

Evidence of little correlation between redshank *Tringa totanus* breeding density and morphological or vegetation characteristics of Venice lagoon (Italy) saltmarshes

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The saltmarshes of the Venetian lagoon host the largest concentration of nesting redshanks *Tringa totanus* around the Mediterranean, with about 1000 pairs counted in 1993 (Valle e Scarton 1996). In 2001, a new survey of breeding redshanks was made (Scarton e Valle 2004). We used data collected during this work to investigate possible correlations between breeding pair density and some morphological or vegetation characteristics of the breeding sites.

Study area and methods - The lagoon of Venice with its 55000 ha is the largest around the Mediterranean and includes about 3,700 ha of saltmarshes. The halophytes occurring in these saltmarshes may be grouped in species of "high" marsh (*Halimione portulacoides*, *Inula crithmoides*), "medium" marsh (*Sarcocornia fruticosa*, *Limonium narbonense*, *Puccinellia palustris*, *Juncus* sp.) and "low" marsh (*Spartina maritima*, *Salicornia* sp.).

The whole saltmarsh area of the Venice lagoon, was divided in 328 census units (CU), each one embracing one or more adjoining intertidal islets. These CU had a mean surface of 8.9 ± 2.0 ha. Every CU was visited once in the period 15th May-15th June 2001, which corresponds to the peak period of laying in Venice lagoon (Hale *et al.*, in press); repeated visits were not possible due to logistical constraints. The occurrence of non breeders may be excluded, on the ground of our field experience. At a second level of spatial organisation, several adjoining CU were grouped in one larger census areas (CA); the resulting 16 CA ranged in size between 650 and 3918 ha. Using digitalized maps of the lagoon and a recent vegetation mapping available for half of the study area we measured, using the ArcGis software, the following extensions for each CA (vegetation data were available only for 11 of them): a) area of saltmarshes (not including tidal creek and pond area), b) extension of surface covered with 1) *S. maritima*, 2) *Salicornia veneta*, 3) *L. narbonense* + *P. palustris*, 4) *S. fruticosa*, 5) *H. portulacoides*, c) area of tidal creeks and ponds, d) area of tidal flats (with an elevation between 0 and -0.30 m).

Results and discussion - The minimum number of breeding pairs estimated in 2001 was 1588. About 75% of pairs were

found in the southern lagoon; in particular, just three CA hosted about 60% of the whole population. In the saltmarshes inside these last three CA, several colonies of seabirds (black-headed gull *Larus ridibundus*, common tern *Sterna hirundo*, sandwich tern *Sterna sandvicensis*, little tern *Sterna albifrons*) regularly occur. Redshank nests together with these seabirds, with colonies up to 150 pairs. Compared to the 1993 estimate, the new survey suggests a marked increase of about 60%. Mean density of breeding pairs was 43.7/100 ha of saltmarshes; among the CA, density ranged between 6.3 and 104.9 pairs/100 ha. These values are comparable with those observed at several coastal sites in northern or central Europe (Brindley *et al.* 1998, Kleijn *et al.* 2001).

Relating density of breeding pairs with morphological or vegetation characteristics of CA showed only one highly significant correlation (Spearman $r = 0.74$, $p < 0.01$), i.e. that with extension of tidal flats. Breeding density did not correlate with saltmarsh area *per se*, surface covered with vegetation, tidal creek + pond area. Indeed, a negative relationship, though not significant, was observed with this last variable. With regard to the type of vegetation coverage, breeding pairs density increased, but not significantly, with the area covered with either *S. fruticosa* or *S. maritima*, whereas it significantly decreased considering extension of saltmarsh covered with the other halophytes. The observed increase of breeding pair density with the area of surrounding tidal flats is most likely linked to the use of this habitat as feeding area. We suggest other variables must be considered in further analysis, notably the co-occurrence at nesting sites of nesting seabirds and prey abundance or availability.

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