

Population Trend, Colony Size and Distribution of Little Terns in the Lagoon of Venice (Italy) between 1989 and 2003

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Abstract.—Between 1989 and 2003 colonies of Little Terns (*Sterna albifrons*) occurring in the lagoon of Venice (55,000 ha; Italy) have been surveyed. Each year the number of breeding pairs ranged between 31 (in 1997) and 611 (in 1995), with a yearly mean of 205 (SD = ±163). An overall stability in breeding numbers was observed, with an increase from 1989 to 1995 and a decrease afterwards. 34 sites were used; 13 (38%) were saltmarsh islets, twelve (35%) dredge islands, four (12%) beaches and the remaining five (15%) artificial beaches. Colony size median ranged between 25 and 15 pairs, with no differences among site typology. Sites used each year ranged between one and twelve, with a mean of 4.7 ± 3.0 sites. Turn over rate was high, 60%, and it did not vary significantly among colony sites type. Larger colonies were not more stable than smaller ones. Despite historically breeding at both beaches and saltmarshes, over the 15 years of study a shift in colony sites from beaches to saltmarshes and from these to dredge islands has been documented. Dredge islands, taken as a whole, were over the last years the most important breeding site in the entire lagoon. Received 01 September 2006, accepted 20 September 2007.

Key words.—Little Tern, breeding site, lagoon of Venice, dredge islands, saltmarshes, beaches.

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The Little Tern (*Sterna albifrons*) is nowadays considered a Species of European Concern (SPEC) 3 species, with the status of “declining” throughout Europe (BirdLife 2004) and an European population small, between 35,000 and 55,000 pairs. In Italy about 2,500-6000 pairs were estimated to occur by the same authors; nevertheless, more recently Brichetti and Fracasso (2006) reduce the estimate to only 2,000-3,500 pairs.

This species has been often the subject of monitoring plans or studies; particularly along the Mediterranean, several authors have dealt with this species (see Oro *et al.* 2004 for a detailed review). Nevertheless, analysis of the breeding population trend and of some nesting characteristics less commonly have included a long, continuous series of years; among these, the most interesting works are those of Fasola and Canova (1996) and Sadoul *et al.* (1996).

Nevertheless, no detailed data seems available for a long period about colony site turn over, shifts from one breeding habitat to another, use of man made structures. For a species like Little Tern, which normally exhibits dramatic interannual fluctuations in numbers of breeding pairs and breeding sites, only the results of annual censuses performed over a long time may describe with accuracy several aspects of its breeding biology.

We present here the results of a 15-year-long survey which dealt with Little Terns breeding in the lagoon of Venice, Italy, with particular emphasis on population trend, colony site turn over and use of new available habitat.

STUDY AREA AND METHODS

The Venice Lagoon is a large (550 km²) shallow coastal lagoon located on the north-eastern coast of the Adriatic Sea (with its centre at about lat 45°N, long 12°E; Fig. 1). There are two barrier islands which separate the lagoon from the sea and water is exchanged through three large inlets. One of this barrier island, where only a one km beach occurred until the nineties, was provided with an artificial beach nine-km long and about 80 m wide through artificial nourishment. These are the only beaches existing in the lagoon, apart from just one tidal sand bar located inside the northern lagoon.

Most of the lagoon area is occupied by an open water body (about 400 km²) which is partially vegetated by macroalgae and seagrasses. The mean depth of the lagoon is 1.1 m and the tidal range during spring tides is about one meter, 0.6 m being the mean range. There are extensive intertidal salt marshes, with hundreds of muddy islets, especially in the south-western and northern portions of the lagoon. Dominant marsh species include *Limonium narbonense*, *Salicornia veneta*, *Sarcocornia fruticosa*, *Atriplex portulacoides*, *Puccinellia palustris*, *Spartina maritima* and *Juncus maritimus*.

About 10,000 ha along the western part of the lagoon are occupied by fish-farms, privately owned and completely surrounded by dikes. A new feature of the open lagoon are dredge islands. From 1988 to 2003, 57 dredge islands have been created, ranging in size from 0.4 to 57.4 ha, with a mean of 10.5 ha and a total area of about 600 ha. They are built making containment cells by using

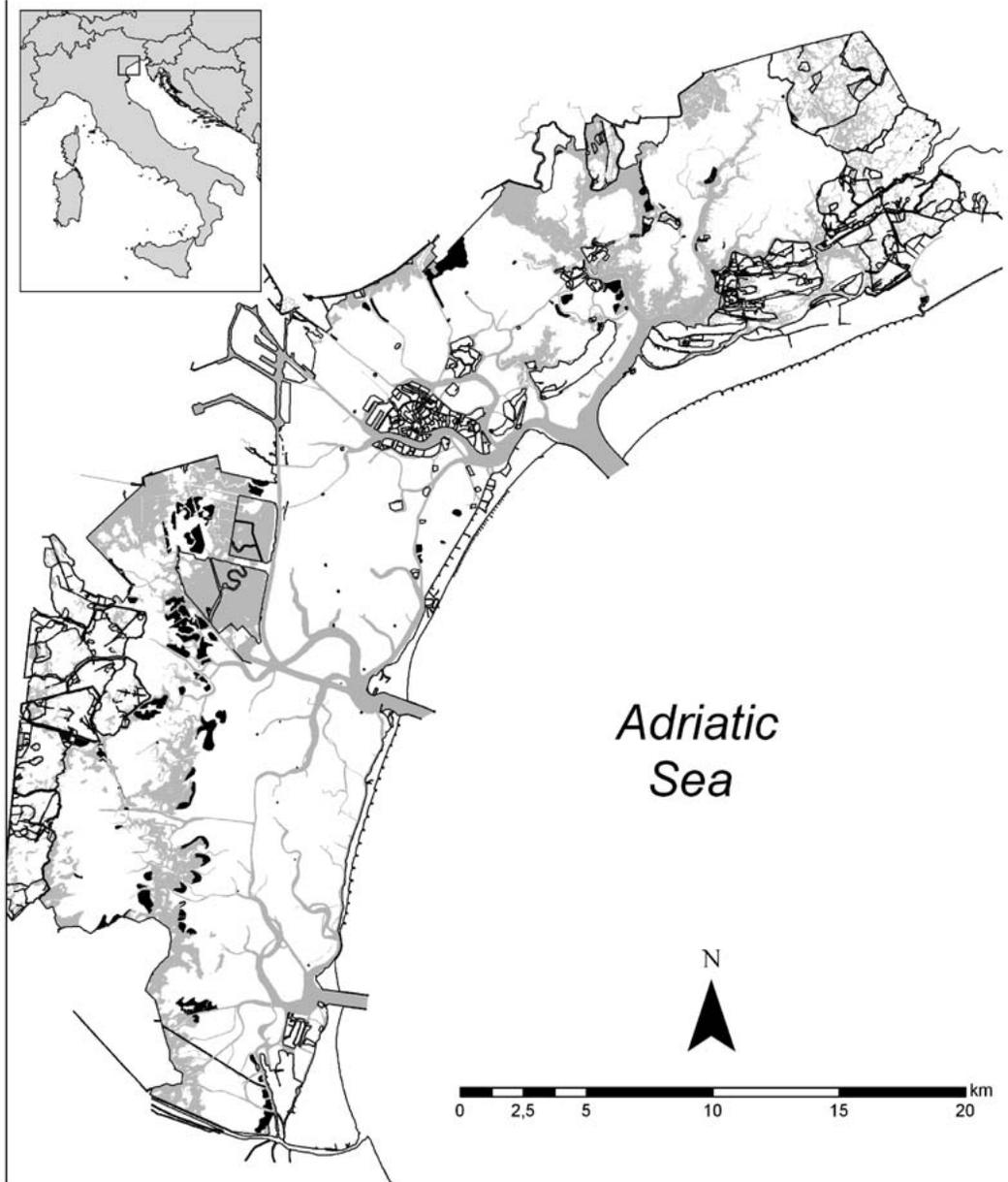


Figure 1. Lagoon of Venice, with saltmarshes in light grey and dredge island in black.

wooden piles and a hydraulic net to contain the mud and to reduce turbidity (Cecconi 2005). The substrate of the islands is usually composed of clay-silty sediments, but some islands have a prevalence of silty-sand or pure sand; all the sediments come from dredging operations. Elevation of the dredge islands is most of the time around 0.5 m above sea level, which means they are flooded during high tides; nevertheless, some dredge islands are, entirely or for a large part of their area, completely above that level, which means they are rarely or never inundated. Vegetation cover of dredge islands, mostly due to halophytic vegetation, in 2003 ranged between 10 and 90%, depending on the age of each site (Scarton 2005).

The Venice lagoon regularly hosts significant breeding populations, at a national or Mediterranean level, of several seabirds: Common Tern (*Sterna hirundo*), Sandwich Tern (*Sterna sandvicensis*; often the largest Italian population), Little Tern and Black-headed Gull (*Larus ridibundus*) (Scarton *et al.* 1993; Scarton 2004). All of these species have been regularly monitored during the breeding season since 1989, both in the open lagoon and along barrier islands; data for the fish-farms, where access is limited, are extremely scarce and will not be considered here.

Each year, all the lagoon was visited by boat, looking for new colonies; barrier islands were visited on foot. Each colony was visited at least twice, but mostly three

times, during the breeding season (May-August) by the same observers, which counted all the nests with eggs and/or chicks; only the peak value was considered for each colony, and number of breeding pairs was considered the same as counted nests. Site abandonment and settlement on new sites during the same year did occur, but not frequently. At saltmarsh islets used by Little Tern, other colonial species frequently occur: Common Tern, Sandwich Tern, Black-headed Gull, Pied Avocet (*Recurvirostra avosetta*), Black-winged Stilt (*Himantopus himantopus*), Common Redshank (*Tringa totanus*, which may nest in colonies in the lagoon of Venice (Hale *et al.* 2005). At dredge islands Common Terns were only occasionally recorded, whereas European Oystercatchers (*Haematopus ostralegus*), Kentish Plovers (*Chavardrius alexandrinus*) and Yellow-legged Gulls (*Larus michahellis*) were commonly found. Beaches, both natural and man-made, hosted far less species, usually only Kentish Plovers and/or Oystercatchers.

In this paper, "colony" is a group of at least two pairs using a "site" (saltmarsh islet, dredge island, etc.); "natural" sites are saltmarsh islets and beaches, whereas "artificial" sites are dredge islands and artificial beaches. Colony turnover is expressed as in Buckley and Buckley (2000), as a percentage ranging between 0% (no new sites used from one year to the following) and 100% (all sites of the second year were new). Mean annual population change (λ) was calculated as: $\lambda = (N_{t+1}/N_t)^{1/T}$, where N_t is the local colony size at time t , N_{t+1} is the locale estimated colony size at time $t+1$, and T the number of years between t and $t+1$. Trends were analyzed using the Pearson correlation coefficient with the log of pair numbers for each year; both statistics are as in Oro *et al.* (2004).

RESULTS

The number of breeding pairs over the 15 years of study ranged between 31 (in 1997) and 611 (in 1995), with a yearly mean of 205 (SD = ± 163 ; Fig. 2). Over the 15 years, the breeding population showed two distinct phases; from 1989 to 1995 the population grew at a mean rate of +15% per year, whereas from that year to 2003 it decreased at a mean rate of -21%. Nevertheless, if the whole study period is considered, the population may be considered as stable, the slight increase being not statistically significant ($r_s = 0.036$, $P > 0.05$). One important feature of the population trend is that between two following years there were marked increases (up to 885%) or decreases (-65%).

Over the 1989-2003 period, 34 sites were used at least once by Little Tern; 13 (38%) of these were saltmarsh islets, twelve (35%) dredge islands, four (12%) beaches and the remaining five (15%) artificial beaches. Sites used each year ranged between one and twelve, with a mean of 4.7 ± 3.0 sites. Number

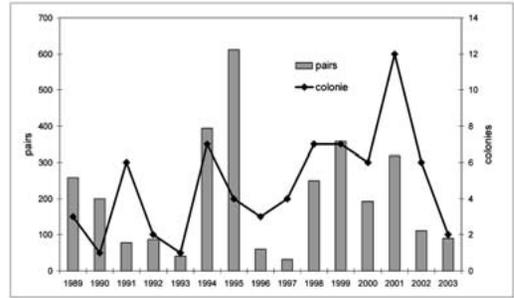


Figure 2. Breeding pairs (bars) and colonies (line) of Little Terns in the lagoon of Venice.

of sites increased with the time and with total yearly breeding population, but the relationship was not statistically significant ($r_s = 0.45$ and 0.38 , $P > 0.05$ in both cases).

Site fidelity was extremely low, with 29 sites (85%) being used only in one or two years; only three sites were used five or more years. As a consequence, mean turnover rate was high, being 59.6%, and it ranged between 33% and 100%. Despite an apparent increase of the turnover rate through the years, this was not significant ($r_s = 0.21$, $P > 0.05$). Mean size of colonies using a specific site increased with the number of years that site was used, but with no significant correlation (Fig. 3). Considering these mean colony sizes, they were divided into "small" (i.e., less than 25 pairs) and "large" (more than 25 pairs) colonies; there were not significant differences in number of years of occupancy among the two groups (Mann-Whitney U-test; $z = 0.51$, $P > 0.05$).

Mean occupancy years varied between 4.2 for natural beaches, 2.1 for saltmarsh islets, 1.8 for artificial beaches and 1.5 for dredge islands; these differences were not

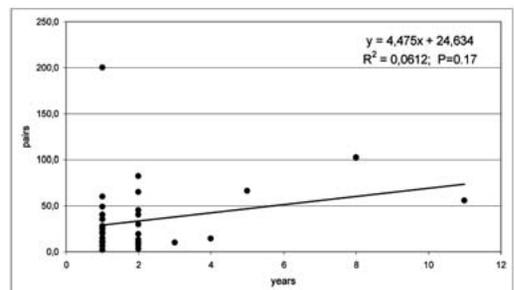


Figure 3. Mean colony size and years of occupancy for 34 Little Terns breeding sites between 1989 and 2003.

significant (ANOVA Kruskal-Wallis, $\chi_3 = 1.78$, $P > 0.05$).

Over the whole period, 71 colonies were found and 3,078 pairs censused; colony size had a median of 20 pairs (mean \pm SD = 43.4 ± 70.1), with a minimum of two and a maximum of 481 pairs. The large majority of the colonies had less than 50 pairs (58; 82%), with only seven colonies (10%) having more than 100 pairs. Mean colony size decreased with time, but the trend was not significant ($r_s = 0.44$, $P > 0.05$).

Considering site typology, 27 colonies out of 71 (i.e., 38%, accounting for the 27% of the pairs breeding over the 15 years) were located on saltmarsh islets; 18 colonies (25% and 26%, respectively) on dredge islands; 17 colonies (24% and 24%) on beaches and only nine colonies (13% and 5%) on artificial beach (Fig. 4). The importance of man made sites (dredge islands + artificial beaches) as nesting places has been increasing over the last years; between 2001 and 2003, percentage of birds nesting at artificial sites increased from 44% up to 90% of the total. The size of colonies found at saltmarsh islets had a median of 25 pairs; for dredge islands 28 pairs, for beaches 18 pairs and for artificial beaches 15 pairs; these difference were not statistically significant (ANOVA Kruskal-Wallis, $\chi_3 = 1.30$, $P > 0.05$).

DISCUSSION

The lagoon of Venice hosted over the whole study period a breeding population of about 200 Little Tern pairs, decreased to about 170 pairs during the last three years of the census (2001-2003); this represents between 2 and 8% of the most recent estimates for the Italian population. The increase observed in the first half of the nineties and the subsequent decrease agrees with the overall trend for Europe (BirdLife 2004).

Dramatic fluctuations among years were observed, as is typical for this species (Fasola *et al.* 1993; Sadoul *et al.* 1996; Ratcliffe *et al.* 2000; Cramm and Muselet 2004; Oro *et al.* 2004). This makes short period census, i.e. less than three years, to be of very little value for conservation or management purposes.

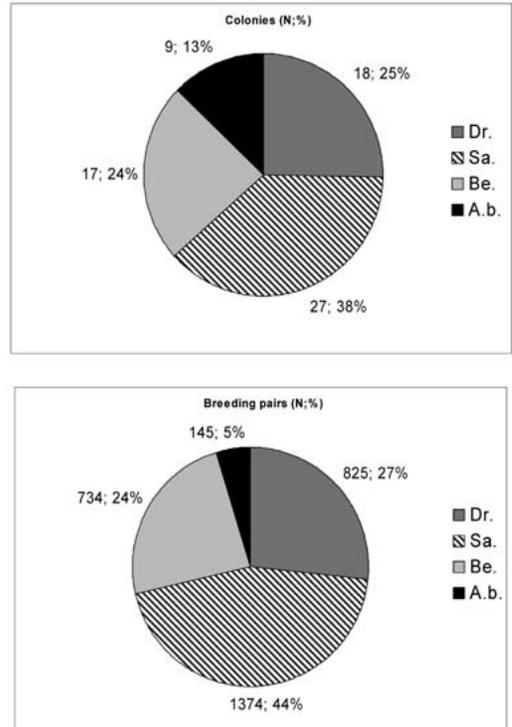


Figure 4. Distribution of colonies (above) and pairs (below) among different Little Tern colony sites; N and % for each are shown. Dr. = dredge islands; Sa. = saltmarshes; Be = beaches; A.b. = artificial beaches.

Large fluctuations at a specific site may involve contemporary increases, or decreases, at nearby breeding sites, which for this reason should be also monitored. During the years 2000-2002 years Scarton *et al.* (2005) censused the whole northern Adriatic coastline north of the Po river mouth, for a length of 220 km, where other important breeding sites occur (the Grado-Marano and the Caorle lagoons, north of Venice lagoon, and the Po delta, south of it). The results (Fig. 5) indicate as fluctuations, in the order of 20%, may be seen over a much larger area; the decrease observed between 2002 and 2001 in Venice lagoon was only partially compensate for by an increase in the Po delta, leading to an overall general decline of the Little Terns population breeding along the northern Adriatic coastline.

Colony sites were represented by beaches, both natural and man-made, saltmarsh islets and dredge islands. Despite the lack of

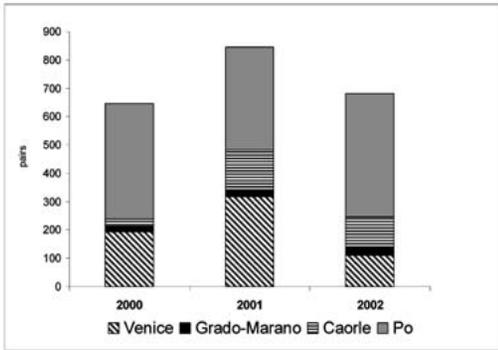


Figure 5. Results of survey of Little Tern breeding pairs along the northern Adriatic coastline (data from Scarton *et al.* 2005).

reliable detailed information, Little Terns in the lagoon of Venice has been since long time nesting both at beaches and saltmarsh islets. During the first, even if not exhaustive, census of the species made in 1982, several sites of both kinds were found (Fasola *et al.* 1986). Other anecdotic information indicate nesting at saltmarshes were known at least since the seventies. At Venice saltmarshes, nesting takes place on shell fragments heaps or wrack (made of algae or seagrass leaves) which occur along the edge or inside the saltmarsh islets, often near tidal creeks.

During the first two years of our survey almost all the pairs were breeding at a natural beach, facing the Adriatic Sea, with a large colony (200 pairs); this site was used at least since the beginning of the eighties, and most likely even before, when other beaches along the two barrier islands were also occupied. Since 1991 this beach became less and less used, and from 1999 onwards it was only occasionally used by a few pairs. The site abandonment was most likely due to the increasing disturbance made by sun-bathers, particularly high in the week-ends in June and July, the peak breeding season for Little Tern in Venice lagoon. Even the sand-nourished beach from 2004 onwards has been not used any longer (Scarton, pers. obs.).

Beach abandonment and use of other available sites have been observed at other Mediterranean coastal sites as well (in Portugal: Catry *et al.* 2004 and Medeiros *et al.* 2007; in France: Cramm and Muselet 2004; in Italy:

Fasola and Canova 1996; Valle and Scarton 1999; Scarton *et al.* 2005). Years ago, it was suggested that breeding habitats such as saltmarshes could be of lower quality, or “sub-optimal”, than beaches, for several gulls or terns; but more recent works concluded that this was not the case, at least for Common Terns (see Safina *et al.* 1989, for a discussion). Also, Common Terns has never nested on beaches over the last thirty years in Venice, always selecting saltmarshes.

We may observe that for Little Terns nesting at saltmarshes has been a common behavior in the lagoon of Venice, even if larger colonies were more likely to be found at beaches. The overall stability of Little Terns breeding numbers in Venice lagoon over a 15 years period (and even in following years, until 2006; Scarton, unpublished data) indicate that both saltmarsh islets and dredge islands may support a viable population.

Saltmarsh islets were used since the beginning of the census, and became more important in the following years until 2001; from this last year onwards, most of the breeding pairs were nesting at dredge islands. Use of the dredge islands is frequently cited for *S. antillarum* in USA (Krogh and Schweitzer 1999; Erwin *et al.* 2003); in Australia (Victoria Dept. of Sustainability and Environment 2003) *S. albifrons sinensis* do nest on dredge islands, whereas for Little Terns in Europe few data seem to exist, as for all concerns bird use of newly created salt marshes (Atkinson *et al.* 2001; de Jonge and de Jong 2002; Atkinson 2003). Our data testify dredge islands are now a regular breeding sites for Little Terns in Europe as well. Dredge islands built in Venice lagoon have higher elevation above sea level than saltmarsh islets, so preventing nests from being flooded during the highest tides or during summer storms. Flooding is the most important cause of breeding failure in the Venice lagoon, according to our field observations. On the other hand, predation by mammals (in particular rats *Rattus norvegicus*) is probably higher at the artificial sites, but detailed study on the reproductive success of Little Terns in the lagoon of Venice were never done.

At a few dredge islands, always among the largest, there were both colonies of Little

Tern and Yellow-legged Gull as well, spaced each other of at least 200 m. Nesting of Little Terns in close proximity with large gulls, that can predate on eggs and/or chicks, has been recorded also elsewhere (France: Yesou *et al.* 2002), whereas it does not occur in the Ebro Delta, Spain (Oro *et al.* 2004) or in the Po Delta (Fasola and Canova 1996).

Turnover rate, being on average about 60%, may be considered as high; the sister specie *S. antillarum* shows higher site tenacity (Burger 1984; Thompson *et al.* 1997). Again, larger colonies in Venice lagoon were not more stable than smaller ones, as instead is reported for Least Tern (Thompson *et al.* 1997). Among the four colony site typology, the turn over rate it is even higher, though not significantly, for dredge islands; these sites are used during the first years since their building, sometimes even when building activities are not yet completed, and personnel with equipment still are in place. Vegetation growth and encroachment usually make the same sites unsuitable for Little Terns after a few years, and Little Terns move to other, just built islands.

Colonies size is similar with those observed by Oro *et al.* 2004 in the Ebro Delta and Calado (1996) in Portugal; the preference of this species for breeding in small, loose colonies is well known (Fasola *et al.* 1993). For this reason, the colony with 481 nests at a saltmarsh islet we found in 1995 must be considered as quite unusual for this species.

Only two sites were used for eight or more years, so they may be considered as "stable"; one is the beach site already referred to whereas the other is a saltmarsh islet that since 1996 hosts a large, multispecific colony (with Sandwich Terns, Common Terns, Black-headed Gulls) that can reach up to 1,200 pairs. Most of the other sites were used only for one or two years. The low site tenacity is quite common in this species (Ratcliffe *et al.* 2000) and this become even more evident in the Venice lagoon, due to the particular nature of two typology of sites used, i.e., saltmarsh islets and dredge islands, that may be considered truly "ephemeral".

For this reason, a monitoring project for this species in a wetland site with several pos-

sible breeding habitats must encompass three or more subsequent years, must consider all the possible colony sites (even new and very ephemeral sites, such as mounds of sandy or silty sediments placed just above the mean water level) and should preferably being performed in accordance with other monitoring project at close breeding sites. Moreover, giving the low site tenacity the Little Terns exhibits in the lagoon of Venice and, most likely, at other wetland sites as well, an effective management approach should not involve only a few sites, but several sites must be included, of different kind. A management plan should not consider only a few sites among those already known, but each year a early survey should be done, identifying sites where colonies are making nesting activity.

At the present time, new dredge islands are built each year in the lagoon of Venice, so new habitats become available for Little Terns; nevertheless, vegetation control or disposal of a mixture of sand and shells at some of the previous used sites may be of extreme value. At a few saltmarshes, careful placement of shells and/or dry vegetation (stray, seagrass leaves, etc.) was tested about ten years ago (Scarton *et al.* 1995), attracting to nest both Common Terns and other Charadriiformes (but no Little Terns), so it would be useful to repeat this work at more sites. Beach sites, on the other end, seem at least in Venice and at other Adriatic sites extremely difficult to manage for Little Terns, since so far limitation to the their use and frequentation by summer visitors has been not really enforced.

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