Flooding and Environmental Challenges for Venice and its Lagoon: State of Knowledge

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61 • Breeding birds and vegetation monitoring in recreated salt marshes of the Venice Lagoon

F. SCARTON

INTRODUCTION

In the Lagoon of Venice the area of salt marsh has fallen from about 12 000 ha to less than 4000 ha between 1900 and the present, due to reclamation, erosion and natural and man-induced subsidence. A dredging programme, undertaken for the Ministry of Public Works, has been under way since 1984 to maintain channel depths for the purposes of navigation and to increase tidal flushing in the inner lagoon. The resulting dredged material has been used to build artificial salt marshes (hereafter called dredge islands) and tidal flats (Cecconi, 2001). It was soon observed that after the end of the works, and following different patterns, dredge islands become covered with vegetation and become a suitable habitat for many species of wetland birds. The Lagoon of Venice is of particular importance for waterfowl, both wintering (it hosts the largest concentration in Italy, with about 130 000 birds counted in January; Zenatello *et al.*, 2002) and nesting. Among the nesting species, 80-90% of the Italian populations of Redshank and Sandwich Tern are found here, whereas for other species, i.e. Common Tern, Little Tern, Avocet, Black-winged Stilt, it hosts between 5% and 30% of the national totals (Valle and Scarton 1996, 1999).

Several studies have been published about birds or salt-marsh vegetation occurring at dredge islands, most of them dealing with sites in the USA (Delaney *et al.*, 2000; Erwin *et al.*, 2001, 2003; Neckles *et al.*, 2002; Shafer and Streever, 2000; Zedler, 2000) or the UK (ABP Southampton, 1998; Atkinson *et al.*, 2001) sites. Concerning the Lagoon of Venice, so far only a short review of birds has been published (Scarton and Valle, 1999) whereas information on vegetation has been presented only in unpublished reports. Here data gathered during the years 1993-2002 is presented, with particular attention to the breeding birds and the vegetation succession observed at dredge islands.

STUDY AREA AND METHODS

The Venice Lagoon is a large (550 km^2) shallow coastal lagoon located on the north-eastern coast of the Adriatic Sea (with its centre at about 45° N 12° E). There are two barrier islands which separate the lagoon from the sea and water is exchanged through three large inlets. Most of the lagoon area is occupied by an open waterbody (about 400 km^2) which is partially vegetated by macroalgae (*Ulva* sp., *Chaetomorpha* sp., *Vaucheria* sp.) and seagrasses (*Zostera marina*, *Zostera noltii* and *Cymodocea nodosa*), these latter communities covering a surface of approximately 5430 ha. The mean depth of the lagoon is 1.1 m and the tidal range during spring tides is about one metre, 0.6 m being the mean range. There are extensive intertidal salt marshes, 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*.

Up until 2003, 57 dredge islands had been created, ranging in size from 0.4 to 57.4 ha, with a mean of 10.5 ha and a total area of 600 ha. They are built by making a containment cell, using wooden piles and a hydraulic net to contain the mud and to reduce turbidity. The substrate of the islands is usually composed of clay-silty sediments (indicated here as 'silty islands'), but some islands have a prevalence of silty-sand or pure sand and are referred to here as 'sandy islands'. Elevation of the dredge islands is most of the

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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.

Data on the use by breeding birds come from opportunistic observations from 1988-1992 and from regular visits, at least two to each site per season, from 1992 onwards. Some of these sites were studied in more detail, with bimonthly surveys. Data about nesting populations reported here refer to the 2000 period, unless specified otherwise. Vegetation surveys started in 1997, with a detailed mapping of each site being made in 2002.

BREEDING BIRDS

Overall, about 60 species (not considering passerines) were observed at least once at dredge islands, and gulls, waders and herons were the most abundant groups (Table 61.1). Most of the species used the islands as feeding sites (especially wintering waders such as Dunlins *Calidris alpina* and Curlews *Numenius arquata*, but also Little Egrets *Egretta garzetta* and Grey Herons *Ardea cinerea*) or resting sites (mostly gulls, i.e. Yellow-legged Gull *Larus michahellis* or Black-headed Gull *Larus ridibundus*, and herons), whereas nine species nested. The breeding species include rare or localised species throughout Italy, such as Shelduck *Tadorna tadorna*, Avocet *Recurvirostra avosetta*, Oystercatcher *Haematopus ostralegus*, Black-winged Stilt *Himantopus himantopus*, Redshank *Tringa totanus*, Kentish Plover *Charadrius alexandrinus* and Little Tern *Sterna albifrons*. Table 61.2 presents the number of pairs nesting at dredge islands, compared with that of the whole lagoon of Venice and with the most recent estimates available for Italy.

It can be seen that, for some species such as Oystercatcher or Little Tern, most of the pairs breeding in the lagoon are found at dredge islands. Moreover, for Oystercatcher, Shelduck and Redshank the number of pairs breeding at those sites make a significant percentage, more than 5%, of the total estimated Italian population. Colonies of Yellow-legged Gull occur each year at 10-15 dredge islands. The nesting of this species is of particular concern as predation on chicks and eggs of other species, more important from a conservation point of view, has been reported for other Mediterranean sites (Vidal *et al.*, 1998; Hernandez-Matias and Ruiz, 2003). Despite the lack of a comprehensive census, the Yellow-legged Gull may be considered as increasing in the whole lagoon since in the last few years, it has also begun to nest on the roofs of historical buildings in Venice. Quite surprisingly, colonies of neither Common Tern *Sterna hirundo* nor Sandwich Tern *Sterna sandvicensis* have been observed so far at dredge islands; the two terns have comparable breeding populations in the Lagoon of Venice (800-1000 pairs each) and they are known to take advantage of dredge islands at other coastal sites, as happens along the USA Atlantic coast (Erwin *et al.*, 2003). Over the years 1996–2002, the breeding species exhibited different trends: Yellow-legged Gull and Oystercatcher increased markedly, Little Tern and Avocet showed strong fluctuations between years, whereas Black-winged Stilt, Kentish Plover and Redshank were more stable.

For nine sites for which more detailed data are available, it has been observed that ageing of sites reduces diversity, in terms of number of breeding species; maximum numbers are attained after five to six years, then the numbers start to decrease (Fig. 61.1). This is certainly due to vegetation encroachment, which has made most of the sites unsuitable for several species (such as Kentish Plover, Oystercatcher, Little Tern), which prefer bare substrates. Conversely, Redshank has become more abundant at the same sites. Quite different trends have been observed between sandy or silty islands (Fig. 61.2); the latter, which are also higher above sea level, become more rapidly covered with non halophytes (see also below) and even after a few years host very few species, sometimes only Yellow-legged Gull. Since other sandy sites, with an elevation below the high tide level, showed the occurrence of typical halophytes, it seems quite clear that elevation, not just the kind of substrate, is the driving force, or at least one of the most important factors, regulating vegetation growth. Within the nine dredge islands studied in more detail, the only morphological characteristic (among size, perimeter, elevation, distance from other salt-marshes, area of open water) which

Table 61.1 *Species, excluding passerines, recorded at dredge islands in the 1992–2002 period, and use of the sites (continued overleaf).*

	Nesting	Feeding	Resting
Podiceps cristatus		x	
Podiceps griseigena		x	
Podiceps nigricollis		x	
Phalacrocorax carbo			x
Egretta garzetta		x	x
Casmerodius albus		x	x
Ardea cinerea			x
Ardea purpurea		x	
Phenicopterus ruber		x	x
Anser fabalis			x
Tadorna tadorna	x	x	x
Anas crecca		x	
Anas platyrhynchos	x	x	x
Anas querquedula		x	
Somateria mollissima			x
Mergus merganser		x	
Circus aeruginosus		x	
Circus cyaneus		x	
Circus pygargus		x	
Buteo buteo			x
Falco columbarius		x	x
Falco peregrinus		x	x
Haematopus ostralegus	x	x	x
Himantopus himantopus	x	x	x
Glareola pratincola			x
Recurvirostra avosetta	x	x	x
Charadrius dubius		x	
Charadrius hiaticula		x	
Charadrius alexandrinus	x	x	
Pluvialis apricaria		x	
Pluvialis squatarola		x	x
Vanellus vanellus		x	
Calidris minuta		x	
Calidris ferruginea		x	x
Calidris alpina		x	x
Philomacus pugnax			x
Gallinago gallinago		x	

Table 61.1 *continued.*

	Nesting	Feeding	Resting
Numenius phaeopus		x	
Numenius arquata			x
Tringa erythropus		x	
Tringa totanus	x	x	x
Tringa glareola			
Tringa nebularia		x	
Actitis hypoleucos		x	
Arenaria interpres			x
Catharacta skua			x
Larus melanocephalus			x
Larus minutus			x
Larus ridibundus			x
Larus canus		x	x
Larus fuscus			x
Larus michahellis	x		x
Sterna sandvicensis			x
Sterna hirundo			x
Sterna albifrons	x		x
Chlidonias niger		x	
Cuculus canorus			x
Apus apus		x	
Alcedo atthis			x
Total: 58	9	38	35

correlated positively and significantly with the number of species was the area of tidal ponds and creeks excavated by the tides (Fig. 61.3). This suggests that tidal creeks and ponds, with the associated occurrence of invertebrates and juvenile forms of fish, are important feeding sites for birds breeding at those islands.

Human use of dredge islands is due to (1) fishermen, who lay nets over the surface to have them dried; (2) hunters, who build hides to shoot wintering birds and sometimes create ponds to attract more birds; and (3) sunbathers, especially during weekends. Despite being limited in numbers, sunbathers posed a real threat to breeding birds, by causing desertion of nests or chicks at some sites.

The major findings can be summarized as follows:

- dredge islands are a new, important habitat feature of the Venice Lagoon; they host several species of particular concern, sometimes with populations of national importance (more than 1%);
- creation of a network of tidal ponds and creeks is needed at each site, if a higher number of breeding species is desired;

Table 61.2 *Number of pairs nesting at dredge islands compared to that for the whole Venice Lagoon and that for Italian populations, along with the status of each species in Italy.*

	Dredge islands	Lagoon of Venice[1]	Italy[2]	Italian Red List[3]
Shelduck	5–8	40–60	150–180	Endangered
Mallard	4–7	500–1000	10,000–20,000	Not evaluated
Oystercatcher	12–16	14–18	120–140[1]	Endangered
Black-winged Stilt	50–180	350–400	900–1,700	Lower risk
Avocet	30–140	100–200	1,200–1,800	Lower risk
Kentish Plover	20–30	70–90	1,500–2,000	Lower risk
Redshank	50–70	1,500–1,600	1,600–1,700[1]	Endangered
Yellow-legged Gull	200–400	5,000–6,000	24,000–27,000	Not evaluated
Little Tern	50–300	100–400	5,000–6,000	Lower risk

[1] Scarton and Valle, personal estimates, years 2000–03.

[2] Brichetti and Gariboldi, 1997.

[3] Bulgarini *et al.*, 1998.

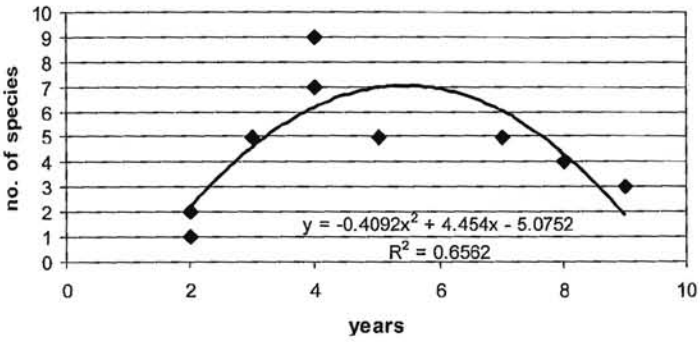

Fig. 61.1 Correlation between number of breeding species and years since the construction at nine dredge islands.

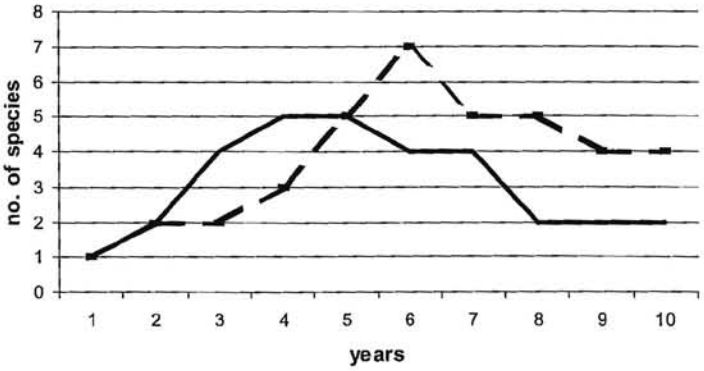

Fig. 61.2 Number of breeding species at sandy (solid line) and silty (broken line) sites.

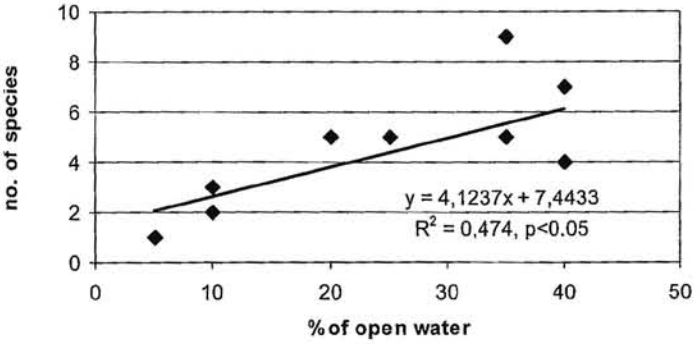

Fig. 61.3 Correlation between number of breeding species and percentage of tidal pond and creek areas inside dredge islands.

- ageing of sites and the concurrent vegetation growth reduces breeding species, so some management activities (such as vegetation cutting, or spraying of new sediments over the surface) are needed;
- sandy sites, if higher than high tide levels, become quickly less useful for breeding birds; and
- human use of the sites (especially by sunbathers) should be controlled and Yellow-legged Gull reproduction should be discouraged.

VEGETATION

Vegetation growth and species occurrence at dredge islands are clearly linked to (1) soil characteristics; (2) elevation above sea level; and (3) age of the sites. Silty-clay islands, regularly flooded, become covered with halophytes (mostly *Salicornia veneta, Puccinellia palustris, Spartina maritima*) after at least three years following the end of the works. Almost always the first two species to colonize the new sites are *Salicornia veneta* and *P. palustris*; the first species reaching in the colonized sites a coverage of some hectares at the end of the summer. After five to six years, about 90% of the islands are covered with vegetation, and all the sites develop a vegetation coverage after ten years or more. Bare areas do persist at several sites. Tidal ponds and creeks show only occasionally the occurrence of *Zostera noltii* and, even less frequently, that of *Ruppia maritima*. It is worth noting that at several sites vegetation cover appears well structured and different habitats (according to the 'Habitat' European Directive 92/43) were recorded during a recent mapping. Among the most valuable habitats, i.e. of community importance, 'Mediterranean and halophytic scrubs (Sarcocornetea fruticosi)', Natura 2000 code 1420, and 'Salicornia and other annuals colonising mud and sand', code 1310, were the most widespread, covering 72 ha and 82 ha each respectively.

Sandy islands, irregularly or never flooded, show a very different trend of vegetation growth; after a few years, halophytes (salt-tolerant) or truly psammophilous (sand-living) species become restricted to the less elevated areas, whereas most of the sites become covered with dense stands of nitrophilous or ruderal species (i.e. *Calamagrostis epigejos, Agropyron repens, Oenothera biennis, Conyza canadensis*). Small bushes like *Tamarix gallica* are also sometimes found. Since 2002 at a few dredge islands, and at natural marshes as well, we have observed the occurrence of *Spartina x townsendii*, which is the first record for Italy and most likely for the whole Mediterranean (Scarton *et al.*, 2003). We deem this hybrid has been introduced deliberately, maybe for erosion control, but no confirmed data is available. Almost circular clumps of this hybrid were found scattered on the surface of the islands, interspersed with *P. palustris* and *S. veneta*. Nevertheless, we have also observed this plant at lower elevation, on the fringe of the sites, on bare silty areas where no other terrestrial species occurs, the only other vascular plant being *Zostera noltii*. Preliminary data show that, as is known for other coastal areas (e.g. Denmark: Vinther *et al.*, 2001), *S. x townsendii* can grow at much lower elevations than any other halophyte (Fig. 61.4).

Other activities performed at dredge islands include setting up of permanent quadrats and testing transplanting success of a few halophytes. Permanent quadrats were installed in 2002 and their position and elevation above sea level were recorded with an accuracy of a few centimetres, using DGPS. Quadrats will be used to detect changes in species composition over the next few years. The transplanting tests were done at three sites, using different species at

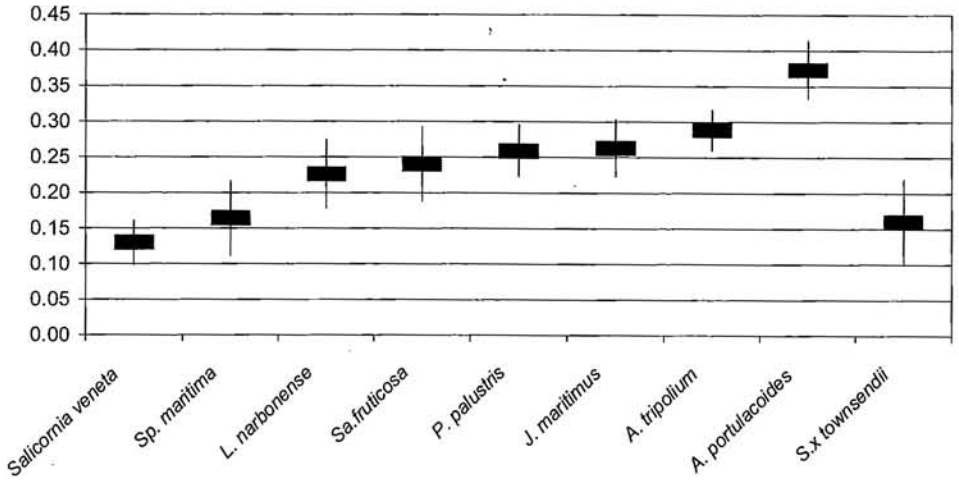

Fig 61.4 Vertical zonation (m above sea level; mean ±1 s.d.) of the most common native salt marsh species and of *S. x townsendii*, measured at Venice Lagoon salt-marshes (after Scarton *et al.*, 2003).

different elevation. *P. palustris* showed a good success at low (here defined as the 0.10–0.20 m range) and medium (0.20–0.30 m) elevation above sea level, whereas *Spartina maritima* grew vigorously only at low elevations, along tidal creeks and ponds. The results with *Sarcocornia fruticosa* (at medium or high, i.e. more than 0.30 m) and *Atriplex portulacoides* (only at high elevation) were on the contrary very poor.

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