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Protocol for the Monitoring of Mediterranean Lesser Crested Terns (*Thalasseus bengalensis emigrates*)

Delegates are kindly requested to bring their documents to the meeting

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ABSTRACT

Actions and methods are described to monitor the breeding population of the Mediterranean Lesser Crested Tern, which is currently confined to Libya. The aim is providing a tool which will allow a coherent and safe approach to a population of extremely high conservation value, which is potentially vulnerable to many sources of threat, not least monitoring itself. Assessing changes in population size, distribution and breeding success is crucial for conservation. We attempted to gather recent experiences carried out under the RAC-SPA umbrella to produce a document available for further sharing, that may ensure a correct continuation of activities in the next future.

INTRODUCTION

Libya hosts a localized population of Lesser Crested Tern *Thalasseus bengalensis*, a highly social seabird that is not known to nest with regularity anywhere else in the Mediterranean. The whole stock was known to be concentrated at Garah island in the Gulf of Sirt, Libya, which has been visited by ornithologists in less than five years during the entire course of the 20th century. Very few pairs had actually been discovered in Lebanon before the Libyan colonies were found, but they were never confirmed subsequently. Only odd pairs or single breeders paired to other species have sometime been reported from large South European tern colonies.

Three more Lesser Crested Tern breeding sites were found in Libya in recent years, none approaching Garah colony size. Despite their discovery, still Garah concentrates the largest fraction of the global population of what seems to be a Mediterranean endemic (ssp. *emigratus*). It's of utmost importance that monitoring this species goes on with regularity, according to a consistent protocol, without putting the breeding success at risk and storing the data in a safe and accessible form. Because many colonial seabirds, and most notably terns, are prone to suffer from disturbance when they are breeding, studying other natural features at Lesser Crested Terns' breeding sites, and particularly at Garah, should take place in full awareness and respect of this unique avian component, without exposing the colony at any risk. On Garah, all activities that are not specifically addressed to conservation should be discouraged, or evaluated under a particularly strict impact assessment.

Having so much stressed the role of Garah tern colony does not entail that monitoring other breeding sites (and even non-breeding sites) should be dismissed, un-regulated, or considered of little value. In a scenario of priorities, however, a top level should be attributed to Garah only, in order to prevent that a number of secondary actions would dilute what seems most crucial for the conservation of the Mediterranean population of Lesser Crested Tern.

GENERAL REMARKS

Target of monitoring – The main parameters that should routinely be recorded or measured at Lesser Crested Tern known breeding sites are the presence/absence of the colony (or of the chicks), timing of breeding, position of the colony, number of breeding pairs, clutch size, breeding success, and possibly diet composition.

Intensity of monitoring and methods – Not all the parameters above are of the same importance, have the same impact risk, or can be recorded by persons with the same level of experience. The order in which they are listed roughly reflects an increasing effort and experience needed. The monitoring protocol, moreover, cannot be the same for all colonies due to site-specific features. For this reason, recommended actions will be listed here site by site.

¹ cf. Hamza et al. 2007 - Report on census and ringing of Lesser Crested Tern *Sterna bengalensis* in Libya (2-10 August 2007) with a preliminary inventory of Libyan islands. Report to UNEP, EGA and RAC/SPA, 27 pp.; Hamza, Azafzaf & Yahia 2012 - State of knowledge and population trends of the Lesser Crested Tern *Sterna bengalensis emigrata* in the Mediterranean: threats identified and proposed actions for small islands in the Mediterranean, In Yésou, Baccetti & Sultana (Eds.) Ecology and Conservation of Mediterranean Seabirds and other bird species under the Barcelona Convention - Proceedings of the 13th Medmaravis Pan-Mediterranean Symposium, Alghero 2011: 171-177, and references therein.

¹ e.g. Scarton, Valle & Rusticali 2000 - New breeding site of Lesser Crested Tern in Italy. British Birds 93: 448-451.

¹ Carney & Sydeman 1999 -A review of human disturbance effects on nesting colonial waterbirds. Waterbirds 22: 68-79; Beale & Monaghan 2004 -Human disturbance: people as predation- free predators? Journal of Applied Ecology, 41: 335-343.

Frequency of monitoring – Most actions require multiple surveys during the June to August season every year. As a precautionary measure to avoid any possible impact caused by monitoring activities and extra human presence, some activities on Garah should take place every second year. Details and proposed dates are indicated within each action, and summarized in Table 1.

ACTIONS AT BREEDING SITES IN LIBYA

All known colony sites (Garah island, Sabkhat Jeliana in Benghazi and Ulbah/Ftiha islands in the Gulf of Bumbah), if they are occupied, should receive every year at least a visit to assess presence and size of the breeding colony. Data so far available show that the seasonal timing of reproduction differs between Garah and the other sites (c. 7 days earlier at Bumbah and much earlier at Benghazi, where clutches were not synchronous in some years).

For small colonies (up to 50 pairs), such as those at Bumbah, a visit by 1-2 people will allow a direct nest count with less than 5 minutes of disturbance for the adults (count and note first all nests with 2 eggs, then those with one, and eventually the empty nests). Colonies around 100-200 pairs can be best counted using one or two photos, without the need of ropes. Larger colonies require a more composite method, as described below for Garah.



J. Sultana – Breeding colony at Garah, August 2007.

Garah island

1) Surveys from vessel – Targets are determining presence/absence of the colony (or of the chicks), timing of breeding, and position of the colony.

Equipment. Binoculars, digital camera.

Methods. A vessel slowly moving around the island, or along its eastern side, will easily allow to spot the breeders as they from time to time take flight, in a white cloud shape, and land again after several seconds. The colony position can easily be determined by binoculars at take-off or landing. It is useful to wait for several repetitions of this behaviour to exactly fix the colony position on map, and possibly to take photos of the 'cloud' in air to get a rough estimate of the number of birds. If the survey is in August, chicks will probably be visible on the ground, once the colony position has been determined. On very early or very late surveys (June or late August), presence of adults or juveniles grouped on the shoreline or isolated rocks should be assessed.

Timing: the ideal dates for Garah fall around 15 July (for incubating birds, in years when no nest count takes place) and around 10 August (for the chick rearing period, when no ringing takes place i.e. in most years). Whenever the opportunity arises, additional surveys from the sea around 25 June and 25 August would allow a better monitoring of timing of breeding and breeding success, and better planning nest count or ringing dates. We suggest to pay these 2-4 visits always in the mid-morning hours, to avoid any confusion with night roosts.



N. Baccetti – Colony site on cliff edge at Garah, August 2007

2) Ground survey to assess number of breeding pairs and clutch size – Targets are determining the breeding population size (number of nests or pairs), fecundity (clutch size) and timing of breeding according to the nests' contents. Secondary target, only when opportunity arises, collecting diet samples. These three main targets can be achieved simultaneously. This action requires approaching the nesting area and, thus, forcing adults to temporarily leave their nests: to limit the

effect of disturbance, it should take place in the shortest possible time (not exceeding 15 min.) and under ideal weather condition, with an adequate number of operators. We recommend to collect data according to two different methods, by separate teams working at the same time. One person should have the responsibility of checking the exact time when adults are flushed upon operators' arrival, and decide when 15 minutes have passed (setting the alarm clock on a phone can be useful). All the equipment needed should be ready at hand before the adults are flushed; do not bring extra stuff, binoculars etc. at the colony.

Equipment. Tape measure (20m long), digital camera, GPS, notebook, 6-7 ropes (white or colourful strings, c. 10 m long), square frame made of polyethylene irrigation pipe (1x1m, with square angle joints), plastic bags for food remains (one for each participant).

Methods. Two simultaneous actions, described as follows.

Action A) Team of two operators plus one secretary, to determine the colony position, shape and size, as well as the nest density. The secretary takes a good GPS position (waypoint) from the edge of the colony and roughly draws on paper the shape of the area where nests are present; the operators measure the orthogonal diameters of the nesting area (at least two, but it depends on its shape), which the secretary notes on the map using identification letters as appropriate. Done this, the operators gently place the pipe frame on the ground (i.e. on the nests) at least 10 random spots of the colony and count how many nests fall inside each of them¹. The secretary notes each value, asking every time if it refers to the edge (<2m from the perimeter) or centre of the colony. If time allows, the perimeter of the area occupied by active nests can be recorded as a GPS track, slowly walking along the colony edge, provided that accuracy shown by the device is no more than 6 m.



N. Baccetti – Group of chicks on Garah top plateau, August 2007

Action B) Team of two operators only, start with unfolding the ropes on the ground, to roughly delimit counting sectors (ropes do not need to be straight, nor to go exactly from one edge to the other). One operator then takes photos of all parts of the colony, standing out of the edges and making sure that the ropes or any natural landmark are visible and wisely positioned in the monitor. The other operator gently removes all ropes, as soon as one of them has already been passed by the photographer. Do not make too many photos and do not use the same camera during the operation time for purposes other than nest counting, in order to simplify the photo identification process. No later than at the end of the same day, or better within a couple of hours, should photos be examined on a pc monitor and their position identified; only the useful shots should be selected and files conveniently named referring to the map on paper. The nest count can be done on following days, on a large monitor, counting separately 1-egg nests, 2-egg nests, empty scrapes that are recognizable as being nests, and groups of non-incubated (abandoned) eggs, if any. The sum of nests from all photos should be compared to the estimate obtained from nest densities (method A).

All team members during the operation might have the chance of **collecting diet samples** (dry or fresh fishes) when these are casually seen among nests, provided that this does not cause delay to the main activities. Preys can be placed in plastic bags and then examined/processed as soon as possible, away from the colony.

¹ A nest falling exactly under the frame can be counted as 0.5.

Timing. Every second year. The ideal date for the colony size assessment should fall at the end of the incubation period, but before the earliest chicks have hatched. This condition will be found at Garah around 15 July. An earlier survey, as described in point 1), could help choosing the date more precisely and accounting for year to year variation. The colony should be approached in the early morning hours, no later than 9 a.m., with an air temperature lower than 32°C. Keeping adults in flight later in the day (when the sun is higher above horizon and temperature is higher too) would cause a mass death of the egg embryos in a much shorter time than the suggested 15 minutes.



3) Ringing of chicks and estimation of breeding success –

An exceptional action on Garah², with the double target of colour marking a pre-determined number of chicks and assessing their overall number (the latter as a proxy of breeding success). Expert ringers are strictly needed.

Equipment, Required tools are: steel rings, ringing pliers for metal rings, PVC

colour rings, circlip pliers (to remove metal rings if needed and to put colour rings), a cloth or net fence to temporarily trap the chicks, to be fixed on ground by poles/sticks set at regular intervals, field ringing forms for data storing, small plastic bags to collect regurgitated/dry fishes found in the colony.

Methods. Five phases can be identified.

Phase A) Planning the ringing session. Ringing should be performed by teams of 4-6 people including at least two ringers, with proved expertise on colonial terns/gulls monitoring and colour-ringing. A very detailed planning of the fieldwork has to be agreed upon and shared before entering the colony; all participants must accept it and understand their own roles. The fieldwork and the role of each participant must be clearly stated set for all operations, including: colony approach, capture of the chicks, ringing and departure from the ringing site. A table will be useful to preliminarily list the names of all participants, to facilitate the choice of each one's role according to his/her experience. The overall number of people to be involved should be decided in this initial phase, according to the desired number of chicks to be marked with colour-rings. Basing on previous experiences, each team can ring, measure and release c. 50 birds in 30 minutes, which is the maximum suggested duration of ringing visits (from first disturbance of the colony to departure from the colony site).

² We do not feel advisable to continue this activity in what is the main colony in the world, unless for a very limited number of events that are needed to complete the past actions and having a representative dataset.

Phase B) Catching. A fence (approx. 2 m diameter) is set in a place close to the colony and, as soon as it is ready, chicks are herded to it and trapped. Chicks, which tend to group together when approached, must be guided to the enclosure by a group of coordinated people walking slowly behind them. If only a part of the chicks are caught, chicks outside the fence must be guided to an area where they are not disturbed by ringing operations and where they are clearly visible by flying adults. One person must remain all the time at the enclosure (once the chicks are in) to look after them and hand them to the ringing teams.

Phase C) Ringing. Two or three independent teams, each one composed by one metal ringer, one PVC ringer, one secretary and two people bringing chicks from the fence to the ringers (carriers). If measurements or blood/feather samples are needed, an additional person is required. Carriers must individually bring the chick from the fence to the ringers and then release it out of the ringing area, allowing it to escape in the appropriate direction to join again the rest of the nursery. The secretary (one for each team) should clearly write on a form the number of metal ring, the number of associated PVC ring and its reading sense once it has been put on the chick tarsus (i.e. from top to bottom or vice versa). He/she should also double-check that rings are used in the appropriate sequences and supervise the ringing process of the team. At the end of ringing, all researchers must quickly collect all equipment and leave the area.

Phase D) Breeding success. During capture of chicks, one or two persons should count as precisely as possible all chicks, which sometimes split in different small groups, and taking pictures as complete as possible to be later used to double-check the number of chicks. These persons should be chosen in advance, before entering the colony, and should be aware of their role.

Phase E) Diet samples. During ringing, or after chicks have been released, people might have the chance of collecting diet samples (dry or freshly-regurgitated fishes). These must be collected and placed in paper bags and then examined/processed as soon as possible, away from the colony.

Timing. The visit must be performed in the early morning hours, to reduce the risks of overheating of chicks. Since chicks must be large enough to bear rings and run easily, under normal conditions ringing should take place around 10 August.



4) Breeding success, post fledging assessment - If a proper count of chicks has been made during ringing, then the number of live and dead chicks on a later date, possibly separating those with rings from those without ring, allows a rough calculation of breeding success.

Methods. If juveniles are grouped away from the colony, and hardly any incubating birds are sitting in the nests (e.g. late clutches), then the colony site can be explored on foot to count unfertilized/lost eggs, dead chicks (separating marked and unmarked ones) and to collect colour rings of dead chicks and prey items. Rings (colour and metal) on dead chicks must be removed and securely stored, to be later written down away from the colony. If removal is too difficult, all dead ringed chicks must be collected and rings later removed and written down. A typical session involves four people: two of them must concentrate on ring-reading (see detailed description at point 5 for Ulbah island), the remaining two people must scan the colony for colour rings, as previously described at point 2, method B.

Timing. These activities can be performed during a visit around 25 August.

5) Ring monitoring – Ring-reading on breeding adults and unfledged chicks can hardly be performed on the colony of Garah, and – if attempted - will likely impact to a large extent the local breeding population. As a rule, it should be avoided here. Rings on individuals roosting on nearby rocks can be approached and read with no problems. Detailed ring-reading methods are described for Ulbah island.



Ftiha Island

1) Surveys from vessel – Same targets as for Garah.

Equipment. Same as at Garah.

Methods. Same as at Garah.

Timing: the ideal dates fall around 1 July (for incubating birds, in years when no nest count takes place) and around 25 July (for the chick rearing period, when no ringing takes place i.e. in most years). Whenever the opportunity arises, additional surveys around 10 June and 15 August would allow a better monitoring of timing of breeding and breeding success, and better planning nest count or ringing dates. We suggest to pay these 2-4 visits always in the mid-morning hours, to avoid any confusion with night roosts.

2) Ground survey to assess number of breeding pairs and clutch size – Same target as for Garah.

Equipment. Same as at Garah.

Methods. Same as at Garah.

Timing. Every year, if the outcomes of previous surveys do not suggest to reduce the study efforts (e.g. due to excessive disturbance). The ideal date for the colony size assessment should fall at the end of the incubation period, but before the earliest chicks have hatched. An earlier survey, as described under point 1), could help choosing the date more precisely and accounting for year to year variation. The colony should be approached in the early morning hours, not later than 9 a.m., with an air temperature lower than 32°C. Keeping adults in flight later in the day (when the sun is higher above the horizon) and when the temperature is also higher would cause a mass death of the egg embryos in a much shorter time than the suggested 15 minutes.

3) Ringing of chicks and estimation of breeding success – Target is the of colour marking a pre-determined number of chicks and assessing their overall number (the latter as a proxy of breeding success). Expert ringers are strictly needed.

Equipment. Same as at Garah.

Methods. Same as at Garah; thick cardboard boxes might be necessary to keep/transfer small numbers of chicks.

Timing. The visit must be performed in the early morning hours, to reduce the risks of overheating of chicks. Since chicks must be large enough, ringing should take place around 25 July.

4) Breeding success, post fledging assessment - If a proper count of chicks had been made during ringing, then the number of live and dead chicks at a later date, possibly separating those with and those without rings, allows the calculation of breeding success.

Methods. Same as at Garah.

Timing. These activities can be performed during a visit around 15 August.

5) Ring monitoring – Ring-reading on breeding adults and juveniles can hardly be performed at Ftiha, and – if performed - would likely to impact to a large extent on the local breeding population. As a rule it should be avoided here.

Ulbah island

1) Surveys from vessel – This kind of survey seems unnecessary at this site, since the features of the island allow a more detailed survey (ground survey, see point 2) without disturbance to the local breeders. Hence it can be skipped from planning, unless technical constraints make it the sole available option of gathering data on the presence/absence of the colony.

2) Ground survey to assess number of breeding pairs and clutch size – Same target as for Garah.

Equipment. Same as at Garah.

Methods. Same as at Garah.

Timing. Every year, if the outcomes of previous surveys do not suggest to reduce the study efforts (e.g. due to excessive disturbance). The ideal date for the colony size assessment should fall at the end of the incubation period, but before the earliest chicks have hatched (1 July). An earlier survey (around 10 June) could help choosing the date more precisely, also accounting for year to year variation. The colony should be approached in the early morning hours, not later than 9 a.m., with an air temperature lower than 32°C. Keeping adults in flight later in the day (when the sun is higher above the horizon) and when the temperature is also higher would cause a mass death of the egg embryos in a much shorter time than the suggested 15 minutes.

3) Ringing of chicks and estimation of breeding success – Target is the colour



marking of a pre-determined number of chicks and assessing their overall number (the latter as a proxy of breeding success). Expert ringers are strictly needed.

Equipment. Same as at Garah.

Methods. Same as at Garah; thick cardboard boxes might be necessary to keep/transfer small numbers of chicks.



Timing. The visit must be performed in the early morning hours, to reduce the risks of overheating of chicks. Since chicks must be large enough, ringing should take place around 25 July.

4) Breeding success, post fledging assessment - If a proper count of chicks has been made during ringing, then the number of live and dead chicks on a later date, possibly separating those with rings from those without ring, allows a rough calculation of breeding success.

Methods. Same as at Garah.

Timing. These activities can be performed during a visit around 15 August.

5) Ring monitoring – Ring-reading on breeding adults and juveniles can give useful information of site-fidelity, longevity of local breeders and on breeding success of juveniles.

Equipment. Telescope, binoculars.

Methods. The site where adults or juveniles are resting (either the colony or a nearby resting place) must be slowly approached, without flushing the birds. If birds are disturbed, then the team (two people, one who reads colour-rings, one who writes and counts/checks the distribution and movements of birds with binoculars) should move back and try again when birds have settled on the ground. A typical ring-reading session involves scanning all visible individuals, attributing them to one of the following categories: no ring, unknown (tarsus not visible), with ring. Rings must be read as soon as they are first seen, writing colour, code, reading direction of the code (upwards or downwards), age of bird and, for adults, indicating whether they were observed inside the colony or at a nearby roosting place. Time (hours, min) must be written for each reading session. Ideally, after some repeats at a given place, the observers should move to check for other parts of the colony/roost which were not visible before. During these activities, the second observer should count all visible individuals (adults/juveniles) from time to time, to assess their maximum number.

Timing. The visit must be performed in the early morning hours, to increase visibility and reading of rings and to reduce heat stress to eggs/chicks if adults temporarily move away from their nests.. Any hint of disturbance to the colony, especially when eggs or small chicks are present, should cause the interruption of the ring monitoring after 15-20 minutes. If availability of boats and people allows, several visits could be planned at various stages of the breeding season.



Julyanah lagoon

1) Surveys from vessel – This survey must not be performed here (must be avoided). The colony lies on a small islet (enlarged in April 2012) inside the Julyanah lake, which can be fully checked from the border of the lake. Since 2012 terns also breed at a former peninsula on the western shore, isolated from the mainland by a narrow channel. Telescope observations (same as in point 5: Ring monitoring) must replace this action.



2) Ground survey to assess number of breeding pairs and clutch size – Same target as for Garah.

Equipment. Camera, notebook, plastic bags for food remains.

Methods. Similar to Garah, but with 4 people maximum, approaching the islet on a small rowing boat. The colony occupies all the islet, which is very small and cannot be safely walked through. People must remain in the water close to the

border, taking pictures and counting from there.

Timing. Every year, if the outcomes of previous surveys do not suggest to reduce the study efforts (e.g. due to excessive disturbance). The ideal date for the colony size assessment should fall at the end of the incubation period (around 10 June), but before the earliest chicks have hatched. A survey around 25 May, could help choosing the date more precisely and accounting for year to year variation. It must be stressed that birds at this site may lay non-synchronous clutches. Repeated surveys from early June to late July may allow to identify the exact timing of reproduction, hence allowing a proper planning of the ringing activity.

3) Ringing of chicks and estimation of breeding success – Target is the of colour marking a pre-determined sample of the chicks and assessing their overall number (the latter as a proxy of breeding success). Expert ringers are strictly needed.

Equipment. Same as at Garah; thick cardboard boxes might be necessary to keep/transfer small numbers of chicks.

Methods. Same as above. Only one ringing group can be organised. Chicks must be caught and released on site after marking.

Timing. The visit must be performed in the early morning hours, to reduce the risks of overheating of chicks. Since chicks must be large enough, ringing should take place around 25 July, when the youngest chicks will be of suitable age for ringing.

4) Breeding success, post fledging assessment - If a proper count of chicks had been made during ringing, then the number of live and dead chicks at later dates, possibly separating those with and those without rings, allows the calculation of breeding success.

Equipment. Same as at Garah.

Methods. Same as for ground survey (see point 2).

Timing. These activities can be performed during the visit around 15 August.

5) Ring monitoring –Ring-reading on breeding adults and juveniles can give useful information of site-fidelity, longevity of local breeders and on breeding success of juveniles.

Equipment. Telescope, binoculars.

Methods. The colony site can be monitored from the border of the lake without disturbance to adults and juveniles. Apart for this, methods are those already described for Ulbah colony.

Timing. The visit must be performed in the early morning hours, to increase visibility and reading of rings. Given the favourable location of this colony, several visits should be planned along the breeding season.



J. Sultana – Adult and ringed chick at Garah, August 2007.

OTHER ACTIONS: PROSPECTING POTENTIAL BREEDING SITES

All Libyan islands where breeding Lesser Crested Terns have never been recorded should be visited at least every second year, between 1 and 31 July, in order to assess presence/absence of a colony. Should any new site be occupied irregularly (as it happened on Ftiha after it hosted no pairs for more than one season), this should be added to those to be visited every year. Coastal lagoons where deep waters are present in summer (Farwa - including Qattayah island, El Thama, Ayn Zayana and Al Kuz, where a small islet is present at its Eastern end) should be monitored too. A list of all Libyan wetlands and islands, with the respective coordinates, is available on the recently published Atlas of Wintering Waterbirds of Libya (pp 35-41). Coverage of western and eastern sites can, of course, fall in alternate years, in order to reduce the simultaneous workload. A similar activity is highly recommended also for Tunisian islands along the east coast, and contacts should be arranged in order to achieve a regular coverage of Nakhl island in Lebanon.

OTHER ACTIONS: MONITORING STOPOVER SITES AND WINTER QUARTERS

Very little is known about stopover sites, migration routes and winter quarters. Ringing of Libyan chicks has so far determined a few scattered winter records from W Africa, and – more interestingly – regular reports from the Strait of Gibraltar area (African Side), where a migratory bottleneck seems to exist. Contacts should be searched in the Tarifa area for a coordinated monitoring aiming not just at reading rings, but also at identifying roosting sites, obtaining consecutive seasonal counts and assessing ring frequencies.

PLANNING NON-ORNITHOLOGICAL MONITORING ON GARAH

On Garah island, all activities that are not specifically addressed to conservation should be discouraged, or evaluated under particularly strict impact assessment. Monitoring and studying other natural features of this island should take place in full awareness and respect of the avian component, without causing risk to the colony. Botanical, geological as well as archaeological surveys, invertebrate monitoring, bird censuses not addressed to terns, should be organized when the colony is absent, i.e. from mid-September to the end of May. Should any survey be necessarily made in the period when terns are present, one experienced ornithologist should be included in the team, to prevent such activities from causing disturbance to the colony.

DATA STORING AND EVALUATION BY AN ADVISORY PANEL

No less important than field methods, a person and an organisation in charge of safely storing all collected data should be appointed and his tasks made clear. These should not just include safe data storage, but also data processing, feedback about future monitoring and site conservation, dissemination of knowledge. Research/monitoring activities, on Garah especially, that differ from those considered by the present document should of course remain possible. In such cases, an advisory panel (formed, e.g., by three team members of the former expeditions, a EGA representative, a RACSPA representative, one expert Mediterranean seabird biologist, one expert Red Sea seabird biologist and one Sandwich Tern specialist) should be created and involved in decision on issues that are out of this protocol, upon presentation of detailed projects.

Island	(1) Survey from vessel	(2) Ground survey	(3) Ringing	(4) Post-fledging breeding success	(5) Ring reading	Diet samples
Garah	✓	✓ every 2 years	(X)	✓	(X)	✓
Ftiha	✓	✓	✓	✓	X	✓
Ulbah	X	✓	✓	✓	✓	✓
Julianah	X	✓	✓	✓	✓	✓

Numbers refer to paragraphs in the text

Table 1 - Suggested actions at the known breeding sites.



APPENDIX 1 - RINGING AND RING MONITORING

Marking birds with rings bearing a unique alphanumeric code allows several ecological data to be gathered during the lifespan of individuals, i.e.: migration route and timing; migration strategy; fidelity to breeding/natal sites or other areas; longevity, provided that birds are caught again, found dead or observed after marking. Ringing does not provide, on the other hand, useful data to assess the size of the studied population or colony. In long-lived seabirds, such as the Lesser Crested Tern (closely-related Sandwich Tern *Thalasseus sandvicensis* and most *Sternidae* species can reach an age of 30 years or more), the use of an additional plastic colour ring with a unique alphanumeric code which can be read with telescope or from digital photos largely increases the 'recapture' rate, allowing more data to be collected with less disturbance to birds. To maximize the outcome of this activity and in consideration of the possible impacts of a ringing operation on a colony site, ringing with metal rings only should best be avoided.

Summary of previous ringing activities (2006-2012)

In 2006-2012, around 1350 chicks and 2 adults of LCT were ringed at the main known breeding colonies: Garah and Ulbah islands, and Sebkhat Julyanah. Most of these birds were marked with colour-rings (white, blue and black with 2/3-digits codes). Sightings and finding of dead marked birds confirmed the hypothesized migration route and non-breeding distribution of Libyan breeders, which mostly move to the Atlantic coast of Africa after the breeding season. At present the southernmost known staging area of a Libyan marked bird is Sierra Leone. The few sightings at the breeding colonies – in seasons following that of ringing - suggest a certain degree of philopatry to natal colonies, but more reading efforts are needed to improve the quality of the data.



Recovery sites of Libyan-ringed Lesser Crested Terns

What to ring and when

Ringing operations should concentrate on yearlings, to minimize the disturbance to breeding adults. Catching and ringing of juveniles should take place when their legs are long enough to bear a colour ring without disturbance, i.e. approximately at the age of 7-20 days. At this age they are usually also strong enough to tolerate a moderate overheating consequent to adults taking-off on human approach. Their strongly developed crèching behaviour (much higher than in Sandwich Tern and comparable to Slender-billed Gull *Chroicocephalus genei*) will allow herding them – or part of them - to a conveniently built enclosure where they can be easily caught. At sites where assessing chick development from the distance is not possible, date of ringing should be chosen using dates of previous years as a reference. Wherever possible, repeated observations from the distance should allow the best date to be chosen. Ringing should not take place in adverse weather conditions (strong wind, rain). The central hours of the day should also be avoided, to reduce heat-induced stress to chicks.

Plastic rings

Colour rings with inscribed alphanumeric codes must be made of special acrylic material, very strong, UV-resistant and unaffected by temperature changes. The best material so far available, used in Libya since the start of activities, is PMMA (poly-methyl-methacrylate). Engravings on the rings must be neat, so that codes can be read without confusion even from the distance. Letters and numbers forming the codes must be chosen as to reduce confusion (e.g. choose between pair of similar letters: P and R, O and zero, G and C...). Codes only composed by letters which can be read either upwards and downwards (e.g. O, H, N, S, Z, X...) should be discarded. It should be preliminarily checked that the chosen codes allow enough rings to be produced to cover the whole study requirements. It is always convenient alternating code orientation (up or down) during usage.



Ring reading

Rings are usually read with telescope or from digital photos. Birds must be standing out of the water, on bare soil, rocks or other perches. Reading rings in a colony is usually difficult (because of vegetation or density of neighbour breeders obstructing the view), and it is often convenient searching for rings on off-duty birds, that often gather in the immediate surroundings of a colony. Every ring that is read through the telescope should be immediately noted on paper (colour and code), and immediately double checked. Additional elements to be recorded are leg (left or right), direction of reading (up or down), age of the bird, behaviour (in particular, breeding or not).



Colour-ringed Lesser Crested Terns from Libyan colonies, stopping-over at the Gibraltar strait.

Left: black FH ↓, Ceuta (Spain); middle: white D04 ↑ Ceuta; bottom: white D66 ↑ Tarifa (Spain).



