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Chapter 3

Ecological Views

Introduction

The ecological importance of salinas has already been addressed by a number of authors. Britton & Johnson (1987) published an ecological account of the Salin de Giraud in the Camargue (France) that includes data on the invertebrate fauna found in that salina and highlights its importance for birds. More recently other authors have also pointed out the importance for estuarine birds of this man-made habitat, which provides safe roosting and breeding areas as well as supplementary

feeding grounds (Velasquez, 1992; Perez-Hurtado & Hortas, 1993; and Neves & Rufino, 1995). A wide range of waterbird species use the salinas and some authors suggest that the presence of salinas may increase the carrying capacity of the wetland where they are located (Luis, 1998).

This chapter summarises the information available on the ecological value of each of the four ALAS Sites.

An ecological view of the salinas of Lesvos

Hjalmar Dahm

Lesvos can boast two working salinas. They are among the most important ecological sites on the island with an especially rich and diversified bird-life. Migrating, wintering and breeding birds here find a protected environment and ideal conditions for feeding. The two areas are well known to birdwatchers, who come here, especially during the impressive spring migration, from all over Europe.

The salina of Kalloni is designated as an Important Bird Area (IBA) of Europe, the only such site on the island. Both salinas are situated in a Natura 2000 site.

The salina of Polichnitos

The Polichnitos salina covers 60 ha; it is long (2 km) and narrow (300 m) in shape, stretching from south to north along the Bay of Kalloni.

Although less studied and observed than the Kalloni salina, partly because it is smaller and away from main roads and activities, it is interesting for breeding, migrating, wintering and feeding birds. The proximity to other wetlands around the bay also links the salina to them: birds that have been disturbed (while feeding or even breeding) can easily retreat from one site to another.

The salina is also of special interest as the new salt museum is based here.

a) Studying breeding birds

To gain an accurate evaluation of the salina, regular observations of the birds of the salinas were carried out from 1998 until today. Of special interest were the breeding populations of the five most significant species. Their require-

◀ Water byrds
in Tagus Estuary
Salina - Portugal.

Photo: Rui Rufino

ments for nesting sites and feeding grounds were studied with the aim of producing a detailed management plan for the area. (Table 3.1) Other species also breed in or close to the salina.

Table 3.1
The number of pairs of successful breeders in the Polichnitos salina

	1998	1999	2000	2001	2002
Little tern <i>Sterna albifrons</i>	2	6	5-7	5-7	12
Common tern <i>Sterna hirundo</i>	25	30	20	-	10
Avocet <i>Recurvirostra avosetta</i>	3	1	1	-	2
Black-winged stilt <i>Himantopus himantopus</i>	3-4	4-7	5-6	6-8	7-9
Kentish plover <i>Charadrius alexandrinus</i>	5-6	5	5	4-6	6-10

Stone curlews may nest on the sandy banks close to the sea and redshanks with breeding behaviour have been observed. Crested larks hide their nests under low bushes. Swallows and sparrows breed inside the buildings related to the salina.

b) Wintering and resting birds
The salina also provides food and shelter outside the breeding period. Flamingos, waders, storks, herons, birds of prey and gulls can be seen in variable numbers throughout the year. In winter kingfishers regularly dive for small fish in the canals.

Unfortunately the main part of the salina remains dry outside the salt production period,

Table 3.2
The number of pairs of successful breeders in the Kalloni salina

	1998	1999	2000	2001	2002
Little tern	25-30	25	25-30	15-25	15 +
Common tern	20-35	45	30-40	Min. 10	25 +
Avocet	20-25	15-20	15-25	40	25 +
Black-winged stilt	4	5-10	10-12	5	5
Kentish plover	10	10	10-15	10-15	10-15

which explains why the number of birds here is never really high.

The salina of Kalloni
The Kalloni salina (260 ha) lies in the northern part of the Bay of Kalloni. The salina is known as an important site for wetland birds throughout the year. Over a period of many years the salina underwent major restoration works and a study made in 1994 showed that no birds managed to breed within the salina that year, because of ever-changing water levels. The most spectacular phenomenon during the last decade is the increase in numbers of greater flamingos, with several breeding attempts.

a) Breeding birds
The salina proves to be important as a breeding site, especially for the “gang of five” (Table 3.2). The number of breeding avocets in 2001 was very interesting, as the late summer count gave 355 birds (young and adults) (Table 3.2).

b) The flamingo story
In July 1999 the author noted that the flamingos had constructed 10-12 nests in one of the pools in the north part of the salina. This is a known behavior of young flamingos and this attempt never resulted in any eggs. The next year the flamingos no longer showed any interest in what remained of their nests, but a single nest was constructed in another pool in the west part of the salina. In 2001 no nesting initiative was taken.

In spring 2002 the most striking phenomenon was the huge number of greater flamingos that stayed on after winter. Some 400 birds remained and were mainly occupying one pool in the southeast part at the beginning of May. By the end of the month it seemed clear that the birds had built many mud-nests; 25 birds were even sitting on the mud-nests and others were prepa-

ring to breed. The nests were counted from the bank opposite to the colony on June 8. Some 60 nests could be seen and 30-40 eggs observed (always one egg per nest). A second visit on June 11 revealed that the colony had been totally abandoned; the nests were both soaked and eroded by the waves. In fact, the previous days had been very windy with strong winds from the North. This had made the water levels in this part of the salina rise, thus provoking the flooding.

It was interesting to see that, after the departure of the flamingos, the site was immediately taken over by the birds that regularly nested there but had been pushed away by the flamingos. A common tern even laid its eggs in one of the abandoned flamingo nests.

The greater flamingo is today one of the most successful birds breeding in salinas around the Mediterranean. From previously having bred in a few, but very large colonies (over 10,000 pairs in Camargue), the species now breeds in many coastal salinas, in Spain, France, Italy, Greece (Kitros salina), Tunisia and Turkey. Normally flamingos require huge undisturbed areas, therefore it is not likely that Kalloni will ever see any successful breeding.

c) Outside the breeding period
Many resident birds, also present outside the migration periods, find food and shelter in the Kalloni salina. The species habitually observed were the following:

- Greater flamingo (2-40 individuals in winter 1998, 1,550 in January 1999, 900 in August 2001 over 3,500 in late September 2002)
- Waders (*Tringa* spp., *Calidris* spp., *Numenius* spp.)
- Storks (black and white)
- Grey heron (regularly more than 10-25 individuals)

- Little egret
- Great white egret
- Glossy ibis (during migration to the Black Sea/northern Greece)
- Ruddy shelduck (breeding near the salina)
- Shelduck
- Garganey, shoveler and other ducks

The quality of the salina as a wintering site is known. During autumn and winter impressive numbers of greater flamingo and avocet (always around 300 birds) are frequently observed. Waders of several species feed in the shallower pools. Over 20 great white egrets and several dozen little egrets are regularly seen in the north part of the salina. Peregrine falcons can be seen hunting among the wintering lapwings and several species of harriers chase over the area.

The importance of the Kalloni salina as a wintering site is obvious, especially when compared to Polichnitos. There are two reasons for this: the fact that the pools in Kalloni are continuously under water in winter, and the difference in size.

d) Towards an integrated management plan
The importance of the salinas can be confirmed and potentially increased with more careful ecological management. Such a management plan should not be considered as a burden but, instead, reckoned as a part of everyday activity on the salinas.

The aim of the management plan of the area, which is under discussion, is to increase the number of protected bird species through deliberate management of water levels and also by creating nesting and roosting sites.

The management plan will also include rules on the works carried out within the areas, fencing, hunting, training of salters and access to the public.



Common tern, a regular breeder in Lesvos salinas
Photo: Henri Guennec

Ecological features of the Mondego estuary and its salinas

Rui Rufino

The Figueira da Foz salinas are located in the Mondego estuary, in an area with a warm temperate climate. The estuary consists of two arms, which form an island (Murraceira), that divide approximately 7 km upstream from its mouth and come together very close to the sea. The north arm is deeper (5 to 10 m at high tide) and the south arm is generally shallower (2 to 4 m at high tide). The tidal range varies between 2 and 3 m.

The estuary is located at the end of a large catchment basin, 6,670 km² in area. The lower part of this basin, just before the estuary, includes more than 15,000 ha of farmland which is farmed intensively. This area contributes large quantities of nutrients and pollutants to the river. Eutrophication is a problem in the estuary, being particularly evident in the south arm, where algal blooms occur regularly twice a year (Marques, Graça & Pardal, 2002).

During low tide an area of approximately 230 ha of mud and sand flats is exposed. The salinas, located on the island formed by the two arms and on the southern shore of the south arm (Lavos), cover an area of approximately 250 ha. Figueira da Foz is located at the mouth of the estuary with its urban area extending along the north shore. The south shore is also populated but less intensively. Major port facilities are found at the seaward end of the estuary, as Figueira da Foz is one of Portugal's main fishing ports.

The salt marshes are not very extensive, being found mainly in the south arm and in sheltered areas of the north arm. In the salinas, both in Murraceira and in the Lavos area, the vegetation is also dominated by salt marsh plants. In the estuary small *Zostera noltii* meadows are

still present despite the extensive coverage of *Enteromorpha* spp. beds during algal blooms.

Studies carried out in the estuary have revealed considerable differences between the two arms of the estuary in terms of benthic fauna, with the south arm housing a richer and more abundant macro-invertebrate fauna. This arm seems to be less affected by human activities, although it is potentially more exposed to environmental changes (Marques, Pardal & Maranhão, 2002).

The fish community of the estuary can be grouped in four different categories: occasional marine, occasional freshwater, sedentary and migrants. Studies carried out in recent years have shown spatial-temporal variations related to the salinity distribution inside the estuary (Jorge, Monteiro & Lassere, 2002).

Approximately 1 to 2.5% of waders wintering in Portugal are found in the Mondego estuary, with total numbers going up to 2,500 birds in some years. In winter and during migration Dunlin, *Calidris alpina*, is the commonest species but another 29 wader species have been reported in the area.

During the breeding season the number of species is smaller. Black-winged stilt *Himantopus himantopus* and Kentish plovers *Charadrius alexandrinus* are the two commonest breeders but other species, such as mallard *anas platyrhynchos*, moorhen *Gallinula chloropus*, redshank *Tringa totanus* and black-headed gull *Larus ridibundus* are present in smaller numbers (Lopes et al. 2002).

The salinas provide a breeding habitat for all these waterbird species. Mallards and moorhens



◀ Aerial photo of the south arm of the Mondego river

Photo: IPCC (Portuguese Institute for Cartography)

prefer the reservoir areas, which in Figueira da Foz are usually common to several salinas, and therefore cover large areas, while the black-winged stilt and Kentish plover prefer the pans closer to the crystallisation areas of the salinas. Stilt breeding numbers have increased in recent years and may have reached the Ramsar criterion (1% of the flyway population = 400 individuals) in recent years. This criterion attributes international importance to any area that holds at least 1% of a flyway population.

According to Múrias, Marques & Goss-Custard (2002), the destruction of salinas represents a major threat to the wader populations of the Mondego estuary, as it will represent a net loss of existing feeding area for these bird species and this will be further aggravated by ongoing

eutrophication. The reduction in the area of salinas will also represent a loss of habitat for breeding waterbird communities.

Other bird species are present in the area, with a total of 137 species recorded during a ten-year period, the Charadriiforms being the second group in terms of total numbers, just after the Passerines (Lopes et al. 2002).

Among the mammalian community it is worth noting the presence of otters in the estuary.

The estuary is not subject to any formal conservation status, at either national or international level. However the area was recently designated an Important Bird Area by the Portuguese Society for the Study of Birds (SPEA-BirdLife Portugal).

Ecological characteristics of the Sečovlje salinas

Andrej Sovinc

A comprehensive description of the ecological characteristics of the Sečovlje salinas is given in Beltram (1998). Here are the main points:

The Sečovlje salina is located on the southernmost stretch of the coastline, in Piran Bay (*Piranski zaliv*) on the estuary of the Dragonja River. The coastal alluvial plain has developed over the centuries through the continuous deposition of sediments from the Dragonja River and its tributaries. The Sečovlje salina was constructed in the river estuary. According to the Regional Institute for Conservation of Piran, the salina in 1994 covered about 738 hectares, between two peninsulas: the limestone Savudrija Peninsula and the Seča Peninsula and hills, both on flysch, extending from the east to the north-west.

At present, there are two distinct parts of the salina, Lera and Fontanigge. Lera is the salt-producing part. Commercial production has been abandoned in Fontanigge. The adjacent areas cover parts of the two peninsulas, Seča and Savudrija, and the alluvial plain of the Dragonja, Drnica and Jareninski rivers. The immediate fringe zone consists either of freshwater, riparian and terrestrial biotopes, or the marine biotope in the Bay of Piran. Seča is a residential area, Savudrija has several small villages on the plateau and a small summer resort on the coast, and the alluvial plain is a combined agricultural and urban area with an airfield bordering the salina.

Lera – This is the productive part of the salina, between the Canal Grande and Canal Sv. Jernej and a human-dominated ecosystem. It is an intensively managed area, covering 263.5 hectares, of which only a small part consists of salt pans (20 hectares) for salt crystallisation. The

majority of the area is covered with evaporation and concentration lagoons (about 220 ha). This lagoon area is interesting for its halophyte associations. The development of *Salicornietum* and *Limonietum veneti* with rushes (*Juncus maritimus*) depends on the water level in the lagoons. A halophyte grass, *Puccinellia palustris*, can occasionally cover a salt field.

Fontanigge – This is the area between the Canal Grande and the Dragonja. Salt production was abandoned here during the 1960s, but the inner lagoons are still used for evaporation and water supply for Lera. The water regime is thus controlled and the area is managed extensively. Fontanigge consists of water lagoons, dykes and mudflats. *Limonietum veneti* is an association which has developed here in all its various forms, including *Salicornietum* and other xerophytes like *Stachetum-Artemisietum caeruleum*. It is a mosaic of micro-habitats which are mainly determined by the water level in the lagoons and the mudflats as well as the height and exposure of the levees. This part is best represented by *Chenopodiaceae*, whose members are well adapted to high salt concentrations.

The old salt pans (*stare soline*) – At present, this is a brackish marsh in the mouth of the Dragonja. Salt production ceased first in this part. It is a tidal area characterised by a few submerged freshwater springs (*fontanelli*) at the edge of the calcareous Savudrija Peninsula. Representative associations include *Phragmitetum*, *Scirpetum maritimi*, *Juncetum maritimi*, *Salicornietum* and *Limonietum*.

The diversity of these habitats provides a good refuge for many animal species, and is particu-

larly known for waterbirds. Terrestrial and aquatic fauna have been less studied. Of the aquatic species, most characteristic of hyperhaline water is the brine shrimp (*Artemia sp.*). In the canals and evaporation lagoons, where the water is of lower concentration, several invertebrate and vertebrate species occur.

Ecological and Conservation Values

A salina is a transition area, an *ecotone*, between marine, freshwater and terrestrial ecosystems. In the highly modified coastal environment the area represents a noteworthy alternative habitat for many plants and animals, including halophytes and waterbirds. Salinas are, therefore, an alternative to the original coastal marshes, shallow marine waters and river mouths and a wildlife refuge for many more than just wetland species.

The present technology of salt production supports the habitat function of the salina. More valuable however is Fontanigge, where water control provides a good habitat for plant and animal species and which is recognised as important for its ecological and natural heritage values.

Botanical Heritage – Along the Slovenian coast the original halophyte vegetation has been considerably altered by socio-economic development. Therefore, a high diversity of halophyte species and associations in the salina is of particular botanical value. Fontanigge is rich in halophyte vegetation, while the still working Lera is botanically less attractive. Following the water gradient (from the highest and driest areas towards the lowest and the wettest ones), a sequence of halophytes can be observed. The least wet areas are inhabited by sea purslane (*Halimione portulacoides*), wetter areas by sea lavender (*Limonium angustifolium*), whereas in the shallow saline waters (periodically flooded areas and in the salt pans) glasswort (*Salicornia*

europaea) is commonly found. These three main species are accompanied by other halophytes and form several halophyte associations.

According to the IUCN categories of threatened species (Wraber & Skoberne 1989), the flora of Fontanigge includes 35 plant species of different conservation status: 7 are recognised as endangered (E), 18 as vulnerable (V) and 5 as rare (R) on the Slovenian Red Data List. According to another study of the area, 1 species is endangered (E) locally, 14 are rare (R) and 1 insufficiently known (K).

Some localities in the salina's wetlands are unique habitats for certain species found in Slovenia. For the facultative halophytes *Bolboschoenus maritimus* and *Samolus valerandi*, the lower reaches of the Dragonja river are the only habitats in Slovenia. At the opening of the Canal Sv. Jernej, the only example in Slovenia of an orache association, *Atriplicetum tatarici*, was discovered. Cornuti's plantain, *Plantago cornuti*, is the only halophyte of the genus growing in Slovenia.

Zoological Heritage. – In addition to birds, described in more detail below, many animal species protected in Slovenia by a Decree (September 1993) occur in the Sečovlje area and its catchment basin. An asterisk next to the Latin name given in the following paragraphs indicates that the species is protected according to this Decree. Among reptiles, the salinas are one of the few localities for the only species of turtle living in Slovenia, *Emys orbicularis*. Among the snakes, *Natrix natrix*, *Natrix tessellata* and *Coluber viridiflavus carbonarius* are likely to be observed in the area. Among the lizards, *Lacerta sicula campestris*, *L. viridis* and *L. muralis* are found in the salinas.

Mammals of national significance are also attracted to the area. Badgers (*Meles meles*) dig



▲ The Sečovlje salinas offer a variety of habitats for different communities, from aquatic to rocky environments, like old buildings

Photo: Hjalmar Dahm

earths in the fringe area. Stone martens (*Martes foina*) and weasels (*Mustela nivalis*) are common visitors. The wild cat (*Felis sylvestris*) and jackal (*Canis aureus*) are occasional visitors. Mammals are mainly identified by the tracks they leave in the soft mud covering the area.

Bats (Chiroptera) are seen in the area (a *Myotis blythi* has been caught), but detailed studies are still to be completed. Following pellet analysis of three owl species in north-west Istria, 13 different species were identified in the entire area.

Small mammals are usually identified through owl pellets. Altogether 12 species of small mammals live in the salina area. Their abundance is closely related to the vegetation and living conditions. The salina provides habitat for the lesser white-toothed shrew (*Crocidura suaveolens*). Other species worthy of mention include the hedgehog (*Erinaceus concolor*), the mole (*Talpa europaea*), and one of the most conspicuous inhabitants, as well as the smallest, the pygmy

white-toothed shrew (*Suncus etruscus*). This is the only typical Mediterranean species in the area. It is also the smallest mammal in the world, measuring only 2 grams in weight.

Ornithological Heritage – The main ecological value of the salina and its wetland types is its function as a habitat for waterbirds. Endangered bird species at national and international level are particularly important. The Sečovlje wetlands are designated as an Important Bird Area. The area is one of the main breeding habitats for rare and endangered waterbird species, a resting and feeding site for migratory birds and a refuge for wintering waterfowl.

More than 250 bird species have been observed in the area. Of these recorded birds, 35 species breed in the salina and adjacent wetlands. Twelve wetland-dependent species breed in the salina and another 23 in its fringe wetlands.

Fontanigge – This has become an important location for waterfowl. Terns, waders, plovers and gulls nest on the dykes built between the saline lagoons. The breeding success of this species depend heavily on the "passive activities" supporting salt production in Lera, namely those aimed at controlling the water level in the pools and those aimed at maintaining the dykes. Some other species also nest in the buildings, which are rapidly deteriorating. Raptors such as harriers, hawks, and several owls use the salina as a feeding ground.

Lera – The lagoon part is interesting for halophyte associations and birds. Waterbirds come to feed in this area and nests of Kentish plover have been found on the dykes.

Pomorie Lake and Wetland Complex

Gina George

Pomorie Lake is located in the southeastern region of Bulgaria on the Black Sea coastline. It is 25 km to the north of the city of Burgas, in direct proximity to the Burgas-Varna motorway, and near the northern part of the town of Pomorie. The administrative region for the lake is the local municipality of Pomorie, District of Burgas. The complex comprises 760.83 ha of territory including a sand bar of 15.07 ha and the nearby tributaries of the Akheloi River, 11.91 ha. Current economic activities include salt production and the extraction of medicinal mud.

The site is a natural hyperhaline coastal lagoon connected to the Black Sea by one artificial canal. The lagoon is associated with salt marshes, reed beds, salinas and settling pools. Habitats found within the complex include:

- Permanent shallow marine waters;
- Sand, shingle and pebble shores;
- Predominantly saline lagoon;
- Permanent river and creeks from the Akheloi river system;
- Freshwater and tree-dominated wetlands also associated with the Akheloi river system;
- Salt exploitation sites, the salinas and settling pools;
- Canals, drainage channels and ditches.

The Pomorie Lake ecosystem contains no woody, emergent or subemergent vegetation. The shallow waters with marsh vegetation along the banks include primarily *Typha angustifolia*, *Phragmites communis*; marshes completely covered with aquatic vegetation consist of *Phragmites communis*, *Typha angustifolia*, *T. latifolia*, and *Schoenoplectus lacustris*. Halophytic grass formations of *Puccinellia convolutae*, *Limonieta gmelinii*, *Salicornieta*

europaea, and *Aleuropeta littoralis* are observed throughout the region. The hyperhaline basins of the man-made salinas support an insignificant cover of *Salicornia herbacea* and *S. europaea*.

The wetland is considered internationally important because it represents a rare and unique example of a near-natural wetland type found in the Black Sea biogeographical region. The area also supports habitat for vulnerable, threatened and endangered species at the local, national and international levels.

Flora listed as rare and threatened species in the area and included in the Red Data Book of The People's Republic of Bulgaria include *Parapholis incurva*, *Lemna gibba*, *Gypsophila trichotoma*, *Silene euxina*, *Halimione portulacoides*, *Petrosi- monia brachiata*, *Suaeda heterophylla*, *Euphorbia paralias*, *E. peplis*, *Frankenia pulverulenta*, and *Trachomitum venetum*. Species threatened on a European level, *Corispermum nitidum*, *Lepido- trichum uechtritzianum*, and *Tamarix sp.*, are fairly common along the banks. Ichthiofauna also mentioned in the Red Data Book of The People's Republic of Bulgaria (1985) include: *Chalcalburnus chalcoides*, *Pungitius platygaster*, *Gasterosteus aculeatus*, *Atherina mochon pontica*, and *Knipowitschia caucasica*. Globally rare and threatened reptiles occurring in the region are *Ophisaurus apodus* and *Elaphe longissima*.

Pomorie Lake and wetlands are of great importance to breeding, wintering and migrating birds along Europe's second largest flyway, the "Via Pontica." According to the National Database for Ornithology Information at the Bulgarian Society for the Protection of Birds, 215 bird species occur in the region. Of these, four



^ Little egret, a common species in Pomorie lake
Photo: Henry Guennec

are globally threatened species: pygmy cormorant *Phalacrocorax pygmeus* (regularly wintering), dalmatian pelican *Pelecanus crispus* (rare in periods of migration and wintering), white-headed duck *Oxyura leucocephala* (rare in winter), and corncrake *Crex crex* (during migration). Of the 100 bird species included in the Red Data Book of The People’s Republic of Bulgaria (1985), some 65 have been observed in the lake complex. Pomorie Lake is one of the two most important nesting areas for avocet *Recurvirostra avosetta*, kentish plover *Charadrius alexandrinus*, shelduck *Tadorna tadorna*, gull-billed tern *Gelochelidon nilotica*, little tern *Sterna albifrons* and for other species adapted

to hyperhaline water basins. In general, it is also an important nesting habitat for species such as gadwall *Anas strepera*, redshank *Tringa totanus*, black-winged stilt *Himantopus himantopus*, collared pratincole *Glareola pratincola*, and bearded tit *Panurus biarmicus*. The area is significant during migration for a number of species, including *Pelecanus onocrotalus*, terns belonging to the *Chlidonias* genus, a great number of the Charadriiformes, and many songbirds. The lake is of importance for birds during the winter, especially for species such as pygmy cormorant *Phalacrocorax pygmeus*, scaup *Aythya marila*, and great white egret *Egretta alba*.

Table 3.3 – Waterbird numbers in Pomorie Lake (1996–2000)

Species	Breeding Pairs	Non-breeding Individuals
Cormorant <i>Phalacrocorax carbo</i>		570 – 1000
Pygmy cormorant <i>Phalacrocorax pygmeus</i>		10 – 200
White pelican <i>Pelecanus onocrotalus</i>		10 – 100
Little egret <i>Egretta garzetta</i>		140 – 180
Great white egret <i>Egretta alba</i>		10 – 25
Spoonbill <i>Platalea leucorodia</i>		10 – 50
Mute swan <i>Cygnus olor</i>		230 – 1000
White-fronted goose <i>Anser albifrons</i>		80 – 180
Shelduck <i>Tadorna tadorna</i>	5	500 – 63
Mallard <i>Anas platyrhynchos</i>		450 – 880
Shoveler <i>Anas clypeata</i>		100 – 200
Pochard <i>Aythya ferina</i>		2300 – 5000
Tufted duck <i>Aythya fuligula</i>		900 – 4500
Coot <i>Fulica atra</i>		5200 – 10500
Black-winged Stilt <i>Himantopus himantopus</i>	10	100 – 150
Avocet <i>Recurvirostra avosetta</i>	34 – 64	260 – 1000
Curlew sandpiper <i>Calidris ferruginea</i>		350 – 4500
Ruff <i>Philomachus pugnax</i>		300 – 800
Black-tailed godwit <i>Limosa limosa</i>		20 – 500

Redshank <i>Tringa totanus</i>	600 – 1000	
Marsh sandpiper <i>Tringa stagnatilis</i>	30 – 600	
Mediterranean gull <i>Larus melanocephalus</i>	900 – 2600	
Sandwich tern <i>Sterna sandvicensis</i>	173	170 – 1800
Common tern <i>Sterna hirundo</i>	20 – 30	15 – 100
Little tern <i>Sterna albifrons</i>	8	15 – 30

Although the salinas are an artificial habitat, they provide essential grounds for breeding, wintering and migrating bird populations. The shallow lagoons and pans present a gradient of salinity that allows a high diversity of plant and animal communities. The degree of isolation, influence of the water regime, and the salinity gradient are all factors affecting the biological diversity represented in the salinas and settling pools. The variety in unicellular organisms, aquatic and terrestrial plants and invertebrates provides the nutritional foundation that allows great numbers of birds to utilize the natural and artificial systems. All bird species listed in the Table 3.3 have been observed within the salinas and the lake. There is no current research to suggest that habitat selection or species diversification occur between avian populations using the salinas versus Pomorie Lake.

In 1997, Pomorie Lake was designated an Important Bird Area by Birdlife International. In early 2001, the region became a Protected Site under Bulgarian legislation. The following year, documents were submitted to the Ramsar Convention for Wetlands of International Importance and to the Bulgarian Ministry of Environment and Water to include the complex under the strategic framework of the international treaty. The local administration is in the initial phase of the development of a sustainable management plan for the region including the salinas. Specific management guidelines for the traditional salinas, developed through the ALAS project, will be included within the long term development and conservation plan for Pomorie Lake and Wetlands. Funding from local non-governmental organizations and institutes is supporting these measures.

Salinas and Nature Conservation

Rui Rufino

The importance of salinas for nature conservation, and particularly for waterbirds, has been recognised by institutions, NGOs and governments. Indeed, their importance was emphasised by Wetlands International in the Grado Declaration (Anonymous, 1992); the Important Birds Areas designated by BirdLife International include a considerable proportion of European salinas; several designated Ramsar Sites are wetlands in which salinas are an important feature; and a good number of Special Protection Areas, designated under the Birds Directive, are wetlands with salinas. Within the geographic area of the countries participating in the ALAS Project, almost all salinas have some kind of protection status. Many are included in Nature Reserves or some other national nature conservation areas and most of them are designated Ramsar Sites. In the two countries which are



▲ Salt marsh vegetation
Photo: Renato Neves

members of the European Union, the majority of the national salinas are included in Special Protection Areas.

This pattern in terms of conservation status is followed by the majority of the countries located on the northern shore of the Mediterranean. Spain has designated at least 10 Ramsar Sites where salinas are found, including internationally famous sites such as the Marismas de Guadalquivir, the Ebro Delta, the salinas of Cabo de Gata and the bay of Cadiz. France has designated within the framework of this Convention two areas internationally known for their salinas, the Camargue and the salinas of Guérande and Més. In Italy several areas of salinas are also included in the Ramsar network.

According to Tucker & Evans (1997), salinas provide a habitat for almost 60 priority species. However, they are under threat due to changes in land use and coastal development, intensive management and aquaculture.

In fact, despite recognition of the conservation value of salinas and the fact that many of those existing are under a variety of conservation regulations, many of them are still at risk. To guarantee their conservation we need a complex series of actions and conditions which are sometimes difficult to implement. Salinas are man-made habitat and their maintenance depends on human activity. Abandoned salinas, although temporarily important, will lose their conservation value if they are kept without management for an extended period of time.

To preserve the conservation values of salinas, we need to transform salt extraction into a sustainable industry, adding value to the final product in recognition of its quality, which results from a labour-intensive activity, but also in recognition of the role this industry has in nature conservation. Furthermore, new activities which may generate income for salt producers and conservation managers have to be associated with this industry.

Salinas and Birds

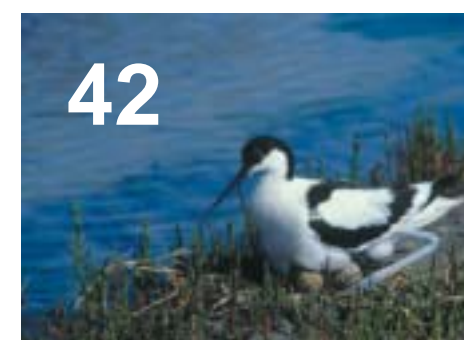
Andrej Sovinc

The list of breeding birds in the salinas and their adjacent salt marshes, reed-beds, tamarisks and small bushes along the channels can exceed one hundred species, depending on the size of the salina and diversity of the habitats. If we consider the core saline areas only, such as evaporation basins, the number of breeding birds is smaller, but they are very interesting. Their common characteristic is predominantly the white colour of their plumage, resembling the colour of salt!

The most typical 'core' breeding species in the salinas in the Mediterranean are the black-winged stilt *Himantopus himantopus*, avocet *Recurvirostra avocetta*, kentish plover *Charadrius alexandrinus*, gulls and terns, especially common and little terns (*Sterna hirundo* and *S. albifrons*). Stilts breed in areas overgrown with halophytes, avocets prefer small, sparsely vegetated islands or dykes, and kentish plovers require areas of bare ground, while gulls and terns breed on dykes, small islands and muddy shores. The original breeding sites for the little tern are made of sand, therefore in salinas they choose similar breeding areas to larger congeners. Another common feature for all the above-mentioned typical salina breeding birds is that they usually nest in colonies; these can be very dense, as is the case with terns or gulls, or scattered, as for kentish plovers, where the character of the colony is determined by the availability of breeding sites. Approximately 90% of the breeding population of black-winged stilt in Portugal is found in salinas (Rufino, Neves, 1991) and all populations of yellow-legged gulls *Larus cachinnans*, little terns and avocets in Slovenia are located in salinas. Around 70% of the total population of the Mediterranean endemic species, Audouin's gull *Larus audouinii*, was reported to breed in salinas in the late 90s (Sadoul, Walmsley, Charpentier, 1998). The breeding population of sandwich terns *Sterna sandwichensis* in the Pomorie salinas and the adjacent salt lake has increased from only 6 pairs in 1996 to more than 400 pairs in 2002 (Nikolov, pers. comm.). This colony is the only regular breeding site of this species in Bulgaria. Another 'white' species can be described as typical for the salinas: the little egret *Egretta garzetta*. This species can be found in the salinas throughout the year, although it does not breed in this habitats. This species has a special nasal gland, an anatomical feature which enables it to get rid of excessive salt, which is not found in other herons.

Although some of the above-mentioned 'white' species are widely distributed across the Mediterranean, the most typical bird in salinas, from the perspective of an average bird-watcher, would most probably be the greater flamingo *Phoenicopterus ruber*. These magnificent pinkish birds were limited to only a few sites in the Mediterranean some decades ago, but nowadays their colonies are spreading both from the west (they have already reached salinas in the Po river delta area (Commachio, in north-eastern Italy) and in the Eastern Mediterranean, where they have established new breeding colonies in Greece.

The mixture of breeding birds, especially Passeriformes, occupying the habitats along the edges of salinas, such as reed-beds, bushes, trees and even buildings, is much more diverse. At least two song-



▲ Black-winged stilt (top)
avocet (bottom), two
common breeders
in salinas
Photos: Henri Guennel

bird species breeding in “core” saline areas should be mentioned: the yellow wagtail *Motacilla flava* and the tawny pipit *Anthus campestris*.

Salinas are very attractive to birds, as they provide plenty of food, especially invertebrates and fish, but also plants. This is an important feature during the migration and wintering period, when the combination of mild climate and high salinity prevents surfaces from freezing even during cold spells. Located along seashores and in estuaries, salinas are on the main migration routes. Waders, dozens of species and thousands of specimens, can be found in salinas during migration. These birds require shallow water, not more than a few centimetres deep, where they can find invertebrates in the mud. Ducks and geese also frequently visit salinas in the cold part of the year; the salinas in Piran are the most important wintering site for wigeon *Anas penelope* in Slovenia and one of the most important wintering sites for coot *Fulica atra*. These birds often feed on submerged vegetation (*Ruppia* sp.) in deeper basins. Among the ducks, we should not forget the shelduck *Tadorna tadorna*, the western Mediterranean breeding population of which often use salinas as breeding grounds. This is one of the few species which migrate northwards after the breeding season (Wadden Sea), but fly back to the Mediterranean in the first half of winter. In the Eastern Mediterranean salinas, this species is sometimes replaced by its globally threatened relative, the ruddy shelduck *Tadorna ferruginea*.

There are other facts which explain the importance of salinas for birds. Firstly, salinas are often one of the few, if not the last remaining relatively undisturbed wetland habitats along the coast of the Mediterranean. The majority of Mediterranean wetlands, more than two thirds in some countries, have been destroyed in the last century or so, mainly due to changes in land use (CEC, 1995). Tourism, agriculture, urban development and related infrastructure and agriculture can be identified as the main reasons for wetland loss. The second reason is that salinas are paradoxical in terms of natural hydrological cycles: these man-made habitats offer plenty of food, especially in times when other ‘natural’ wetlands in the Mediterranean are running short of water. This is often the case during periods of summer drought. Management of salinas for salt production in general supports basins full of water in spring and summer, the driest period of the year. Consequently, shallow or dry basins are left for the autumn and winter, and make excellent feeding sites for migrating waders and other species.

Based on extensive experience gained working in salinas, Hjalmar Dahm (unpublished) provided the following practical recommendations for management of the salinas on Lesvos. These actions would not affect the production of salt in a negative way:

- Manage the water by flooding the salina earlier in the season and keeping water levels as stable as possible (from late March until the end of July).
- Maintain existing breeding sites, especially sites for tern colonies. Small islands should not under any circumstances be taken away. Reinforce sites where breeding takes place, but that are low and thus easily flooded. Reinforce mud banks where breeding was attempted, but not successful due to flooding.
- Manually create new breeding sites in specific zones.
- Remove dense vegetation (*Arthrocnemum* sp.) to allow avocets and black-winged stilts to breed.
- Keep the wooden stakes that remain after the erosion of the dikes as they often are used by resting terns close to the colony.
- Carry out major maintenance works outside the breeding season as far as possible.

- Separate mud flats from the surrounding dike to avoid penetration by predators.
- Carry out a regular survey of the birds the whole year around to acquire greater knowledge and to enable follow-up of the above actions and recommendations.

Salinas are man-made habitats. As such they require human intervention to retain the ecological values and character of the area. Besides, they are one of the very few human interventions in the environment that have proven to be sustainable and even beneficial for nature. Species have adapted to this particular environment and have co-existed with man in these habitats over the centuries. It would make no sense to leave salinas, these precious habitats, to the processes of natural succession. Such an approach should be promoted for those areas where human impacts caused severe damage to the natural environment: examples include estuaries, coastal lagoons, sand-dunes, etc. Here, initial restoration of ecological functions should be carried out and afterwards the areas should be left to natural succession. Traditional salinas should be preserved and managed as shown by our grandparents; not only for the benefit of nature, but also to demonstrate that people are part of nature.

Management Plan for Castro Marim Nature Reserve – Case Study

Rui Rufino¹

The limits of the area are those of the Castro Marim Nature Reserve, located on the right bank of the Guadiana estuary, Algarve (southern Portugal). The Reserve extends over 2,153 ha, 66% of which is classified as wetland, with salt marshes, salinas and intertidal mud and sand flats. The whole area is dominated by halophytic vegetation and is subject to tidal influence. The wetland also includes some ephemeral ponds, both fresh and brackish.

Most of the remainder of the area is occupied by farmland, with small parts being built-up areas or forest. The Management Plan is divided into the following sections:

1. Description
 - General information
 - Environmental characterisation
 - Socio-economic characterisation
2. Evaluation and Objectives
 - Evaluating components
 - Factors affecting management
 - Management guidelines and objectives
3. Management Measures
 - Maintaining and increasing habitat diversity
 - Maintaining and increasing flora and fauna communities
 - Promoting sustainable use of natural resources
 - Promoting knowledge and public awareness of the site
 - Work Plan
 - Revision of the Plan

¹ The management plan summarised in this text box was coordinated by Luis Costa (2000).

Section 1 describes and gives information on the location, ecological characteristics and socio-economic conditions of the Castro Marim Nature Reserve. Section 2 identifies factors affecting management, while as section 3 describes the specific management measures for the area.

Box 1 – Summary information on the flora and vegetation of Castro Marim Nature Reserve

Inside the Nature Reserve, 462 plant species have been identified. Among these, some have special conservation status: *Picris algarbiensis*, a Portuguese endemic classified as vulnerable in the country, *Limonium diffusum* (threatened) and *Beta macrocarpa* (vulnerable). Three other species – *Melilotus fallax*, *Halopeplis amplexicaule* and *Riella helicophylla* – are included in the Habitats Directive Annex II and one species, *Picris willkommii* (an Iberian endemic), is included in Annex IV of the same Directive.

Box 2 – Summary of the legal constraints in the Castro Marim Nature Reserve

Land use constraints – The area is classified as a Nature Reserve within the framework of the Algarve Land Use Plan and the Municipal Master Plans of Castro Marim and Vila Real de Sto. António, the two municipalities where the site is located. The absence of reclassification under Portuguese Decree no. 19/93, and the lack of a specific land use plan limits the decision-making power of the Nature Reserve’s managing board.

Property regime – Most of the land is privately owned.

Hunting – Hunting is prohibited inside the Nature Reserve.

Road network – Changes are expected to be implemented in the existing road network and will affect the Nature Reserve.

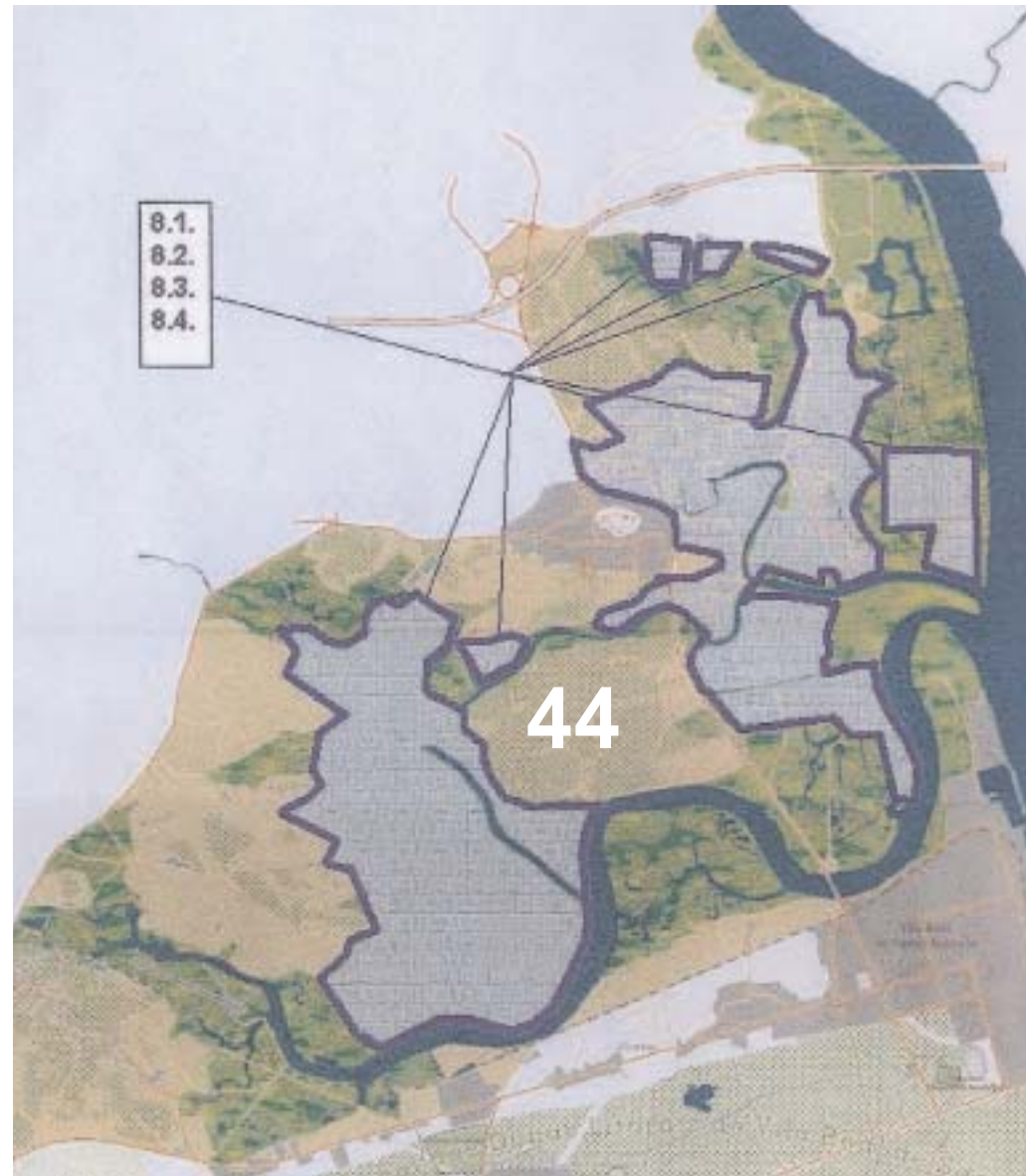


› Castro Marim Salinas
Photo: Hjalmar Dahm

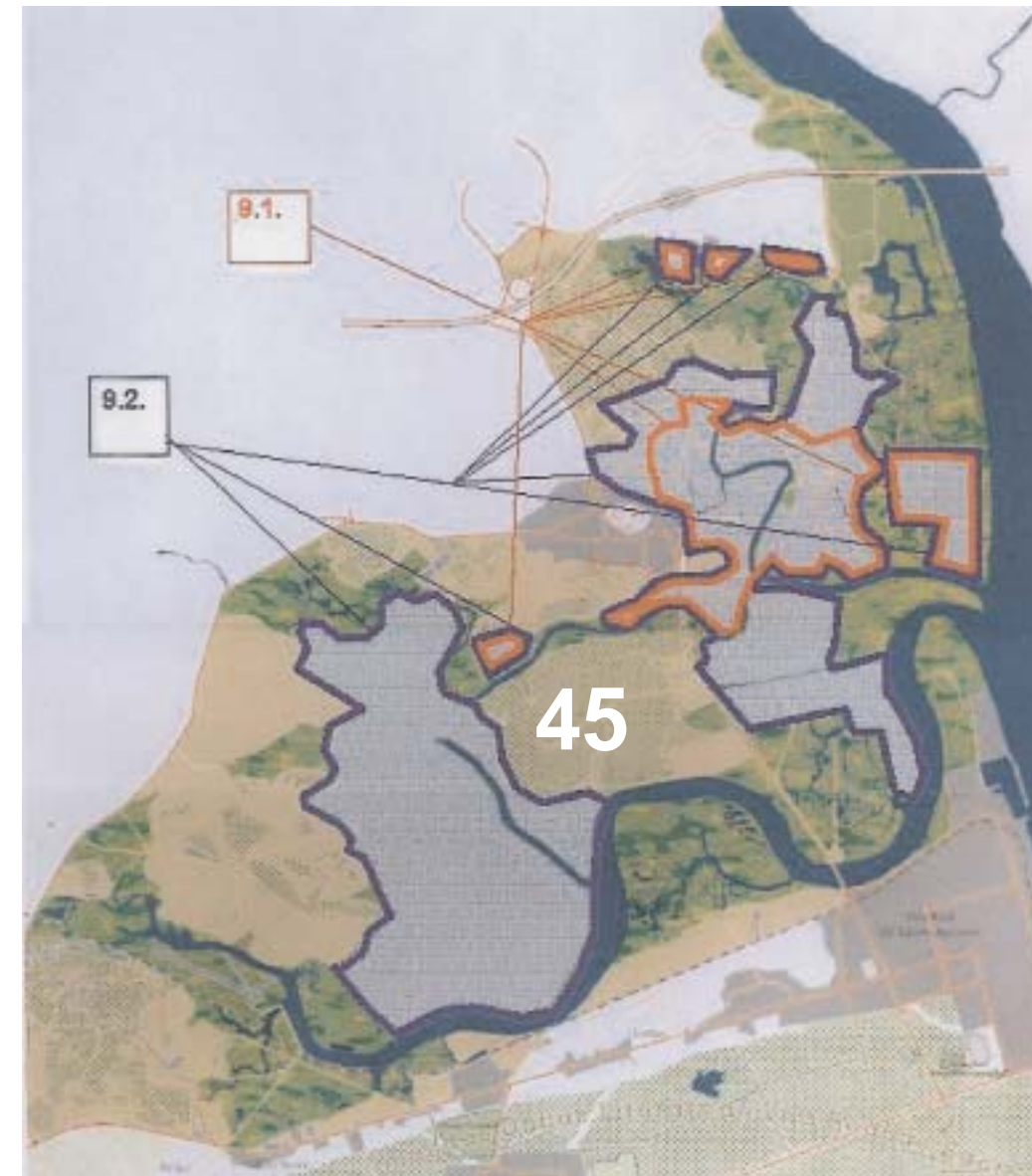
Box 3 – Some examples of the measures described in Section 3 of the Management Plan

Objective 8	Measures	Actions
Increase breeding populations of black-winged stilt <i>Himantopus himantopus</i> , avocet <i>Recurvirostra avosetta</i> and little tern <i>Sterna albifrons</i>	8.1. Maintain breeding sites	8.1.1. Clear the vegetation from the walls
		8.1.2. Maintain adequate water levels throughout the breeding season
		8.1.3. Install an emergency discharge system
	8.2. Control predation of egg and young birds	8.2.1. Reduce the number of stray dogs
		8.2.2. Place deterrent devices on the edge of the bird colony
	8.3. Limit access to the main breeding sites	8.3.1. Fence the main breeding colonies
		8.3.2. Put up gates to prevent car access
		8.3.3. Place panels with information in the main breeding areas
Objective 9	8.4. Monitor breeding populations	8.4.1. Conduct 3 bird censuses during the breeding season
		8.4.2. Map breeding locations
	Increase the population size of migratory water birds	9.1. Ameliorate habitat quality for water birds in traditional-salinas
		9.1.1. Lower the dividing walls in traditional salinas
		9.1.2. Maintain adequate water levels in the pans
	9.2. Monitor wintering water bird populations	9.2.2. Conduct monthly censuses from September to March

For the two measures in Box 3, the maps with their location are given below.



► Location of management plan measures listed in box 3 (page 83)



◄ Location of management plan measures listed in box 3 (page 83)