REGIONAL ORGANIZATION FOR THE CONSERVATION OF THE ENVIRONMENT OF THE RED SEA AND GULF OF ADEN (PERSGA)

IMPLEMENTATION OF THE STRATEGIC ACTION PROGRAMME (SAP) FOR THE RED SEA AND GULF OF ADEN

GUIDE TO STANDARD SURVEY METHODS FOR SEABIRDS

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INTRODUCTION

The seabird populations of the Red Sea and Gulf of Aden have been reviewed by Cooper *et al*. (1984), Gallagher *et al*. (1984), Evans (1987) and Jennings (1995). These works have pulled together information from a wide variety of sources covering a fairly long time span. In the case of the former two papers, the authors have attempted to estimated approximate population sizes, or orders of magnitude, for some breeding species and thereby indicate the potential importance of the Red Sea and Gulf of Aden (RSGA) region in an international context.

However, closer scrutiny of the above reviews shows that little systematic survey work has been done on this group in the region, although there are a few exceptions where whole archipelagos have been covered or national waters surveyed in their entirety. These are given in Table 1. Also, some national avifauna have given estimates of national population sizes and breeding seasons for some of the more

frequently encountered species. However, even where **systematic surveys** have been undertaken, there has been little use of **systematic methodology**. The importance of the RSGA region for seabirds is not in doubt, as several endemic taxa occur, including the White-eyed Gull *Larus leucophthalmus,* Red-billed Tropicbird *Phaeton aethereus indicus,* Spoonbill *Platalea leucorodia archeri* and Brown Noddy *Anous stolidus plumbeigularus*. A further group of taxa, at both specific and sub-specific level, is endemic to the NW Indian Ocean area and important sub-populations of many of these breed in the RSGA region: Jouanin's Petrel *Bulweria fallax,* Socotra Cormorant *Phalacrocorax nigrogularis,* Sooty Gull *Larus hemprichii,* Swift Tern *Sterna bergii velox* and White-cheeked Tern *Sterna repressa*.

Table 1. Sources of information regarding seabird numbers and distribution in the RSGA region.

Country	**National avifauna: atlas (A); list (B)**	**Important recent seabird studies: whole country (A); archipelago (B); single species in large area (C)**	**Name of archipelago**
Egypt	Goodman & Meininger 1989 (A)	Jennings *et al*. 1985 (B)	Islands off Hurghada and much of Gulf of Suez
		Hoath *et al*. 1997 (B)	Mouth of Gulf of Suez
		Frazier *et al*. 1984 (A)	
Jordan	Andrews 1995 (B)		
	Shirihai *et al*. 1999 (B)		
Saudi Arabia	Jennings 1995 (A)	Ormond *et al*. 1984 (A)	
		Newton & Suhaibany 1996 (A)	
		Goldspink *et al*. 1995 (B)	Farasan
		Jennings 1988 (B)	Farasan
		Symens 1988 (B)	Farasan
		Newton & Symens (C)	
Sudan	Nikolaus 1987 (A)	Moore &Balzarotti 1983 (B)	Suakin & Mhd Qol
Eritrea	Smith 1951 (B)	Clapham 1964 (B)	Dahlac
Yemen	Jennings 1995 (A)	Evans 1989 (B)	Al Huhayyah
	Brooks *et al*. 1987 (B)	Porter & al-Saghier 1998 (B)	Al Hudayah
	Porter *et al*. 1996 (B)		
Djibouti	Welch & Welch 1984 (B)		
Somalia	Ash & Miskell 1998 (A)	North 1946 (B)	Mait Island
Socotra	Kirwan *et al.* 1996 (B)		

At this point, it may be appropriate to review the development of seabird survey methods in the biogeographical area, with a longer history of systematic work on seabirds. Within Europe, two neighbouring countries, Britain and Ireland, have a 30-year record of monitoring seabirds in what is a very important area for breeding seabirds in the NE Atlantic. The baseline survey, Operation Seafarer, was undertaken in 1969-70, when professional ornithologists employed by conservation agencies and

amateur volunteers organised by the Seabird Group covered virtually all known coastal seabird colonies, using standardised but flexible methodology. Subsequently, a book was published, Cramp *et al*. (1975), and this was the principal output; clearly though, it could only summarise much of the numerical and distributional data in annotated maps, showing relative colony size, and species accounts using administrative counties as the geographical unit for totals of pairs or individuals. A hard copy file of raw counts for each colony, island or coastal section was deposited in national libraries and amongst all organisations that assisted with the coordination of the Operation Seafarer survey. Fifteen years later, a slightly more rigorous methodology was proposed for a re-survey, the Seabird Colony Register (SCR), which was undertaken between 1985-87. Again, a book was published, Lloyd *et al*. (1991), and this was perhaps a more critical review, as it attempted to differentiate discrepancies between the two surveys in the light of different methodologies used for different groups of species. The major difference between the two surveys was that the principal output of the SCR was a computer database that has been updated annually at a sample of colonies that are monitored regularly as part of the Seabird Monitoring Programme (SMP). A very comprehensive manual of suitable methodologies has been produced, Walsh *et al*. (1995), that covers both basic census and more intensive productivity monitoring. There is now much greater use of standardised methodologies and these are presently being used in a third census of all Britain and Ireland's colonies, Seabird 2000, that is scheduled to span 1999-2001.

Methods used in the RSGA region and elsewhere in the Middle East prior to the 1990's were typically done during brief, opportunistic 'walk around' visits. However, the Gulf War of 1991 and the ensuing serious oil pollution in the northern Arabian Gulf (Evans *et al*. 1993) changed the course of seabird studies in the region. As is often the case, an environmental disaster can, in retrospect, act as a stimulant for much better monitoring and protection of the marine environment. Detailed research carried out on the Saudi Arabian Gulf islands between 1991 and 1995 has resulted in refined methodologies for the census of summer nesting terns (Symens & Evans 1993, Symens & al Suhaibany 1996) and winter breeding Socotra Cormorants (Symens *et al*. 1993, Symens & Werner 1996). All tern species monitored in the Gulf are also breeding in the RSGA region and the methods are directly applicable. The Socotra area itself is fairly peripheral in the breeding range of Socotra Cormorants, though small numbers may nest near the Yemen coast and methods given in Symens & Werner (1996) would be appropriate.

During the early 1990's, several RSGA countries and others in Arabia began to contribute counts of wintering waterfowl to the International Waterfowl Census, organised by the International Wetlands Research Bureau (now Wetlands International). Within Saudi Arabia, only relatively small sections of Red Sea coast could be covered by ground counts but the availability of light aircraft used for protected area patrols with the National Commission for Wildlife Conservation and Development (NCWCD) enabled much larger areas to be covered from the air. This aerial survey work was usually undertaken in January/ February outside the main breeding season for seabirds. However, it soon became apparent that some species were nesting in the winter on some inshore islands, e.g. Pink-backed Pelicans *Pelecanus rufescens*, Brown Boobies and Caspian Terns *Sterna caspia*. With practice by both pilots and surveyors, methods and routes were refined so that these species and their nests could be counted and subsequently numbers and distribution, of

pelicans especially, became better known (Newton & Symens 1996). The next logical step was to expand aerial coverage to summer breeding seabirds and in 1993 a full aerial survey of the Farasan archipelago was undertaken (Goldspink *et al*. 1995) and ground truthing was also done to assess the accuracy of the aerial counts. Following extensive planning, a survey of all other Saudi Arabian Red Sea islands was completed in summer 1996, together with a re-survey of some of the Farasan Islands (Newton & al Suhaibany 1996a, 1996b). Thus, between work in the Arabian Gulf and Saudi Red Sea, a suite of methodologies is now available and their application to the wider RSGA region is pertinent. However, for some species we are still woefully short of information on the precise timing of nesting seasons and whether these vary from year to year and, for petrels (Procellaria) which only visit their colonies during the hours of darkness, we also lack an understanding of their nesting habitat.

Definitions

True seabirds: Typically defined for the RSGA region as members of the following families dependent on the marine environment for the whole of the annual cycle: petrels and shearwaters, tropicbirds, boobies, cormorants, gulls and terns.

***Other seabirds*:** Those families associated with the marine environment for the breeding season and typically for much of the annual cycle: pelicans, some herons and egrets, spoonbill.

***Raptors and waders*:** Osprey *Pandion haliaetus* and Crab Plover *Dromus ardeola* are representatives for each group that are dependent on the marine environment in the RSGA. Although Sooty Falcons *Falco concolor* nesting in the RSGA region utilise marine islands, their food base typically comprises migrant passerine and near-passerine birds. Additionally, many Kentish Plover *Charadrius alexandrinus* nest on mainland beaches and islands and utilise intertidal areas for feeding on invertebrates; some also nest inland around freshwater body margins of rivers, lakes and reservoirs.

Breeding Seasons

Three seasons are referred to in the following text, where the commencement of a season is marked by egg-laying. Summer breeders refers to those species which appear to lay principally in late May – July (most terns); winter breeders, including Socotra Cormorant, Pink-backed Pelican and Osprey, may initiate clutches from the autumn onwards (October) but the former species may nest in "waves", over a protracted period. Spring breeders are those laying between February and late April and include Caspian Tern, Saunder's Tern *Sterna saundersi*, herons and spoonbills. Some species such as the Brown Booby *Sula leucogaster* have been found at nests in most months of the year. This could arise for several reasons: timing varies in response to prey abundance in different areas at different times; they could also nest at sub-annual intervals and, finally, there may be several nesting "waves" at particular colonies, with more experienced breeders commencing earliest and less experienced pairs later. Only regular visits to key sites over a period of several years will throw light on this question.

The purpose of these guidelines is to suggest a possible framework in which member states of PERSGA can commence collecting information on their breeding seabirds. Data collection follows the standardised approach given below, the combined results will be a unique overview of breeding seabirds in a poorly known region.

The specific aims for each PERSGA member country are as follows.

1) Produce a national inventory of seabird colonies in which the following topics are covered: a) species present, breeding status, number of pairs (or individuals), habitats utilised; b) document size, topography and habitats of each island / colony; c) timing of nesting or occupation of islands / colonies; d) human activities on or around each island / colony , direct and indirect threats to seabirds; e) conservation actions needed, especially where human occupation has been noted or sensitive species are present.
2) Estimate geographical (regional) population sizes and then evaluate relative importance of sites. Those holding 5% of more of the biogeographical population may be considered of international importance (such criteria for seabirds are not compliant with RAMSAR Convention regulations where sites holding 1% of a biogeographical population or 20,000 waterfowl are considered internationally important).
3) Produce a Conservation Action Plan which integrates seabird data with other national / regional coastal initiatives towards establishment of Marine Protected Areas (MPAs) and implementation of Integrated Coastal Zone Management (ICZM) strategies.

METHODS

Phase 1: Desktop Planning

The senior ornithologist in each country should commence preparation of a list of all islands in their territorial waters (Gulf of Suez, Gulf of Aqaba, Red Sea, Gulf of Aden). All available maps, and perhaps satellite images, both hard copy and electronic, should be scrutinised. In the RSGA region, virtually all seabird colonies are on islands, as they are free from the majority of terrestrial predators. However, remote sections of mainland coast with sand spits are relatively inaccessible. Cliffs should be added to a reserve list to check as a second priority. Also some mainland bays that harbour dense stands of mangroves often contain isolated stands of mangroves that form small islands without a solid substrate. These can be utilised by tree nesting species such as pelicans, herons and spoonbills. Again, add such sites to the secondary site list.

Maps

The following are usually reasonably accurate and identify most permanent islands.
(A) British Admiralty Navigation Charts or other local equivalents.
Source: Navy, Coastguard.
(B) UK Ministry of Defence

(i) Operational Navigation Charts (ONC) Series 1:1,000,000

ONC H-5 North Red Sea, Suez, Aqaba
ONC J-6 Central Red Sea
ONC K-5 Southern Red Sea
ONC K-6 Gulf of Aden

(ii) The Tactical Pilotage Charts (TPC) Series at 1:500,000 offer much more detail and are perhaps the best for making initial lists of islands. There are four sheets for each ONC, with alphabetic coding as follows: A = north-west; B = north-east; C = south-east; D = south-west.

Thus, sheet TPC J-6C covers the south-east part of ONC J-6 i.e. a small part of the Red Sea coast on the Saudi/Yemen border.
Source: Air Force, Airlines, smaller aircraft charter companies.

(C) Ministry of Petroleum & Mineral Resources, in KSA, produces some good maps at 1:500,000 scale. Other countries probably have equivalents produced by the national authority that regulates oil exploration.
(D) Also look for aerial photographs and, as mentioned earlier, satellite images.

The information extracted from maps should be entered into an Excel type spreadsheet under the following headings:

Name (real or geographically based, e.g. island SE of Jazirat One), note any alternatives in use.
Latitude (central point if large island)
Longitude (central point if large island)
Approximate size (three categories: small = < 500m along long axis; medium = 501 – 5,000m along long axis; large = 5,001m + along long axis)
Any other details (charts may indicate presence of fishing village, coastguard station, mountain plus spot height etc.)

The overall coastal zone should be split into several sectors that may eventually form reasonable field survey units.

Literature

Once the planning team are familiar with the distribution and names of islands in territorial waters, the ornithological literature can be reviewed. Many general references to the RSGA region can be found in the 1990 Alesco-Persga bibliography (pages 132-134 for birds), though these are mostly historical papers and more recent papers are listed at the end of this document. The author will continue to assemble literature relevant to seabirds in the RSGA region and will circulate a new bibliography at a later date. Literature should be classified under two headings: historical (pre-1980) and recent (1980-2000). Experience has shown that the situation described in recent papers is usually still applicable today, unless there have been significant military or tourist infrastructure developments on the island in question. Information extracted from literature should focus on breeding status of species present at the time of survey. Most visits were typically brief 'walk-arounds' and population estimates are usually vague. However, one should be able to extract lists of which species were present, those proven to be nesting, nesting habitat and a broad evaluation of numbers on an order of magnitude scale:
A = 1-10 pairs; B = 11=100 pairs; C = 101-1,000 pairs; D = 1,001-10,000 pairs; E = >10,001 pairs.
Again, such information can be entered on the Excel file as species / breeding (Y/N) / order of magnitude (A-E).
The two lists of islands should then be ranked in order of importance for breeding seabirds. Ranks for assessing the relative importance of species diversity versus population size will be developed in the near future, but at this stage the latter should be given priority as we are attempting to build up overall regional population sizes.

Phase 2: Resource Review

This review needs to assess availability of resources under the following headings: personnel; transport; equipment; contacts and liaison with other organisations.

Personnel

List those personnel in your organisation who can either participate in surveys or act in a support capacity in the field or in the data analysis / presentation phase. Note their

ornithological skills on a three point scale of “some”, “reasonable”, “good”: bird identification; bird census / counting experience; survey techniques (knowledge of transects / quadrats), bird ringing.
Also record other skill that will be useful in seabird surveys: boat handling; ability to swim; navigation e.g. use of compass and GPS; knowledge of particular geographical areas / local contacts.
It is unlikely that many national organisers have an abundance of experienced staff and thus a training regime needs to be considered. The lead specialists in PERSGA may be able to assist with developing an appropriate programme.

Transport
The availability of vehicles, boats and light aircraft needs to be assessed within your own organisation and within others that may be able to assist you to get to particular islands. A useful exercise is to annotate coastal maps with the locations of coastguard stations, navy bases, fisheries patrol vessels / bases and fishing villages, marinas / pleasure boat moorings, marine research centres and so on. Try and find out which islands are covered by staff from these institutions and thereby identify gaps where you will have to use your own boat or charter some alternative.

Equipment
Relatively little scientific equipment is required for basic seabird surveys in addition to the usual binoculars, telescopes and tripods. Waterproof notebooks or “divers slates” are useful during very humid times of year. If detailed nest counts are to be undertaken in dense colonies, then a variety of light ropes (50m in length) and tape measures will be needed. GPS (use water tight “aquapac” pouches to keep them dry), compasses and other marine navigation and safety equipment will be needed if you are to use your own boats. The availability of computers and software needs to be addressed at a later stage. Generally speaking, use of lap top computers in the field in the RSGA region is not advisable owing to dust, sand, humidity etc.

Contacts and Liaison
Within your own organisation, liaise with other specialists (e.g. working on turtles, marine mammals and mangroves) regarding their survey programmes. Sharing transport or survey flights would obviously be beneficial in reducing costs.
Outside your own organisation, you will already have initiated communication with a range of useful contacts (see under B above). However, by this stage, you will have identified all sites deemed sensitive for military or national security reasons and these should be excluded from the list to be visited by field survey teams. Also, in some instances you may be able to recruit volunteer birdwatchers from natural history societies who could assist in field surveys.

Phase 3: Fieldwork Options
Following the above exercises and reviews, it ought to be clearer as to the magnitude of the field operation that is required to produce your national seabird colony inventory. Keep in mind the two main tasks – firstly to do a systematic reconnaissance (which islands are used by seabirds, which species are present, whether they are nesting) and then to undertake more detailed monitoring of the more important, accessible sites / colonies in which numbers may be assessed. In the paragraphs below, I will outline the advantages and disadvantages of different survey methods.

Aerial Survey
Both fixed-wing aircraft and helicopters can be used.

Fixed-wing aircraft
These are perhaps best for rapid reconnaissance. The author and PERSGA Habitat & Biodiversity Lead Specialist have developed considerable expertise in using a light aircraft for identifying important seabird colonies. In summer 1996, virtually all islands in the Saudi Red Sea were over-flown in a series of 12 missions (flights) that ranged in length from 2-5 hours flying time (Newton & al Suhaibany 1996a). A basic protocol is as follows. (1) Discuss your rough itinerary with pilot several weeks in advance; he will advise you as to restricted areas, range / flying time with different numbers of observers etc. He will need time to lodge and get approval of flight plans. (2) The day before your flight, give the pilot a numbered list of coordinates for all islands / sites you wish to overfly the next day. He will enter these into the aircraft GPS and this will relieve you of much navigational responsibility during the flight so that you can concentrate on identifying and counting birds. (3) Immediately prior to your flight (1 hour), take motion sickness pills if necessary, check you have all necessary maps and recording forms plus sufficient drink and food (easy to eat in confined space). Divide data collection topics between the number of observers you have (usually 1-3) so that one observer may record island information (size, substrate, signs of human occupation, habitats etc.) and the other(s) record bird counts. The most experienced person should do the latter. (4) Once airborne over the sea in your target area, fly at 100-300 feet above sea level as slowly as possible (probably about 90 knots). Usually several overpasses of each island will be required to cover the range of species. If two bird counters are present, split the species, or one count nests and the other birds. In the first few surveys, try and evaluate which species flush first and disperse furthest on approach by the aircraft and those which stay together for longer in more detectable flocks. Several overpasses are often necessary to flush species which nest under thick cover, e.g. Brown Boobies. Non-breeding birds of whatever species are present tend to flush and disperse first, whereas those on nests with eggs and/or chicks are usually most reluctant to fly off. Once bird counts have been made, if time and fuel permit, make a further overpass to photograph dense colonies. Over smaller islands (size categories A and B) you should not spend more than 5 minutes overhead, and often a lot less. Aerial surveys in summer should be confined to early morning (06.00 – 10.30) or late afternoon (15.00 – 18.30) to minimise heat stress on adult birds or their eggs and chicks. During winter, a longer part of the day may be used.

Helicopters
These tend to be noisier and probably cause more disturbance to nesting birds and are also slower. Helicopters may be better as platforms for aerial photography of dense colonies (e.g. Socotra Cormorants, Pink-backed Pelicans), given their ability to remain stationary. However, do not fly too low as the downdraft from the rotors could blow eggs and chicks out of their nests. See Symens & Werner (1996) for more detail.

Boat Survey
Boats will usually be used to gain access to islands. The larger and faster the boat, the better for access to more remote offshore or distant locations, but you will also need an inflatable dingy with outboard engine to land on many islands with barrier reefs.

During crossings of open sea, try and maintain watch for seabirds, particularly petrels and shearwaters, as this may be your only opportunity to discover which nocturnal or burrow-nesting species are present in your area as they will not be seen during daylight visits. However, in some instances, it may not be feasible to land and a boat circuit of the island may be your only opportunity to see what is there. Landing may be prevented by too rough weather, island totally surrounded by impenetrable reef or inaccessible cliffs or you simply have insufficient time. For small (Class A) islands, a sea circuit may provide enough information or be necessary to count cliff-nesting species such as tropicbirds. If a prior aerial reconnaissance has not been done, often a boat circuit can be useful to indicate habitat and species presence and distribution and help you to plan your strategy once you are on the ground. Some nesting species, e.g. Brown Boobies, should not be approached closely during the incubation and early chick stages as they are unable to defend their nests from marauding White-eyed or Sooty Gulls, which are usually present around the periphery of colonies.

Landing on Islands

Both the time available and size of island are pivotal in decision making as to how to spend your time. Often some spells of careful observation from higher vantage points may be a better use of time than a mad rush to walk to each corner of the island or around its perimeter.

A-size islands

Plan to spend about 2 hours on land for a rapid assessment, as long as your presence is not continually disturbing all nesting birds on the island. All areas can be reached on foot and even mangrove stands or dense shrubbery can be checked.

B-size islands

Allow 8 hours, i.e. all day, and try and pick a day with some cloud cover, so that personal exhaustion and dehydration do not influence your results.

C-size islands

Some of these are likely to have permanent human settlements of one sort or another, in which case vehicles may be available to move about the island (e.g. Farasan Kebir and Segid in the southern Saudi Red Sea or Dahlac Kebir in Eritrea). However, it is also likely that cats, rats and mongooses will be present and large seabird colonies are unlikely. For example, the only seabirds nesting on Farasan Kebir away from tall, dense stands of mangrove are a couple of small Saunder's Tern colonies in remoter sandy beaches or headlands. It may require several days to cover such islands adequately.

In sections that follow, I describe methods appropriate to all species known to nest in the RSGA region. However, some basic methodologies are common to various species groups or habitats and will help in the rapid assessment of islands if time is limited.

General Methods

Most methods require the estimation of nest densities in different habitats and then the extrapolation of these to the approximate area of the island covered by a habitat type. Prior awareness of the types of situations in which various species nest and colony types will help in allocating search effort. Two slightly different approaches are needed to determine the potential number of nesting seabirds, depending on whether they are semi-colonial or colonial. For the former, e.g. Bridled Terns, vantage points need to be located and counts made after the birds have resettled. If counts are

conducted during incubation, one member of a pair incubates while the second frequently perches above the nest on the top of a bush. Thus, the total number of perched birds approximated the number of pairs in the area. In more compact colonies, e.g. White-eyed Gulls and White-cheeked Terns, it is necessary for two observers to walk in parallel 3-5m apart and record the number of nests and clutch sizes.

Dispersed species
Territorial, e.g. Osprey, possibly Goliath *Ardea goliath* and Purple Heron *A. purpurea* (but in dense mangrove).
Scarce habitats, e.g. Red-billed Tropicbird in caves / niches, in cliffs or fossil coral overhangs.

Semi-colonial or loosely colonial species (may cover whole island)
Ground nesters, e.g. Caspian Terns, Saunder's Tern, Brown Booby, Sooty Gull (usually beside or under some cover).
Under light vegetation, e.g. Bridled Tern, also under overhangs in fossil coral.
Sub-colony, in or under medium height vegetation, e.g. Little Green Heron *Butorides striatus*, Western Reef Heron *Egretta gularis*, Brown Noddy.

Colonial species (usually discrete entities covering relatively small parts of island)
Ground nesters, very compact colonies, large numbers, e.g. Swift and Lesser Crested Terns *Sterna bengalensis*, Socotra Cormorant.
Ground nesters, compact colonies but inter-nest distances 1-5m e.g. White-cheeked Tern, White-eyed Gull.
Underground nesters, usually in dunes / berm or other sandy area, e.g. Crab Plover.
Tree nesters, usually on canopy, e.g. Pink-backed Pelican, Spoonbill, Cattle Egret *Bubulcus ibis*.

Ringing
Bird ringing is a widely used tool in ornithological monitoring studies, but in general it does not have a significant role in standard surveys aimed at assessing population sizes. The main information to be gained from ringing is concerned with survival / mortality rates, longevity, breeding site fidelity and perhaps determining wintering or non-breeding areas of birds using the RSGA region for breeding. As adults, seabirds are not easy to catch, given their normal habit of nesting in open habitats. Thus, most seabird ringing involves catching and marking pre-fledging chicks; large numbers can be ringed relatively quickly in colonies. However, seabirds are usually long-lived and do not return to breeding areas for several years. Information is gained from the use of standard metal rings only when the individual is recovered, i.e. found dead or deliberately killed, or retrapped. Use of field readable colour rings increases the likelihood of detecting ringed birds and a single colour could be used to indicate chicks ringed in a particular year or from a single location (colony or island).

Chick ringing can be used in intensive single site based studies to give information on survival and fledging rates or in mark-recapture studies that can indicate efficiency in finding chicks for species that tend to hide in vegetation.

Although, as described here, ringing is not a census tool, it is always worth checking the legs of all dead birds found while doing fieldwork. Ring recovery can yield important information about the origins of birds in your colony.

Threats to Nesting Seabirds

The majority of seabirds nest in close proximity in colonies, which also increases their vulnerability to disturbance from human visitors or predators. When visiting seabird islands, one should always be aware of the disturbance that you are causing and try and minimise the impact of our visit. However, while you are on islands, try and collect as much information as possible, not only on the birds themselves but also on human uses and their likely impact, and on predator presence or absence. If you are present in an archipelago for several days, talk to as many local inhabitants, especially coastguards and fishermen, as possible and assemble a short log sheet of useful information to supplement your own observations.

Factors threatening the well-being of breeding seabirds are numerous and include oil pollution, over-exploitation of fish stocks and habitat destruction (e.g. from development or over-grazing of mangroves). These issues will not be discussed further here (but see Evans 1987 for further details).

Human Disturbance

Casual human visits to breeding islands, whether by fishermen or for recreational purposes, can cause significant disturbance to nesting birds even if there is no deliberate interference. Small agile species such as terns respond quickly to intruders but also resettle relatively rapidly although their mobbing response is much reduced and not so persistent compared to closely related species nesting in temperate or Arctic conditions. However, the heat stress on eggs or small chicks exposed during the middle of the day is potentially very damaging. For some larger species, being forced to leave their nests can give sufficient time for predators to steal eggs or chicks. This has been observed in Brown Boobies - in flight they are not very manoeuvrable over land and have difficulty in getting back to their nests, thus allowing Sooty, and possibly also White-eyed Gulls, plenty of time to steal eggs. Once chicks are able to move independently, disturbance may cause them to break cover and walk or run out of their natal territory and they become vulnerable to harassment and sometimes predation by neighbouring conspecifics (observed in Sooty Gulls). Sometimes parents of such displaced chicks may fail to relocate them, or feed them, once they are away from their own nests (reported in the literature for Brown Boobies). In many areas, access to islands is under the control of the local Coastguards; landing may be forbidden except on designated islands where overnight shelters and “temporary” camps are sometimes established. However, rules and regulations are seldom rigidly adhered to, and undesignated islands can often become popular breakfasting and meeting places amongst fishermen; disturbance is caused when they search for firewood etc.

Human Exploitation

This can take one of two forms - collection and consumption of eggs or chicks. Currently the latter does not seem a problem in the Red Sea, though it is, or has been, a traditional activity elsewhere especially at Socotra Cormorant colonies in the Arabian Gulf and off southern Oman. Anecdotal evidence can be collected from local towns, which may indicate if food exploitation is taking place presently or has been in

the past. The collecting of eggs of tropical seabirds, particularly terns, is a widespread phenomenon in the Indian Ocean, Red Sea and Arabian Gulf. Based on experience in the Farasan and Al Wajh archipelagos, Saudi Arabia, it is often difficult to ascertain how deliberate or planned egg collecting is, or whether it is mainly opportunistic. Egg collecting is not restricted to fishermen or local villagers, but can also be carried out by government officials. If egg collecting takes place early in the nesting cycle it may have relatively little impact as the birds have sufficient time to relay. However, repeated collecting may have a severe impact on the distribution and overall breeding success of terns, with long-term consequences at the population level. Egg collectors leave a trail of footprints and these can be separated easily from those of casual visitors, particularly when they move between and around vegetation patches systematically looking for Bridled Tern nests, or they link a chain of empty White-cheeked Tern scrapes.

Introduced Predators

Cats are often deliberately brought to new human settlements, both fishing camps and coastguard stations, on offshore islands to control rodent populations (rats and mice), though some introductions are no doubt accidental from "hidden" ship borne animals. Cats soon become feral and numbers can increase rapidly, with waste human food and garbage acting as a buffer against seasonally fluctuating "natural" food supplies. Sometimes unwanted cats and dogs may be translocated to nearby islands, rather than killing them. The White-tailed Mongoose is also present on some larger Red Sea islands. These small carnivores have been shown to severely affect the breeding success of large species such as Ospreys (Fisher, pers. comm.) and presumably they are the principal factor preventing ground nesting seabirds from using certain islands.

Count Units

Make sure that count units and method are recorded on field sheets or notebooks; the following can be used:

Individuals: usually for non-breeding birds or aerial counts where sub-canopy nest cannot be seen.

Occupied (adult present) or Active (egg or chick present) Nests: either from ground or aerial counts.

Nests: vacated or contents not visible and present breeding status thus indeterminate.

Census Techniques

Aerial Survey

Two approaches can be used in isolation or in combination: direct counts and aerial photography. If sufficient personnel are airborne or if the area to be covered is relatively small, you should aim to do both. Photography is best used if personnel are relatively inexperienced, although learning to make rapid but approximate estimates is a valuable skill to acquire, since films can be lost by developers or may develop poorly (over or under exposed, out of focus). Tally (clicker) counters are very useful and to speed up the process, count in units of 10 or 50 if numbers are large. The present availability of motor drives, rapid autofocus and zoom lenses has made this method very easy and reliable nowadays. Choice of film type, slides versus prints, is not important, though if the latter are used, then print size needs to be somewhat large than standard (i.e. at least 30 x 20 cm). Using a camera that prints date and time onto each shot can save much writing whilst in the air. However you should always record notes of island, sub-section etc. on a film shot log that can be cross-checked with the

recorded route / time log that the pilot or navigator will keep. Once back at base and the films have been developed, procedures for prints versus slides are slightly different.

Prints

Make several good quality photocopies (generally enlargements) and assemble an overlapping mosaic. Sub-divide an island colony into sub-sections drawn on the prints and get each team member to mark nests (cross or circle) with a fine pen. Repeat the exercise several times and use the average count. Remember to include the count unit on your data sheet: individual birds e.g. roosting cormorants; or occupied nests with adults in attendance or eggs or chicks.

Slides

Project them onto large sheets of white paper, where they can be marked in the same way as prints. It is usually more difficult to separate adjacent sub-colonies reliably on slides as they cannot be viewed simultaneously.

Several useful papers review topics such as the comparability of print versus slide media and detailed counts versus estimates (e.g. Reynolds & Booth 1987) and between-observer variability in colony counts for photographs (Harris & Lloyd 1977). Aerial photographs also provide good records of the actual location of colonies on particular islands and how they grow if the population is increasing (e.g. Hill 1989) and can be very useful during subsequent ground visits.

Ground Counts

The main techniques used do not require equipment other than binoculars or telescopes and include: counts from vantage points, flush counts and walk-through counts. More time consuming methods such as belt transects (for terns) and quadrats (for terns and cormorants) require some basic mapping and you will need ropes, tape measures, compass and bamboo canes (or similar) as markers.

Vantage Points

This method requires the presence of dunes or other slightly elevated terrain. Count the number of occupied nests using binoculars or telescope. If the colony is fairly large, split it into sections first using landmarks that you can relocate with ease. Suitably chosen vantage points cause little disturbance but are best used for small to medium sized colonies. Where birds are very densely packed or the colony is very large, sampling procedures will have to be used.

Flush Counts

These can be used when the nesting birds (usually those incubating or with small chicks) rise up reasonably synchronously and fly around above the colony in a relatively compact flock, on approach by a human. It is especially useful for terns in medium to large sized colonies. Always attempt counts, even if you intend to walk into the colony to undertake a nest count. The count unit is of individual birds and the mean of several counts should be recorded. The relationship between the number of birds counted and the number of pairs or nests present varies with the stage of incubation and species. Validation studies need to be conducted if it is necessary to have counts as number of pairs or nests. For example, Bullock & Gomersall (1981) give a conversion factor of 1.5 for temperate nesting Common and Arctic Terns during late incubation in Scotland. In this case, a count of 100 individuals would approximate with 67 nests. Symens & Alsuhaibany (1996) give similar information for White-cheeked and Bridled Terns nesting in the Arabian Gulf, although their precise conversion factors may not be applicable in the RSGA region.

Walk-though Counts
In small to medium sized tern or gull colonies, walk-through counts can be quite effective. Depending on nest density, two or more observers should walk in parallel through a colony counting nests on either side within half the distance between the next person. Tally counters are useful, especially if you are recording clutch sizes or several species in the same colony. If several passes through the colony are needed, then it can be useful to lay a rope through the colony to delimit the area you have covered. On sandy substrates your footprints can also be used to prevent double counting. An alternative technique, which does not require *in situ* counting is as follows: enter the colony with a bag containing a sufficient quantity of counted dry pasta pieces. Place one piece in each nest as proof that it has been counted. Once the colony is finished, subtract the number of remaining pasta pieces from the initial total to get the number of nests. Do not use this method if large numbers of rodents (mice or rats) are present on the island.
Belt Transects
These are best used for species such as White-cheeked Tern and Bridled Tern, which do not nest at extremely high densities. Conduct transects at regular intervals of 500-100 m parallel to the short axis across an island or colony. For each nest found, record species, clutch size and location along the transect. Also record total transect length. Use densities calculated from these data to estimate total populations for each island or colony (see Symens & Evans 1993; Symens & Alsuhaibany 1996).
Quadrats
Both Swift and Lesser Crested Terns nest at extremely high densities and belt transects right through colonies would cause excessive disturbance. Make a light weight frame of rigid wire measuring 1 x 1 m. Lay this carefully down at a selection of locations evenly spread across the colony and count nests. The number of 1 m^2 quadrats done will depend on time available and colony size. Between 10 and 30 should be adequate. While one person or team counts the quadrats, another should draw a map and measure the size of the colony (at least the maximum length and breadth), so that the quadrat density estimates, when averaged, can be extrapolated to the area of the colony. This technique is best done during the incubation period.
Counts of Nest Structures outside the Breeding Season
This method can be used for large Socotra Cormorant colonies and perhaps Swift and Lesser Crested Terns and Brown Boobies, when the colony has been vacated. Nest scrapes, mounds or depressions can be identified and such counts, either complete or sampled by transects or quadrats, may indicate the maximum number of pairs that attempted to breed in the previous season. Symens & Werner (1996) give details and limitations of this technique, but note that heavy rainfall may obliterate much evidence of nesting.

Methodologies for species breeding in RSGA region
Where known, habitats utilised, colony type and nesting season are given in addition to methods. References in bold give detail of methodologies.

Jouanin's Petrel *Bulweria fallax*
A) Area: Socotra and neighbouring islands?
B) Habitat and colony type: Not known.
C) Nesting season: 2 colonies recorded in May 1999.
D) Appropriate methods: None described. 'Tape playback' may be appropriate.

E) Relevant literature: Bradshaw 2000, [see **James & Robertson 1985** for other *Puffinus* species, **Ratcliffe *et al*. 1998** for small petrels].

Persian Shearwater *Puffinus (lherminieri) persicus*
This species possibly nests somewhere in the Gulf of Aden, given it has done on islands off southern Oman.

Red-billed Tropicbird *Phaethon aethereus*
A) Area: Whole RSGA region.
B) Habitat and colony type: Dispersed; holes and crevices in cliffs.
C) Nesting season: Probably April –August, possibly later in Gulf of Aden.
D) Appropriate methods: Direct counts of occupied holes, but usually can only be detected if bird seen entering or departing. Adults flying around cliffs during the probable nesting season may be an indication of local breeding.
E) Relevant literature: Hansbro & Sargeant 2000, Clapham 1964, North 1946.

Masked Booby *Sula dactylatra*
A) Area: Scarce; southern Red Sea, Gulf of Aden.
B) Habitat and colony type: Not well described; rocky islands, possibly use trees on occasions.
C) Nesting season: Summer – autumn?
D) Appropriate methods: Direct count of nests from air, sea or vantage point.
E) Relevant literature: Morris 1962, Newton & al Suhaibany 1996b.

Brown Booby *Sula leucogaster*
A) Area: Widespread, whole RSGA region.
B) Habitat and colony type: Very varied, sandy beaches and islands, under medium sized bushes, open rocky islands, occasionally cliffs.
C) Nesting season: Very variable; possibly a prolonged season commencing in summer in the south but with colonies active until January; in north may start earlier (? April).
D) Appropriate methods: Direct counts of nests from air or vantage point. Do not disturb colony during incubation by walking through it as gulls will rapidly prey upon unguarded eggs.
E) Relevant literature: Newton & al Suhaibany 1996a, Hoath *et al*. 1997, Clapham 1964.

Socotra Cormorant *Phalacrocorax nigrogularis*
A) Area: Islands off Yemen coast in Gulf of Aden.
B) Habitat and colony type: No recent description in Gulf of Aden; usually large dense colonies on sandy or rocky substrate in Arabian Gulf.
C) Nesting season: In Arabian Gulf, September – April with peak laying October – January.
D) Appropriate methods: Direct counts of nests from a distance in colonies of size B – low D. For large colonies, high D – E counts of "apparently occupied nests" from aerial counts.
E) Relevant literature: **Symens & Werner 1996**.

Pink-backed Pelican *Pelecanus rufescens*
A) Area: Southern Red Sea.

B) Habitat and colony type: Usually on top of tall mangroves *Avicennia marina*, occasionally *Rhizopora mucronata*, or lower bushes and exceptionally on the ground.
C) Nesting season: Winter; possibly November – March.
D) Appropriate methods: Direct counts from air or aerial photographs, virtually impossible to see nests from ground or sea level.
E) Relevant literature: **Newton & Symens 1996**.

Little Green Heron *Butorides striatus*
A) Area: Widespread, whole RSGA region.
B) Habitat and colony type: Usually concealed in or under dense vegetation (e.g. mangroves) but also in more isolated thickets of *Euphorbia.* Sometimes under nests of other species (Western Reef Heron, Spoonbill), occasionally in holes and crevices in fossil coral.
C) Nesting season: Spring, probably commencing in March – April.
D) Appropriate methods: None known except through searches of dense vegetation; presence / absence possibly only data that can be gathered.
E) Relevant literature: Newton & al Suhaibany 1996a, Goodman & Meininger 1989.

Cattle Egret *Bubulcus ibis*
A) Area: Southern Red Sea.
B) Habitat and colony type: This species may nest on nearshore islands in tall vegetation; however, it does not utilise the marine environment as a food source.
C) Nesting season: Throughout the year, perhaps dependent on rains.
D) Appropriate methods: Direct nest counts of small colonies; aerial counts for large colonies.
E) Relevant literature: Jennings 1995.

Western Reef Heron *Egretta gularis*
A) Area: Whole RSGA region.
B) Habitat and colony type: Usually small – medium colonies (A-B) in dense vegetation, both mangroves and trees, often sub-canopy; occasionally low cliffs.
C) Nesting season: Spring – summer (March – August).
D) Appropriate methods: None described; thorough searches on foot of suitable habitat on smaller islands.
E) Relevant literature: Jennings 1995, Newton & al Suhaibany 1996a, Goodman & Meininger 1989.

Purple Heron *Ardea purpurea*
A) Area: Local, southern Red Sea.
B) Habitat and colony type: Probably dense mangrove, unlikely to be colonial, cf Jennings 1995.
C) Nesting season: Not known, possibly spring – summer.
D) Appropriate methods: None described, thorough searches necessary to prove breeding. Presence outside winter (April-August) may indicate local breeding.
E) Relevant literature: Jennings 1995.

Goliath Heron *Ardea goliath*
A) Area: Local, whole Red Sea.
B) Habitat and colony type: Usually areas with plenty of mangrove; nests solitarily, sub-canopy or on ground under cover.

C) Nesting season: Probably winter – spring.
D) Appropriate methods: Thorough searches necessary to prove breeding.
E) Relevant literature: Newton & al Suhaibany 1996a.

Spoonbill *Platalea leucorodia*
A) Area: Whole Red Sea, most common in south.
B) Habitat and colony type: Usually smallish colonies (B) on top of dense vegetation, both mangroves and thickets, often associated with Western Reef Heron.
C) Nesting season: Spring – summer.
D) Appropriate methods: Aerial counts, though ground counts feasible if nesting in thickets of medium height shrubs.
E) Relevant literature: Jennings 1995, Newton & al Suhaibany 1996a, Evans 1989.

Osprey *Pandion haliaetus*
A) Area: Widespread whole RSGA region.
B) Habitat and colony type: Usually well-spaced, large nest structure in open situation, all habitats though rarely directly in or on vegetation. Occasionally semi-colonial.
C) Nesting season: Winter (November – April).
D) Appropriate methods: Easily detectable on ground; aerial counts necessary to get meaningful data from whole archipelago.
E) Relevant literature: Jennings 1995, Fisher 1996.

Sooty Falcon *Falco concolor*
A) Area: Scarce, whole length of Red Sea.
B) Habitat and colony type: Variable, crevices or caves, on ground under mangroves.
C) Nesting season: Spring – summer.
D) Appropriate methods: Pairs usually flushed if landings made on island; usually detectable by aerial survey.
E) Relevant literature: Gaucher *et al*. 1995.

Crab Plover *Dromas ardeola*
A) Area: Local along length of Red Sea.
B) Habitat and colony type: Nests underground in burrows; in colonies (B-C) on sandy islands.
C) Nesting season: Summer (commencing May/June).
D) Appropriate methods: Colonies can be quite easy to overlook; direct counts of burrows straightforward but not easy to prove occupancy. If possible, do not walk through colony as burrows very easy to collapse.
E) Relevant literature: Goldspink *et al*. 1995, Nikolaus 1987, Morris 1992.

Kentish Plover *Charadrius alexandrinus*
A) Area: Widespread, probably whole RSGA region.
B) Habitat and colony type: Dispersed nests on open shore just above high water mark in seaweed, flotsam or broken coral rubble.
C) Nesting season: Spring, mostly February – May.
D) Appropriate methods: Nests difficult to find, but adults frequently employ distraction displays which are sufficient proof of breeding.
E) Relevant literature: Jennings 1995.

Sooty Gull *Larus hemprichii*
A) Area: Widespread, probably whole RSGA region.
B) Habitat and colony type: Dispersed or loose colonies on both sandy and rocky islands. Nests usually in shade of rock or small bush.
C) Nesting season: Commences April/May in north, June/July in south.
D) Appropriate methods: Flush counts of adults emerging from nests can be made from air; loose colonies usually small so nests can be counted directly during ground work.
E) Relevant literature: Jennings 1995, Nikolaus 1987, Goodman & Meininger 1989, Newton & al Suhaibany 1996a.

White-eyed Gull *Larus leucophthalmus*
A) Area: Widespread, probably whole of RSGA region.
B) Habitat and colony type: Small colonies (B), often in open sand, occasionally more rocky substrate.
C) Nesting season: Summer, probably commence June in north and July in south.
D) Appropriate methods: As for Sooty Gull.
E) Relevant literature: As for Sooty Gull.

Caspian Tern *Sterna caspia*
A) Area: Widespread but scarce, probably whole of RSGA region.
B) Habitat and colony type: Solitary or dispersed loose colonies, usually fairly open sandy areas. Occasionally nests on mainland coasts, e.g. sandspits.
C) Nesting season: Spring, usually February – April/May.
D) Appropriate methods: Nests can be detected from air if few other species present; otherwise detailed groundwork needed.
E) Relevant literature: Jennings 1995.

Swift and Lesser Crested Tern *Sterna bergii, S. bengalensis*
A) Area: Widespread but local, whole of RSGA region.
B) Habitat and colony type: Large dense colonies of both often side by side; often on edge of larger sandy islands or more centrally on smaller ones.
C) Nesting season: Summer, usually June – August, Swift Terns possibly earlier than Lesser Crested Terns.
D) Appropriate methods: Aerial counts can yield acceptable estimates of numbers of individuals and nests; photographs could be useful for more accurate counts. Otherwise, nest density needs to be measured in sample quadrats or belt transects and extrapolated to measured / estimated area covered by colony.
E) Relevant literature: **Symens & al Suhaibany 1996, Symens & Evans 1993,** Newton & al Suhaibany 1996a, Moore & Balzarotti 1983.

White-cheeked Tern *Sterna repressa*
A) Area: Common and widespread, whole of RSGA region.
B) Habitat and colony type: Usually medium size B – low C colonies, frequently in open sandy areas or coral rubble; may be several discrete sub-colonies even on quite small islands.
C) Nesting season: Summer, usually June – August.
D) Appropriate methods: Often difficult to detect during aerial counts as colonies are amongst larger numbers of Bridled Terns or Brown Noddies. However, the number of nests can usually be counted by two or more observers walking in parallel through a

colony. Care needed not to trample eggs as nests can be quite cryptic. Flush counts of adults attending nests satisfactory if time limited.
E) Relevant literature: As Swift Tern, Simmons 1994.

Bridled Tern *Sterna anaethetus*
A) Area: Common and widespread, whole RSGA region.
B) Habitat and colony type: Colonies often comprise whole islands with moderate to dense vegetation cover. Nests fairly well dispersed under bushes (although there may be more than one nest under any one bush) or small rocky overhangs.
C) Nesting season: Summer, usally May/June – August.
D) Appropriate methods: Numbers of adults flushed from nests can be estimated during aerial counts. On the ground, counts of adults perched on bushes following flushing during the incubation period may give approximation of numbers of pairs. If more detail required, then sample quadrats or belt transects are necessary. Make sure sampling covers the range of vegetation types, bush densities and heights.
E) Relevant literature: As Swift Tern, Sweet 1994.

Sooty Tern *Sterna fuscata*
A) Area: Occasionally recorded breeding in Gulf of Aden on African side.
B) Habitat and colony type: In other parts of the world, nests in the open in very large dense colonies similar to Swift and Lesser Crested Terns. However, colonies in RSGA region probably relatively small.
C) Nesting season: June?
D) Appropriate methods: Detailed methodology given in paper below.
E) Relevant literature: **Ratcliffe *et al*. 1999**.

Saunder's Tern *Sterna saundersi*
A) Area: Widespread but local on Arabian side of Red Sea, apparently scarcer on African side.
B) Habitat and colony type: Small loose colonies (A-B) in sandy areas; may nest on mainland coasts.
C) Nesting season: Spring, first eggs usually April.
D) Appropriate methods: Very seldom detected during aerial surveys; detailed ground work needed to prove presence of nests.
E) Relevant literature: Jennings 1995.

Brown Noddy *Anous stolidus*
A) Area: Widespread, southern Red Sea and Gulf of Aden, usually on islands well offshore (> 20 km).
B) Habitat and colony type: Colonies usually large (C-D) on well-vegetated islands usually covered with *Suaeda fruticosa*; rarely mangrove *Avicennia marina*. Nests sub-canopy on branches of trees or bushes.
C) Nesting season: Probably summer, May – August.
D) Appropriate methods: Several aircraft overpasses usually flush many adults from vegetation, but not known if some adults sit tight. However, aerial counts probably easier to undertake than ground counts where it is very difficult to count nests in dense vegetation. More validation work urgently required on this species.
E) Relevant literature: Moore & Balzarotti 1983, Newton & al Suhaibany 1996a.

DATA ANALYSIS

All field data should be transcribed onto clean sheets as soon as possible after surveys and then entered into Excel spreadsheets on return to your base. Two formats can be used, one covering information on the islands themselves and a second giving bird and nest counts. Suggested formats are provided below.

Island Spreadsheet

The island database lists all background information collected on islands visited. Definitions of habitat variables and other parameters are given below:
No. isles = number of islands included in count unit.
Code No. = sector reference (A-G) followed by unique number.
Size A = 50 - 500m (longest axis); B = 501 – 5,000m (longest axis); C = >5,001m (longest axis).
%Sand = % of island surface (above high water mark) covered by soft substrates: sand, silt, mud, loose soil; includes most land covered in mangroves.
%Rock = % of island surface (above high water mark) with hard substrate: coral rock, volcanic rock, boulders.
%Veg = % of island surface covered by vegetation: mangroves, bushes and shrubs, graminoids.
Veg.Ht 0 = mangrove or sand and rock only; 1 = low bushes (<1m) and graminoids; 2 = tall bushes, shrubs and trees (>1m, but usually 2-3m).
Mangr 0 = none; 1 = 1-33% of surface area covered by mangroves; 2 = 34-66% of surface area covered by mangroves; 3 = 67-100% of surface area covered by mangroves.
Relief 0 = flat; 1 = undulating or some low cliffs or dunes; 2 = relatively mountainous.
Huts = number of fishing camps/shelters present on the island (R = ruins/remains, CGS = coastguard station).
Boats = number of boats on or within 2km of island; primarily refers to fishing boats but also includes dhows, larger vessels and coastguard boats at sea.
ID = location reference used on field maps and recording forms, which may be different from final code number.
Alt.name/Notes = other names for island or nearest named landmark on maps available. Also record other information such as the presence of turtle pits.

An example of an island spreadsheet for a section of the Saudi Arabian Red Sea coast.

Code No.	Name	Northing	Easting	No.isles	Size	%Sand	%Rock	%Veg	Veg.Ht	Mangr	Relief	Date	Huts	Boats	ID	Alt. Name/Notes
B 96	Matbakhayn	17 28	41 47.5	3	1	0	100	0	0	0	1	01-Jun	R		3	
B 97	Wasaliyat S	17 40	41 01.5	1	1	100	0	0	0	0	0	12-Jun			1	
B 98	Wasaliyat N	17 41	41 01.5	1	1	100	0	0	0	0	0	12-Jun			2	
B 99	Sumayr	17 47	41 25.5	1	2	95	5	90	2	0	0	01-Jun			2	
B 100	Zahrat Sumayr	17 49.5	41 10	1	1	95	5	0	0	0	0	12-Jun			3	
B 101	Kutambil	17 53	41 41	1	2	30	70	4	1	0	2	05-Jul			1	
B 102	J. al Aqamah S	18 01.5	41 36	1	1	100	0	0	0	0	0	05-Jul			2	Khawr Wasm
B 103	J. al Aqamah NW	18 03	41 34	1	2	100	0	60	1	0	0	05-Jul	1		3	Khawr Wasm
B 104	J. al Aqamah NE	18 03.5	41 35	1	1	100	0	0	0	0	0	05-Jul			4	Khawr Wasm
B 105	J. Hasr	18 09	41 32	1	2	100	0	50	1	1	0	05-Jul			5	
B 106	J. ad Durayqi	18 16.5	41 29	1	1	100	0	0	0	0	0	05-Jul			6	Khawr Nahud
B 107	Marka	18 14	41 19.5	1	2	100	0	100	2	0	0	01-Jun	1		1	
B 108	Zuqaq E	18 03	41 00	1	1	100	0	0	0	0	0	12-Jun			4	
B 109	Zuqaq SE	18 02	40 57	1	1	100	0	0	0	0	0	12-Jun			5	J. Miraya
B 110	Zuqaq SW	18 01.5	40 49	1	1	50	50	0	0	0	0	12-Jun			6	
B 111	Zuqaq W	18 04	40 47	1	1	95	5	0	0	0	0	12-Jun			7	J. Zuqaq
B 112		18 09	40 49	1	1	100	0	0	0	0	0	12-Jun			8	
B 113		18 14.5	40 53	1	1	100	0	100	2	0	0	29-Jun			9	
B 113A		18 18	40 55	1	1	100	0	0	0	0	0	29-Jun		2		no count
B 114	Al Umm S	18 13	40 43.5	1	1	50	50	0	0	0	0	12-Jun			9	
B 115	Al Umm central	18 15	40 44	1	1	100	0	100	2	0	0	12-Jun			10	
B 116	Al Umm E	18 16	40 45.5	1	1	100	0	100	2	0	0	12-Jun			11	
B 117	Al Umm N	18 16.5	40 44	1	1	100	0	100	2	0	0	12-Jun			12	

Bird Spreadsheet

Separate Excel spreadsheets can be created for aerial and ground counts. An example from an aerial survey of the Saudi Arabian Red Sea coast is given below.

Island Number	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	**Total**
Species																							
Red-billed Tropicbird	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Brown Booby	40	40	200	60	150	40	0	0	3	0	0	300	25	20	0	25	2	160	15	200	50	100	**1430**
Brown Booby Nests	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Pink-backed Pelican	0	0	0	8	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	**10**
Little Green Heron	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Cattle Egret	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Cattle Egret Nest	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Western Reef Heron	0	0	0	1	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	**13**
W.R.H. Nests	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Gray Heron	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Purple Heron	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Goliath Heron	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
Spoonbill	0	0	0	0	0	8	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	**9**
Spoonbill Nests	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**5**
Osprey	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	1	0	0	0	1	**5**
Sooty Falcon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Crab Plover	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Sooty Gull	0	0	0	0	0	60	0	70	0	100	25	0	0	0	0	0	0	0	0	0	0	0	**255**
White-eyed Gull	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	**2**
Gulls	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**10**
Caspian Tern	0	0	0	0	0	0	0	0	6	0	0	0	1	0	0	0	0	0	0	0	2	0	**9**
Swift Tern	10	0	300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**310**
Swift Tern Nests	0	0	200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**200**
Lesser Crested Tern	0	200	300	0	40	0	40	0	0	40	0	300	0	10	0	150	15	0	0	0	0	0	**1095**
L.C.Tern Nests	0	0	300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**300**
White-cheeked Tern	0	0	0	0	0	0	0	0	0	200	120	0	0	0	0	0	0	0	0	0	0	0	**320**
Bridled Tern	0	0	0	200	0	0	0	0	0	0	0	0	0	0	0	0	0	50	0	100	75	150	**575**
Saunder's Little Tern	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Terns	0	0	0	10	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	**15**
Brown Noddy	0	0	0	630	0	0	0	0	0	0	0	400	0	0	15	40	5	20	0	700	500	1000	**3310**

DATA PRESENTATION

The island and bird spreadsheets can be copied into a relational database such as Oracle or Microsoft Access. Linked and composite tables can then be generated and analysed. At the time of writing, software is being developed that will permit plotting of maps in the RSGA region suitably annotated with accurate colony locations overlain with bird population sizes. A prototype map for the Saudi Red Sea is attached to this document.

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