy up to four meters).
However, there remains some degree of inaccuracy that results from the "Geometric Dilution of Precision (GDOP)" and varies with time at any point of the earth. This DOP depends on the number and position of the satellites received: it will be lower if the satellites are more numerous and if they are better positioned in the sky. DOP values as well as their corresponding EPE (Estimated Positional Error) are given continuously by the GPS. This EPE is expressed in meters if the GPS is set to metric UTMWGS 84.
To make it simple, for increased accuracy, the DOP should be the lowest possible (the closest to 1). Therefore, try to

work with as many satellites as possible, even if it means waiting for some time to increase accuracy. The EPE gives an estimate of the 68% confidence circle, i.e., for an EPE of 6 meters for instance, 68% of your position fixes would fall within, and 32% would fall outside.

For measuring colony surface areas, it is important to have a maximum accuracy; it is therefore highly recommended to check the DOP and EPE values at each bearing.

Photos A,1.1 et A.1.2. *The two photos represent GPS screen shots showing different values for EPE and DOP. The left hand screen gives an accuracy that is twice as much as the right hand screen.*



Two main systems are conceivable: either an automatic system using computer and software, or a manual system with paper transfer.

Automatic system for transferring data to map:

1. The contour line of the colony is covered with the GPS (see chapter 6.3.3.2), walking quite slowly at a regular pace, the GPS being set so as to record a point every 1 or 2 seconds (the pace depends on the desired DPO and of the sensitiveness as well as the rapidity of the GPS for calculating again the positions): all the automatically recorded points of the same contour are stored in the GPS as "track";
2. The "track" is imported from the GPS to a computer, using a transfer software (for example, Winship, Fugawi);
3. The "track" is then computerized using a mapping software (for example Mapinfo, Arcview, Arcgis, etc.): the contour can thus be corrected (ill positioned or lacking points) based on field observations and turned into a surface area. The area is automatically calculated by the software.

This automatic method requires:

1. A GPS enabling to record and export the "tracks", like the Garmin 12XL (check the explanatory leaflet of the GPS, for not all brands enable to do so).
2. The availability and command of computer as well as transfer and mapping software.
3. The GPS should be set so that the coordinates and projection system used be compatible with the systems recognized by the transfer and mapping software.

Consequently, this method is rather reserved for mapping specialists and will not be further explained here. (Note: some GPSs (like Garmin 12XL) have a function that gives an estimate of the surface contoured by the « track ». But this function does not permit to correct the data and, therefore, is clearly more inaccurate.)

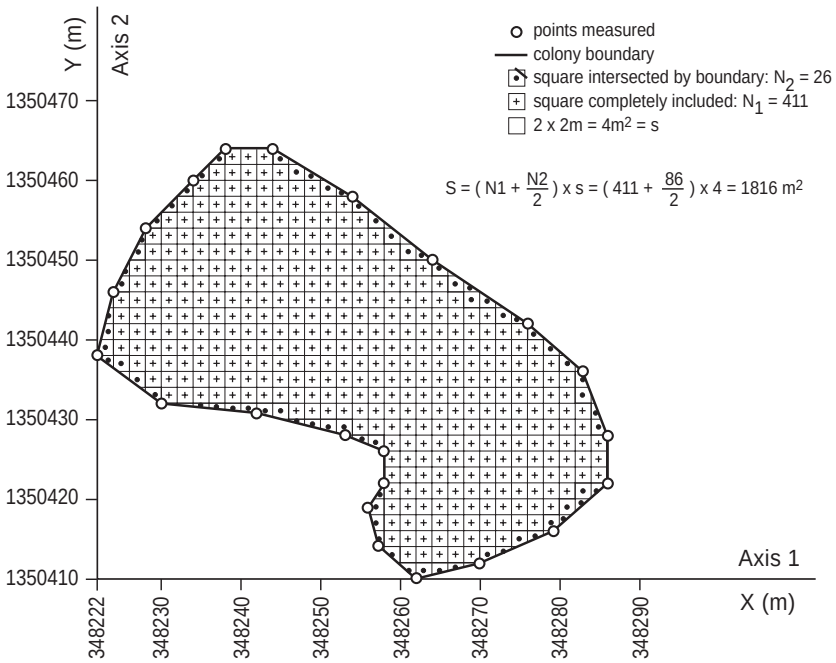
Manual system with paper transfer (see example of schematic map using a system of metric UTMWGS84 coordinates in figure A.4.1.):

1. The observer walks around the colony reading a point on the GPS (the latter being set to the metric coordinates system) every 10 to 15m approximately, as well as at every important corner making the shape of the colony. Each point is recorded in the GPS's "Waypoints" list (see GPS explanatory leaflet). For obtaining enough accuracy, the observer ascertains at each reading of point that the EPE is below 10 m; to do so, he can wait for 5 to 10 seconds at each of these points, but not more in order not to create too much disturbance in the colony (if EPE remains over 20 m, it is preferable to postpone the reading to another time when the satellites will be more numerous and better positioned)
2. Once the whole contour has been covered, the observer returns to the camp and writes in a notebook the coordinates of all the points recorded in the "Waypoints" list (latitude X and longitude Y).
3. The minimum values of X and Y are located as well as the maximum values (for the example of the map below, we have: Xmin= 348,222, Ymin= 1,350,410, Xmax= 348,286 and Ymax= 1,350,464).
4. Then the following values are calculated:
   DX = Xmax – Xmin = 64 m
   DY= Ymax – Ymin = 54 m
   Length = L = highest value between DX and DY
   Width = P= lowest value between DX and DY
5. On a squared A4 paper (0.5x0.5 cm square grids), a vertical and horizontal axis is drawn, as presented in figure A.4.1 (axis 1 and axis 2). If DY is lower than DX, the X values will be plotted following axis 1 (the highest) and the Y values will be plotted following axis 2 (the lowest). If, on the contrary, DY is higher than DX, it is the Y values that will be plotted following axis 1 and the X values following axis 2 (write on each of the axes "X" or "Y", as the case may be).
6. Axes X and Y are graduated by starting from the lowest value (Xmin for the X axis and Ymin for the Y axis) and by choosing in the following table the appropriate scale according to the values of L and P (the same scale should be used for both axes; in the example of figure A.4.1, a square = 2x2m).

P(m)	L comprised between 20 and 50 m	L comprised between 50 and 100 m	L comprised between 100 and 150 m	L comprised between 150 and 200 m
15-36	Square = 1x1m	Square = 2x2m	Square = 3x3m	Square = 4x4m
36-72	Square = 2x2m	Square = 2x2m	Square = 3x3m	Square = 4x4m
72-108	-	Square = 3x3m	Square = 3x3m	Square = 4x4m
108-144	-	-	Square = 4x4m	Square = 4x4m

7. Each point of the contour of the colony (whose X and Y coordinates have been read on GPS in the field) is plotted on the A4 paper by referring to the graduated axes (black crosses in figure A.4.1).
8. The points are then linked by a straight line (continuous bold line on the schematic map) in order to represent the theoretical limit of the colony. Because of the inaccuracy of the GPS, some points may appear to be ill positioned. In that case, they can be suppressed or slightly moved in order to correct the drawing of the contour of the colony, based on field observations.
9. All squares (0.5x0.5cm) on the paper, fully contained inside the theoretical limit, are counted and centrally marked by a cross; the number of these "crossed squares" = N1.
10. All squares on the paper that are cut by the theoretical limit (squares that are only partly inside the colony surface) are counted and centrally marked by a black dot; the number of these "dotted squares" = N2.
11. It is considered that on average, each "dotted square" has one half of its surface inside, and the other half outside of the limit of the colony; thus, the total surface area of the colony (S) is calculated as follows: S = (N1 + N2/2) x s, where s = surface represented by a square of the paper, that is, for the example of figure A.4.below: S = (411 + 86/2) x 4 = 1816 m^2.

Figure A1.1.



Annex 2

DATA SHEET FOR MEASURING CLUTCH SIZE				**Sheet no.** SbG/01/2003
Species: Goéland railleur		**Place:** IaO		
Date: 1 mai 2003		**Observer:**		
Number of eggs in nest				
1	**2**	**3**	**4**	
///// ///// /////	///// ///// /////	///// ///// /////	///// /////	
	///// ///// /////	///// ///// /////		
	///// ///// /////	///// ///// /////		
	///// ///// /////	///// ///// /////		
	///// ///// /////	///// ///		
	///// ////			
Total nests 21	114	98	10	**all nests** 243
x1 =	**x2 =**	**x3 =**	**x4 =**	
Total eggs 21	228	294	40	**all eggs** 583
MEAN CLUTCH SIZE is: **All eggs / all nests=** 583 **/** 243 **=** 2.40 **eggs/nest**				

DATA SHEET FOR MEASURING CLUTCH SIZE				Sheet no.
Species:		**Place:**		
Date:		**Observer:**		
Number of eggs in nest				
1	**2**	**3**	**4**	
Total nests _____	_____	_____	_____	**all nests** _____
x1 =	**x2 =**	**x3 =**	**x4 =**	
Total eggs _____	_____	_____	_____	**all eggs** _____
MEAN CLUTCH SIZE is:				
All eggs / all nests= _____ **/** _____ **=** _____ **eggs/nest**				

Annex 3

How to use a pair of vernier calipers

A pair of vernier calipers (figure A.6.1) is used for measuring the length of objects with an accuracy of 0.1 or 0.05 mm. In the framework of the monitoring of colonially breeding birds it is used to measure: (1) the length and diameter of the eggs and (2) the length of head + bill of the chicks.

To carry out the measurement, the object is placed between the jaws of the vernier calipers which are then closed up so as to slightly block the object (see photo opposite). The thumb wheel is then screwed on so as to fix the sliding jaw and avoid any movement of the latter during reading. The object is then removed in order to be able to read easily, without risk of damage.

Figure A.3.1. *Measuring egg using vernier calipers*

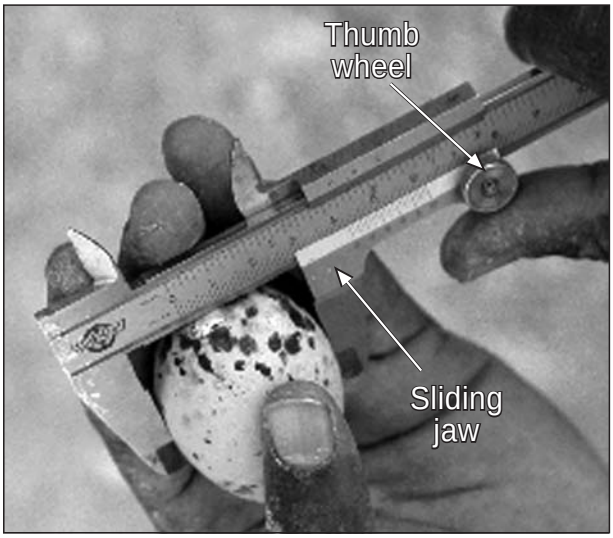
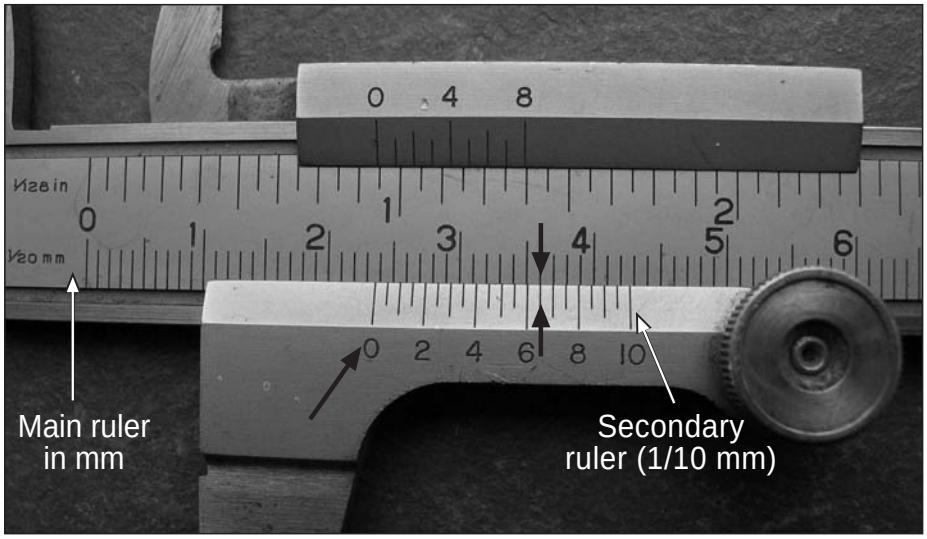


Figure A.3.2. *Detail of the graduation system of the vernier calipers*



The reading is as follows:

1. locate the “0” graduation of the secondary ruler and observe the point it indicates on the main ruler;
2. read on the main ruler the position of this point (in mms): the lower full graduated value is retained as full value of the measurement (for example in figure A.6.2. the “0” of the secondary ruler fixes a point on the main ruler located between 23 and 24 mm, therefore, the 23 mm are retained as full value) ;
3. to obtain the tenths of mms of the measurement, locate the graduation of the secondary ruler which is located precisely in front of one of the graduations of the main ruler and read its value on the graduation scale of the secondary ruler (in the example of figure A.6.2, the value of the graduation is 6.5 tenths of mm)
4. add these tenths of mm to the full value to obtain the exact value (in the example, 23mm + 6.5 tenths of mm = 23.65 mm)

Annex 4

DATA SHEET FOR MEASURING EGGS	Fiche no. RT/01/2003
Species: Royal Tern	**Place:** Bijol Islands
Date: 14 May 2003	**Observer:** Training2003

nest no.	# eggs	length	width	volume	nest no.	# eggs	length	width	volume
1	1	58,00	40,60						
2	1	57,70	39,70						
3	1	57,70	41,20						
4	1	62,69	42,49						
5	1	61,98	42,61						
6	1	57,93	39,88						
7	1	61,00	41,75						
8	1	57,10	41,70						
9	1	69,30	40,90						
10	1	61,80	41,70						
11	1	60,40	41,50						
12	1	62,10	41,20						
13	1	59,47	40,13						
14	1	59,50	42,00						
15	1	58,20	42.00						
16	1	62,30	41,56						
17	1	61,20	40,22						
18	1	61,18	41,04						
19	1	57,40	41,70						
20	1	59,20	39,50						
Mean	**1,00**	**60,31**	**41,17**						
s.d.		**2,82**	**0,91**						

DATA SHEET FOR MEASURING EGGS	Fiche no.

Species: **Place:**

Date: **Observer:**

nest no.	# eggs	length	width	volume	nest no.	# eggs	length	width	volume

Annex 5

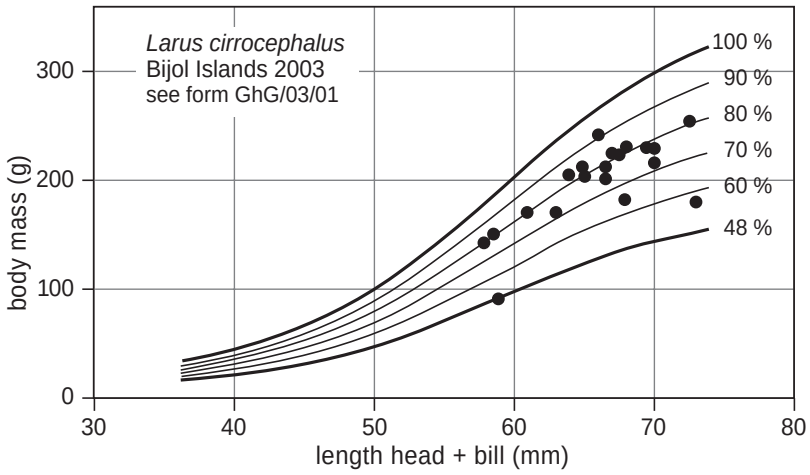
DATA SHEET FOR MEASURING CHICKS	Sheet no. GhG/01/2003

Species: Grey-headed Gull **Place:** Bijol Islands

Date: 14 May 2003 **Observer:** Training2003

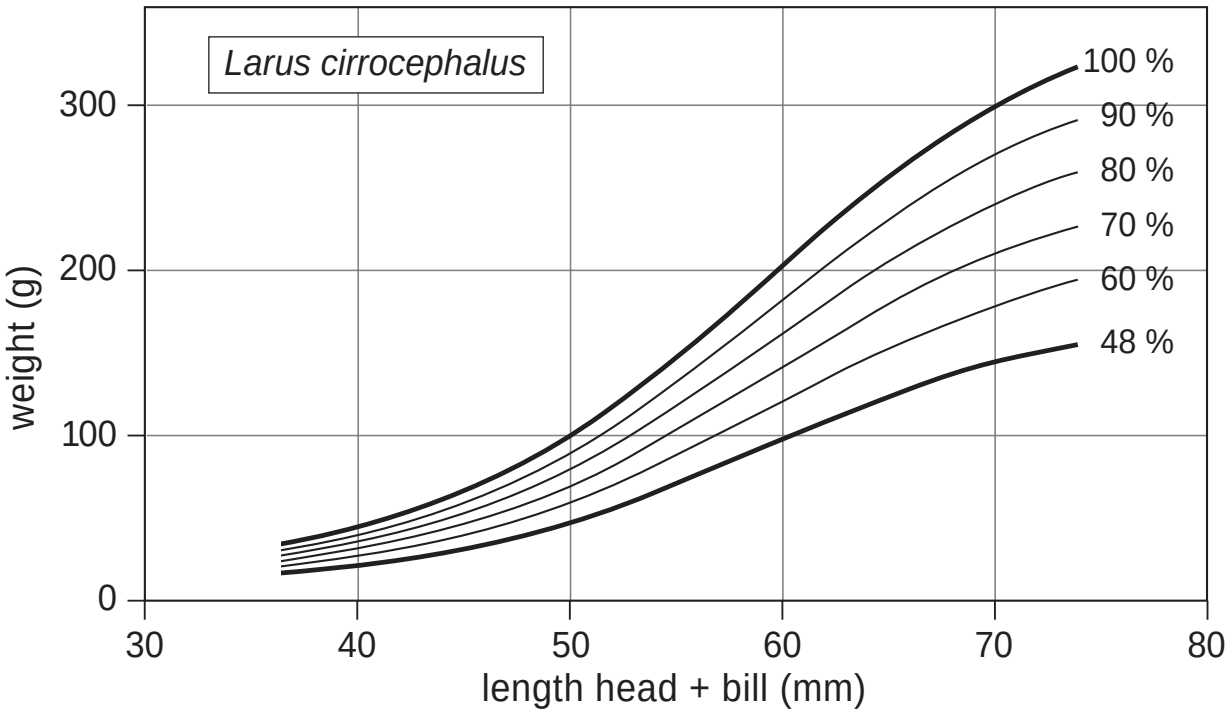
bague no.	tête+bec	poids	bague no.	tête+bec	poids
	61,05	170			
	66,69	202			
	70,14	218			
	69,53	229			
	67,46	225			
	58,91	92			
	62,94	171			
	58,03	142			
	67,80	181			
	70,30	229			
	67,20	225			
	64,90	210			
	68,30	231			
	65,20	206			
	72,50	257			
	66,29	215			
	64,00	206			
	73,00	179			
	58,30	151			
	65,75	241			

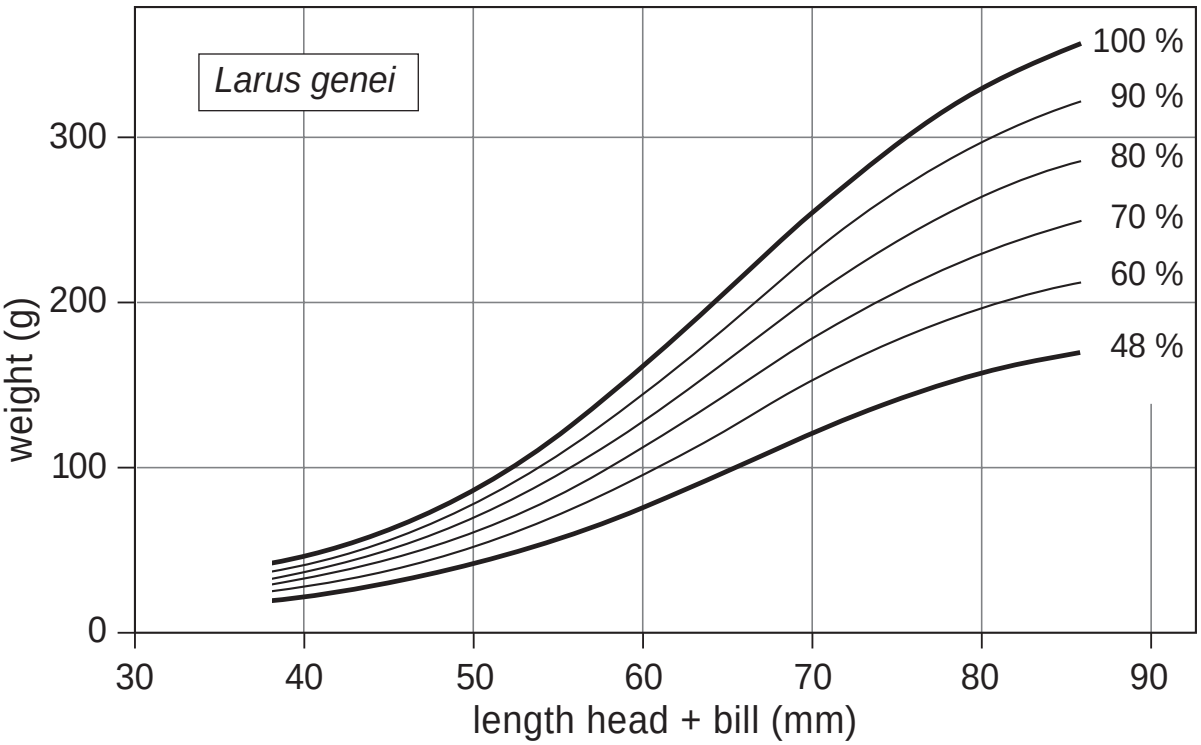
DATA SHEET FOR MEASURING CHICKS			Sheet no.		
Species:			Place:		
Date:			Observer:		
bague no.	tête+bec	poids	bague no.	tête+bec	poids

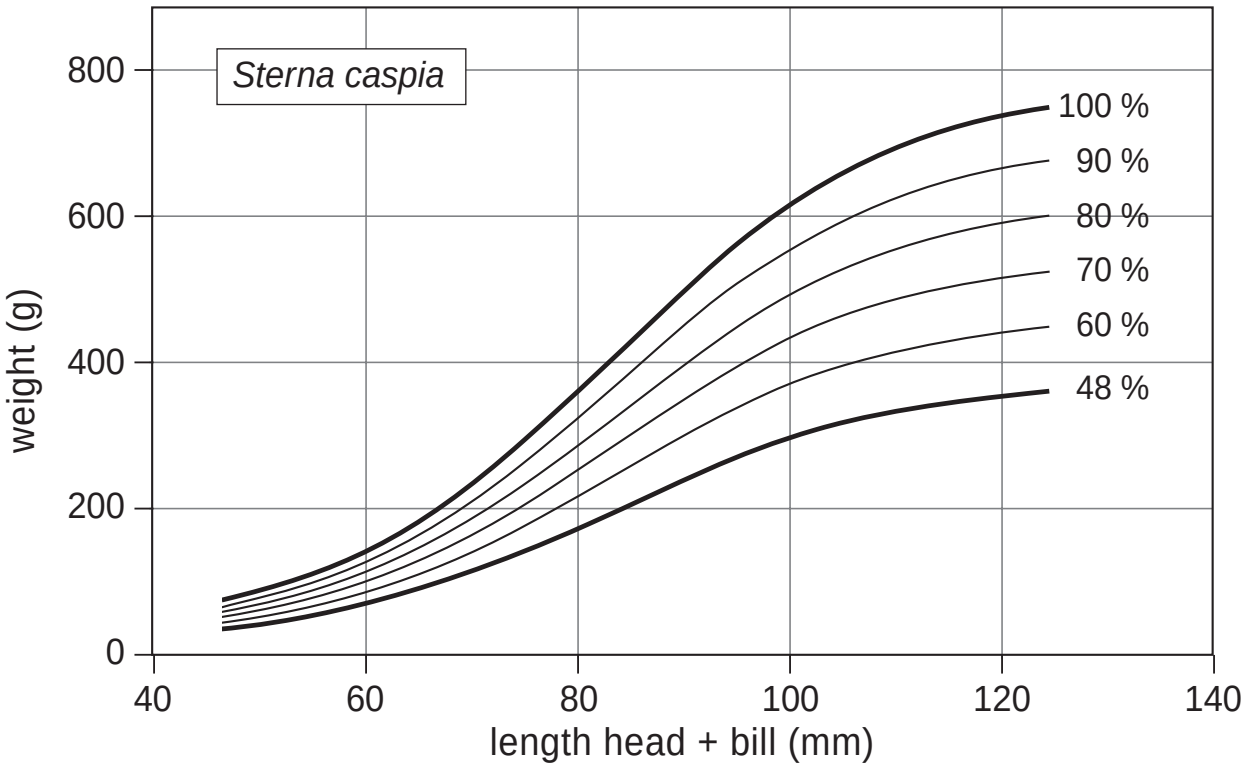


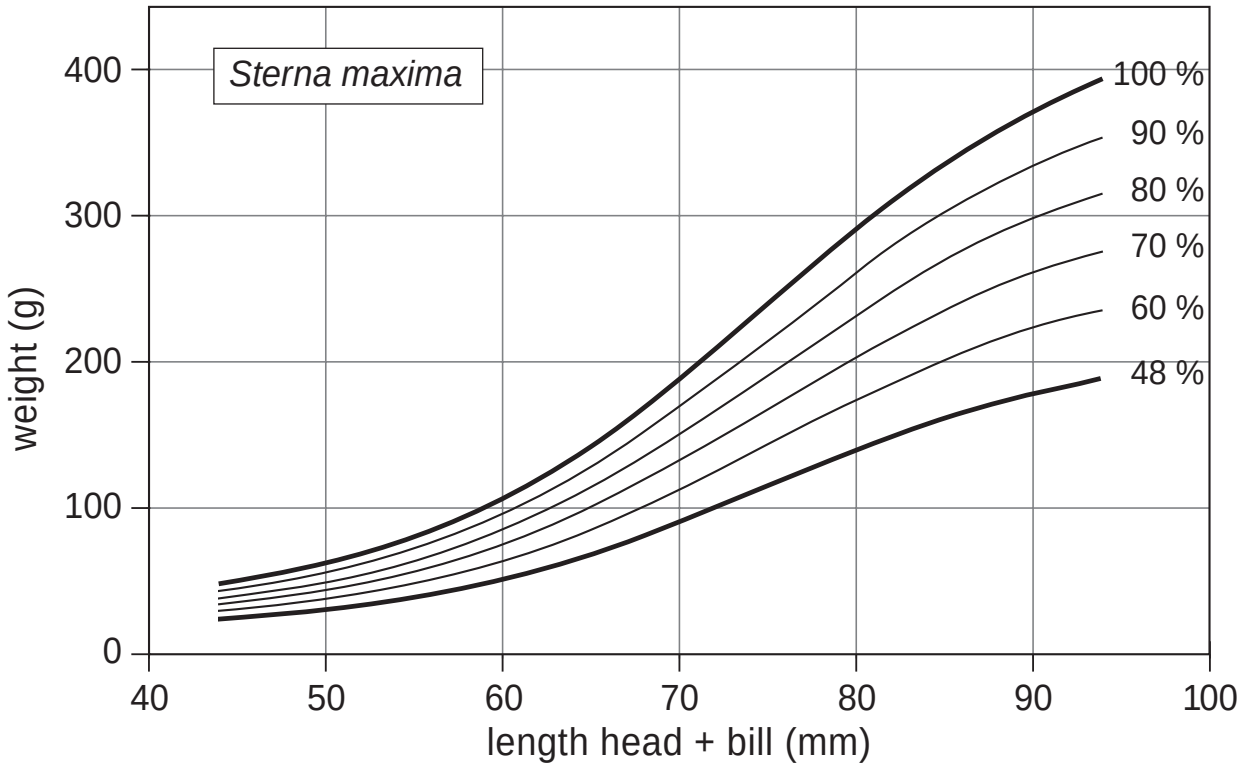
Body condition of chicks of Grey-headed Gulls on the Bijol Islands in 2003. The weight of the chicks in given in relation to the length of head+bill (each star in the figure refers to one individual chick). The upper curve (100%) is the line of maximum growth, whereas the lower curve (48%) is the so-called starvation line. For detailed information see Veen et al. 2002).

Annex 6


Larus cirrocephalus
100 %
90 %
80 %
70 %
60 %
48 %
weight (g)
0
100
200
300
30
40
50
60
70
80
length head + bill (mm)


Larus genei
100 %
90 %
80 %
70 %
60 %
48 %
weight (g)
0
100
200
300
30
40
50
60
70
80
90
length head + bill (mm)


Sterna caspia
800
600
400
200
0
weight (g)
40
60
80
100
120
140
length head + bill (mm)
100 %
90 %
80 %
70 %
60 %
48 %


Sterna maxima
400
300
200
100
0
weight (g)
40
50
60
70
80
90
100
length head + bill (mm)
100 %
90 %
80 %
70 %
60 %
48 %

Annex 7

Name of site: Ile aux Oiseaux-Sine Saloum | **Country:** Senegal | **Sheed no:** 2001/CT/04

Species: Caspian Tern | **Colony no.:** CT-4 | **Year:** 2001

Date of check	1-4	4-4	7-4	10-4	13-4	16-4	19-4	22-4	25-4	28-4	1-5	4-5	7-5	10-5		Summary eggs laid/results
Nest no.																
1	M	e	eee	eee	eee	eeb	ee	ee	ee	ee	ep	pp				eee/bpp
2	M	ee	eee	eee	eee	eee	------									eee/---
3	e	e	e	e	-											e/-
4	M	e	ee	ee	ee	ee	ee	ee	ee	ee	ep	pp				ee/pp
5	M	ee	ee	ee	ee	ee	ee	ee	ee	ep	pp					ee/pp
6	M	e	eee	eee	eee	eee	ee-	ee	ee	ee	pp					eee/pp-
7	e	e	e	e	e	e	e	e	e	p						e/p
8	e	ee	eee	eee	eee	eee	eee	eee	eep	ppp						eee/ppp
9	e	ee	ee	ee	ee	ee	ee	e-	e	p						ee/p-
10	e	e	e	e	e	e	e	e	e	e	e	e	e	e*		e/e*

Analysis

Breeding results:
Clutch size 21/10 = 2,1 per nest
Hatching success 13/10 = 1,3 per nest

Egg mortality factors:
Broken eggs 1/21 = 5% of eggs laid
Rotten/infertile eggs 1/21 = 5% of eggs laid
Disappeared eggs 6/21 = 28% of eggs laid

Summary of data:
10 nests checked
21 eggs laid
1 egg broken
1 egg rotten
6 eggs disappeared
13 chicks hatched

Code: e = intact egg, b = broken egg, d = deserted egg, - = egg disappeared, * = egg rotten, p = chick alive, m = chick dead, M = marking of nest

Name of site:	Country:	Sheed no:
Species:	Colony no.:	Year:

Date of check																Summary eggs laid/results
Nest no.																

Code: e = intact egg, b = broken egg, d = deserted egg, - = egg disappeared, * = egg rotten, p = chick alive, m = chick dead, M = marking of nest

Annex 8

Addresses of organisations involved in the monitoring of seabirds, and their food, in West Africa

Co-ordination, training and monitoring

- Wetlands International, PO Box 8060, 407, Cite Djili Mbaye, Yoff, Dakar-Yoff, Senegal. Tel: +221.8.206478, e-mail: wetlands@telecomplus.sn
- VEDA consultancy, Wieselseweg 110, 7345 CC Wenum Wiesel, The Netherlands. Tel; +31.55.3122279, e-mail: dallmeijer@planet.nl
- Jacques Peeters, Cooperánt APEFE, Conseiller Technique á la Direction des Parcs Nationaux du Sénégal (DPNS), PO Box 6279, Dakar Sénégal, Tel: +2218245221, e-mail: jacques.peeters@apefe.sn
- Fondation Internationale du Banc d'Arguin (FIBA), La Tour du Valat, Le Sambuc, 13200 Arles, France, Tel: +33490972926

Site managing organisations

- Mauritanie: Parc National du Banc d'Arguin, Av. Gamal Abdel Nasser, PO Box 5355, Nouakchott, Mauritania, Tel: +222.5258541
- Sénégal: Direction des Parcs Nationaux du Sénégal, PO Box 5135, Dakar-Fann, Senegal, Tel: +221.832 23 09, e-mail dpn@sentoo.sn
- The Gambia: Department of Parks and Wildlife Management, Abuko Nature Reserve, PO Box 2164 Serakunda, The Gambia, Tel:+220 375888 or 392174, e-mail: wildlife@gamtel.gm
- Guinée-Bissau: ODZH, Gabinete de Planificação Costeira, Appt. 23 1031 Codex-Bissau, Guinea-Bissau, Tel: +245 25 51 64, e-mail: joaosa2003@hotmail.com
- Guinée: Department: Division Faune et Protection de la Nature, Company: Direction Nationale des Eaux et Forets, BP 624, Conakry, République de Guinée, Tel: +224 223907 / 215228, e-mail: dfpn@sotelgui.net.gn

Research on fish and their otoliths

- Fish research: Institut Mauritanien de Recherches Oceanographiques et des Pêches (IMROP), BP 22, Nouadhibou, Mauritanie, Tel: +222 5745 124, e-mail: courrier@imrop.mr
- Fish research: Centre de Recherches Océanographiques de Dakar-Thiaroye (CRODT), BP 2241, Dakar-Thiaroye, Sénégal, Tel: +221 834 80 40
- Fish otoliths: Institut Royal des Sciences Naturelles de Belgique (IRSNB), Dirk Nolf, 29 rue Vautier, B-1000 Bruxelles, Belgique, Tel: 00.32.2.627 44 89

Ringing Centres involved in ringing birds in West Africa

- Belgium: Institut Royal des Sciences Naturelles de Belgique (IRSNB), 29 rue Vautier, B-1000 Bruxelles, Belgique, Tel: 00.32.2.627 44 89
- Africa: African Bird Ringing Unit (AFRING), Dieter Oschadleus, University of Cape Town, Rondebosch 7701, Republic of South Africa, Tel: 021 650-2421/2, e-mail: doug@adu.uct.ac.za

Annex 9

Data sheet for ringed birds as used by the 'Vogeltrekstation' (Dutch Ringing Centre). At present ringing data are usually processed with a computer and sent to the Ringing Centre in digital format. (The sheet has been adapted for this manual.)

Ringing list

Ringed by: _____ **Ring size** ____ **mm**

This form should only be used for one ring size. Use rings in the right order. Fill in the full ring number for every ten rings.
The ringing date should be indicated as follows: 6-5-01. Once the list has been completed it should be sent to the Ringing Centre immediately.
Age: P=pullus; V=full-grown, age unknown, 1kj=bird in first calendar-year, 2kj second calendar-year, etc. For details see end of form.

Ring number	Species	m/f	Age	Date	Place(village/province)	Details
.....01						
2						
3						
4						
5						
6						
7						
8						
9						
10						
.....11						
12						
13						
14						
15						
16						
17						
18						
19						
20						

Ring number	Species	m/f	Age	Date	Place(village/province)	Details
.....21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
.....31						
32						
33						
34						
35						
36						
37						
38						
39						
40						
.....41						
42						
43						
44						
45						
46						
47						
48						
49						
50						

Details - Only use the following codes:

.....P - number of chicks in nest
AT - ringed above tarsus
RI ... - was ringed with ring no.....
MO - moult of wing primaries or tail
EC - in eclipse plumage (ducks)
TC - tame bird or raised in captivity
CR - colour rings added
BR - breeding or feeding small chicks
NR - ringed on night roost
KE - kept for .... days
JU - Juvenile plumage
MD - moult has been described
BI - bird ill or injured
RE - bird released elsewhere (give details)

Annex 10

Example of a detailed planning (Ile aux Oiseaux, Delta du Saloum)

The following timetable exemplifies planning of monitoring activities in the colonies on Ile aux Oiseaux, Delta du Saloum, Senegal. The planning includes all activities carried out on this island in the past. The planning is based on the assumption that human resources (including a scientific co-ordinator and 2 licensed ringers), materials, and financial means are sufficiently available.
The timetable is based on experience from previous years. It is composed to fit in, as well as possible, with the breeding cycles of the Grey-headed Gull, Slender-billed Gull, Royal Tern, and Caspian Tern. Therefore, activities in the field should precisely follow this planning, unless there are unforeseen changes in the occupation of the colonies by the birds. In that case the scientific co-ordinator might decide to change the planning.
It should be stressed that Ile aux Oiseaux is a special case for a number of reasons: The colonies are protected during the breeding season and three wardens are permanently stationed on the island in the period between 1 March and 30 August. This makes it possible to measure hatching success by checking marked nests every 3 days. It also enables one to follow some "extra species" (Kelp Gull, Common Tern, etc.). All other activities are carried out by teams that stay on the island for a couple of days during the monthly counts. Because the island is relatively large and the number of colonial breeding birds is huge (ca.50,000 breeding pairs in total), relatively many observers are needed to carry out all necessary observations. However, it is possible to stay on the island without disturbing the birds.
In many other sites to be included in the West African Seabird Monitoring Programme, monitoring activities will only be carried out on a monthly basis. Consequently, the timetables will be less elaborate.
Specific tasks of the different persons or groups mentioned in the table (SC, GL, CT, RI, GR, see explanation on top of table) are given in chapter 11 of this manual. At the end of each monthly count, data sheets should be completed as presented in annex 1.

*(Human resources : SC : Scientific co-ordinator, GL : Group leader, CT : counter, RI : Licensed ringer, GR : group working in the field consisting of 1 group leader and 2 counters)

Dates	Methods	Activities	Human resour- ces needed* SC	GL	CT	RI	GR
Before 20/02	Preparatory activities	- Preparing the camping site before the wardens of the island and those who will carry out the monitoring will arrive (inspection of huts and other facilities; repairs, etc…..). - Cleaning of those parts of the beach where the birds can be expected to breed (remove old fishing nets, fishing lines, plastic bags and other materials which might harm adults or chicks).	1	2	5		
	Preparation of material	- Preparing 100 numbered sticks for marking the nests of "species of special interest", which breed rather isolated - Preparing 4 x 200 numbered sticks for marking nests to be followed with respect to hatching success (Mayfield method). - Preparation of 25 numbered sticks of 1,5 to 2m (to be used as markings in the area). - Preparing 200 small and thin sticks (length 1m) for marking sectors of the Grey-headed Gull colonies (to be used during monthly counts) - Preparing maps (3 maps format A3), notebooks (6 x size A5, 200 pages) and data sheets to be used in the field (20 sheets and 1 note book for checking "isolated nests", 10 sheets (F11du SIG = internal documents of DPNS) and 10 sheets for monthly counts, 80 sheets and 1 notebook for checking nests in colonies, 4 sheets for measuring eggs, 10 sheets for measuring chick condition, 10 sheets for ringing chicks.					
20/02	Monthly counts	- Counting all nests with eggs in the first colonies of the Caspian Tern and the Grey-headed Gull (if present)		2	2		
01/03	Marking “isolated nests”	- Start of daily protection of colony area - Start of locating and marking nests of some special species with isolated nests (Kelp Gull, Common Tern, Senegal Thick-knee, Black-winged Stilt, Spur-winged Plover, White-faced Whistling Duck, etc….). Activities to be continued till end of season.					+
20/03	Cartography	- Locating the colonies. - First preparations for making the site map (general survey of the site); numbering of the different breeding concentrations (sub-colonies) of the colonially breeding species.	1	3	4		
	Monthly counts	- Counting all nests with eggs in the colonies of the Caspian Tern and the Grey-headed Gull.					
21/03	Monthly counts-continuation	- Continuation of counting nests with eggs in the colonies of the Caspian Tern and the Grey-headed Gull.	1	3	4		
22/03	Hatching success	- Selecting and marking nests with numbered sticks (pilot groups of 50 nests each) to determine hatching success (Mayfield method): Caspian tern: group CT1 and CT2, Grey-headed Gull: group GhG1.	1	3			
27/03	Hatching success	- Checking nests of group CT1, CT2 and GhG1.					+
01/04	Hatching success	- Checking nests of group CT1, CT2 and GhG1.					+
06/04	Hatching success	- Checking nests of group CT1, CT2 and GhG1.					+
11/04	Cartography) Hatching success	- Indicating colonies on site map. - Selecting and marking nests with numbered sticks (pilot groups of 50 nests each) to determine hatching success (Mayfield method):Caspian tern: group CT3 and CT4, Grey-headed Gull: group GhG2 and GhG3. - Checking nests of group SC1, SC2 and GhG1.	1	3			
16/04	Hatching success	- Checking nests of group CT1, CT2, CT3, CT4, GhG1, GhG2, GhG3.					+
20/04	Cartography Monthly counts	- Indicating colonies on site map. - Counting all nests with eggs in the colonies of the Caspian Tern, Royal Tern, Grey-headed Gull and Slender-billed Gull.	1	3	6		
21/04	Monthly counts-continuation Hatching success	- Continuation of counting all nests with eggs in the colonies of the Caspian Tern, Royal Tern, Grey-headed Gull and Slender-billed Gull.. - Checking nests of group CT1, CT2, CT3, CT4, GhG1, GhG2, GhG3.	1	3	6		

22/04	Monthly counts-continuation	- Continuation of counting all nests with eggs of the Grey-headed Gull	1	3	6		
23/04	Monthly counts-continuation	- Continuation of counting all nests with eggs of the Grey-headed Gull	1	3	6		
24/04	Monthly counts-continuation Measuring eggs	- Continuation of counting all nests with eggs of the Grey-headed Gull - Measuring 50 eggs of the Caspian Tern and 50 eggs of the Grey-headed Gull.	1	3	6		
25/04	Collecting pellets and faeces	- Collecting pellets (150) and faeces (10 bags) of the Caspian Tern.					+
26/04	Hatching success	- Checking nests of group CT1, CT2, CT3, CT4, GhG1, GhG2, GhG3					+
01/05	Cartography Hatching success	- Indicating colonies on site map. - Selecting and marking nests with numbered sticks (pilot groups of 50 nests each) to determine hatching success (Mayfield method): Royal Tern : group RT1, RT2, RT3, Grey-headed Gull group GhG4, Slender-billed Gull group SbG1, SbG2, SbG3. - Checking nests of group CT3, CT4, MtG2, MtG3.	1	3			
06/05	Hatching success	- Checking nests of group CT3, CT4, MtG2, MtG3, MtG4, RT1, RT2, RT3, SbG1, SbG2, SbG3					+
11/05	Hatching success	- Checking nests of group CT3, CT4, MtG2, MtG3, MtG4, RT1, RT2, RT3, SbG1, SbG2, SbG3					+
16/05	Hatching success	- Checking nests of group CT3, CT4, MtG2, MtG3, MtG4, RT1, RT2, RT3, SbG1, SbG2, SbG3					+
19/05	Measuring chick condition + ringing Collecting pellets and faeces	- Measuring the condition of checks of the Grey-headed Gull and Caspian. - Ringing of the measured chicks (see above) + extra ringing of chicks of Caspian Tern and Grey-headed Gull. - Collection of pellets of the Royal Tern (150) and faeces of Royal Tern (10 bags) and Slender-billed Gull (10 bags)	1	3	4	2	
20/05	Cartography Monthly counts Measuring eggs	- Indicating colonies on site map - Counting all nests with eggs of the Caspian Tern and Slender-billed Gull - Measuring 50 eggs of the Slender-billed Gull and 50 eggs of the Royal Tern.	1	3	6		
21/05	Monthly counts-continuation Hatching success	- Counting all nests with eggs of the Royal tern. - Checking nests of group MtG4, RT1, RT2, RT3, SbG1, SbG2, SbG3 - Selecting and marking nests with numbered sticks (pilot groups of 50 nests each) to determine hatching success (Mayfield method): Royal Tern : group RT4, Slender-billed Gull group SbG4.	1	3	6		
22/05	Monthly counts-continuation	- Counting all nests with eggs of the Grey-headed Gull	1	3	6		
23/05	Monthly counts-continuation	- Counting all nests with eggs of the Grey-headed Gull	1	3	6		
24/05	Monthly counts-continuation	- Counting all nests with eggs of the Grey-headed Gull	1	3	6		
26/05	Hatching success	- Checking nests of group MtG4, RT1, RT2, RT3, RT4, SbG1, SbG2, SbG3, SbG4					+
31/05	Hatching success	- Checking nests of group MtG4, RT1, RT2, RT3, RT4, SbG1, SbG2, SbG3, SbG4					+
05/06	Hatching success	- Checking nests of group MtG4, RT1, RT2, RT3, RT4, SbG1, SbG2, SbG3, SbG4					+
10/06	Hatching success	- Checking nests of group RT4, SbG4.					+
15/06	Hatching success	- Checking nests of group RT4, SbG4.					+
19/06	Measuring chick condition + ringing	- Measuring the condition of chicks of the Grey-headed Gull, Caspian Tern, Royal Tern and Slender-billed Gull. - Ringing of the measured chicks (see above) + extra ringing of chicks of Royal Tern and Slender-billed Gull.	1	3	4	2	

20/06	Cartography Monthly counts Hatching success	- Indicating colonies on site map - Counting all nests with eggs of the Caspian Tern and Slender-billed Gull. - Checking nests of group RT4, SbG4	1	3	4		
21/06	Monthly counts-continuation	- Counting all nests with eggs of the Royal tern.	1	3	4		
22/06	Monthly counts-continuation	- Counting all nests with eggs of the Grey-headed Gull.	1	3	4		
23/06	Monthly counts-continuation	- Counting all nests with eggs of the Grey-headed Gull.	1	3	4		
24/06	Monthly counts-continuation	- Counting all nests with eggs of the Grey-headed Gull.	1	3	4		
25/06	Hatching success	- Checking nests of group RT4, SbG4.					+
05/07	Measuring chick condition + ringing	- Measuring the condition of large chicks of the Grey-headed Gull, Caspian Tern, Royal Tern and Slender-billed Gull - Ringing of the measured chicks (see above)	1	3	2	2	
20/07	Cartography Monthly counts	- Indicating colonies on site map - Counting all nests with eggs of the Caspian Tern, Royal Tern, Grey-headed Gull and Slender-billed	1	3	4		
21/07	Monthly counts-continuation Counting number of breeding pairs of Herons, Egrets and Ibisses	- Counting all nests with eggs of the Grey-headed Gull. - Counting the number of adult birds which leave the colony early in the morning and estimating the number of adults which stay on the nests (number of pairs is estimated as: total individuals divided by 2)	1	3	4		
22/07	Monthly counts-continuation	- Counting all nests with eggs of the Grey-headed Gull.	1	3	4		
20/08	Cartography Monthly counts	- indicating colonies on site map - Counting all nests with eggs of the Caspian Tern, Royal Tern, Grey-headed Gull and Slender-billed	1	3	4		
21/08	Monthly counts-continuation	- Counting all nests with eggs of the Grey-headed Gull.	1	3	4		
30/08		- Last check of nests of "special species". - End of daily protection of the breeding colonies and of monitoring activities					+
01/09 till 30/10	Handling samples and data analysis	- Sending pellets and faeces to African Otolith Expert - Checking all data, filling in data sheets, making copies - Analysing data - Making tables and graphs	1				
01/11 till 31/12	Writing raport	- Writing draft report - Sending draft to Regional co-ordinator - Completing final version - Sending final version of report to Head Office of Management Organisation - Sending final version, together with copies of data sheets to Regional Co-ordinator of West African Seabird Monitoring Programme	1				

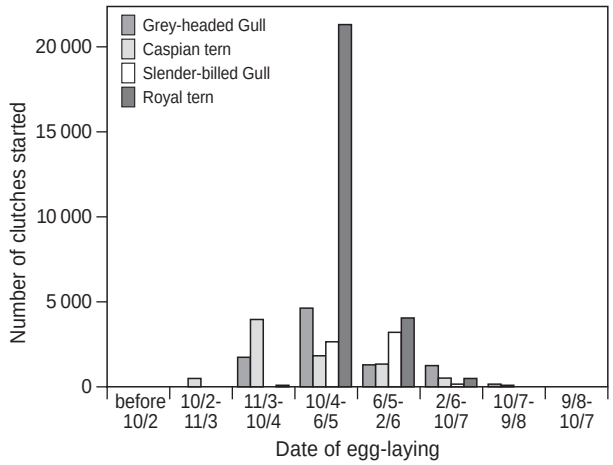
Annex 11

The timing of laying of four bird species on Ile aux Oiseaux, Delta du Saloum

The table and the figure below give the results of monthly counts of the number of nests of the Grey-headed Gull, Slender-billed Gull, Caspian Tern and Royal Tern on Ile aux Oiseaux, Delta du Saloum, in 2001. For Slender-billed Gull, Caspian Tern and Royal Tern the data are based on monthly counts of the number of nests with eggs. In case of the Grey-headed Gull numbers have been calculated, based on counts in a number of study plots and a total count on 6 May.

	Number of new clutches started							
Dateof count	10-Feb	11-Mar	10-Apr	06-May	02-June	10-July	09-Aug	10-Sep
Laying period	avant 10-2	10/2 - 11/3	11/3 - 10/4	10/4 - 6/5	6/5 - 2/6	2/6 - 10/7	10/7 - 9/8	9/8 - 10/7
Grey-headed Gull		0	1 718	4 554	1 251	1 180	123	0
Caspian tern	0	469	3 980	1 752	1 318	489	46	0
Slender-billed Gull		0	8	2 571	3 167	141	3	0
Royal tern		0	59	21 273	4 008	410	0	

Number of clutches started in the course of the breeding season (Ile aux Oiseaux, Delta du Saloum, 2001)



Annex 12

Annotated checklist for making a report at the end of the season

1. Introduction
General description of the site (situation, management, type of protection)
Occurrence of breeding species (table with numbers from previous years that can also be given as an annex; mention national and international importance)
Management objectives for the site

2. Monitoring objectives
General objectives (national and international framework)
Objectives specific for the site
Expected results

3. Methods and materials

3.1 Monitoring methods
- methods used for mapping the island
- methods used for monthly counting the colonies
- methods used for measuring clutch size
- methods used for measuring egg size
- methods used for measuring hatching success
- methods used for measuring chick condition
- materials and methods used for ringing
- methods used for collecting pellets and faeces

3.2 Working programme
Description of working procedures

3.3 Human resources, materials and logistics
General description of the way of working (size and formation of working groups), materials used, etc. (details such as lists with names and addresses, materials and budget can be given as an annex)

4. Results

4.1 Distribution of colonies
Give a short description of the colony distribution, also in relation to habitat (vegetation, height), preferably with a map of the area where the colonies are indicated. Draw conclusions.

4.2 Timing of egg-laying
For each species, describe the pattern of egg-laying throughout the season. Preferably give a table. Draw conclusions.

4.3 Number of breeding birds.
Give an overview of the monthly counts for each species; distinguish between "total number of nests present" and "new nests with eggs since the last count"; summarise data in table. Make clear whether and to what extent the number of clutches laid differs from the number of pairs breeding. Also mention whether your figures are accurate (exact count or estimate?)

4.4 Clutch size
Present an overview of the obtained data as a table. Draw conclusions.

4.5 Egg size
Present an overview of the obtained data as a table. Draw conclusions.

4.6 Chick condition
Present the results for each species on graphs as given in annex 8 of this manual. Draw conclusions.

4.7 Hatching success
Present the results for each species as a table. Draw conclusions.

4.8 Mortality factors of eggs and chicks
Mention mortality factors. Make clear to what extent your data are based on nests checked throughout the season and on those observed incidentally. Try to quantify as much as possible. Draw conclusions.

4.9 Collection of pellets and faeces
Include a table showing what you have collected.

5. Conclusions and discussion
Summarise the most important conclusions drawn when presenting the results. Compare these with data of previous years. Are there any marked differences? What can you say about these? Discuss the results in relation to environmental factors, such as predation, human disturbance, high floods, etc.

6. Recommendations
Make a list of recommendations with respect to future monitoring (how you can improve methods) and with respect to the management of the site.

7. Annexes
7.1 Table with the numbers of breeding birds in the site in previous years (overview)
7.2 Time planning of the project
7.3 Names and addresses of persons who have been involved in the monitoring
7.4 Materials used during the monitoring (mention at the end what should be renewed)
7.5 Financial overview of expenses that have been made for the monitoring