Chapter 6
Evolution, Impacts and Management of the Wetlands of the Grosseto Plain, Italy

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Abstract This chapter analyses the wetland areas of the Grosseto Plain on the central west coast of Italy starting from a general description of the multiple roles of wetland ecosystems and their value to humanity at a national and an international level. A brief description of their geological origin and of their evolution though history is given taking into account human interventions ever since the Etruscan-Roman period. In particular the wetlands of two main areas, the Diaccia Botrona Provincial Nature Reserve and the Maremma Regional Park, are described from a geomorphological, botanical and faunal point of view and are considered intrinsically connected to other water bodies of the region making up the 'Maremma wetland complex'. In the last section conflicts among stakeholders on the main environmental issues are highlighted and focus is made on the ongoing management plans and actions that are now taking place.

Keywords Evolution of environment • Natural and human impacts • Management • Wetlands

6.1 Introduction

According to the Ramsar convention (1971) wetlands are defined as: 'areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed 6 m'. These particular ecosystems host specialised flora and fauna that are highly valuable both from an ecological and biogeographical point of view. The destruction of these environments has taken

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place and still occurs throughout the world. Wetlands are globally distributed so it is not surprising that the first modern intergovernmental treaty on the conservation of nature resources had the aim of protecting these particularly complex environments. For this reason only a few decades ago, international laws and a detailed guidance on the development of National Wetland Policies and on management planning for individual wetland sites were adopted and included in the Italian legislation (Galletti 1995). In the past, it was generally recognised that wetlands were unhealthy environments with little value, which could be exploited advantageously only through land reclamation strategies. However, this concept was based on scanty information on the uniqueness of the environmental characteristics of wetland areas and on the tendency to privilege the enhancement of a territory only through land reclamation strategies (Galletti 1995).

The multiple roles of wetland ecosystems (productive environments providing tremendous economic benefits, cradles of biological diversity, storehouses of plant genetic material, etc.) and of their value to humanity have been increasingly understood and documented in the last century. However, today, knowledge is still lacking in some cases and if present, it is incomplete and/or non-homogeneous. The absence of information is thus a limiting factor not only for science but also for the key role that it plays in the correct management of wetland areas. In fact, inadequate management strategies generally lead to irreversible environmental changes of wetland areas with enormous costs to human welfare.

Due to the particular morphology of its coast, Tuscany has always been characterised by a very rich and diverse number of wetlands and by extensive floodplain woodlands with hydrophilic characteristics. In northern Tuscany marshes could be found at the deltas of the Serchio and Arno rivers, in the Bientina basin (Pisa and Lucca provinces), in the Valdinievole (Pistoia and Florence provinces) and along the Leghorn coast. To the south extensive wetland areas occurred at the deltas of the Bruna, Ombrone and Fiora rivers. Furthermore, in inland Tuscany marshes once covered the areas located in the Arno Plain to the south of Florence and in the Val di Chiana (Siena and Arezzo provinces).

When Italy was unified in 1861, in Tuscany there existed about 57,000 ha of marshlands, equal to 2.4% of its territory. Nowadays, these areas have decreased to about 11,500 ha corresponding to 0.5% of the entire territory. These remaining wetlands differ in typology according to the different altitude at which they occur (plains, hills, mountains) and according to their different origins (coastal, fluvial, glacial and karst) and water quality (from hyper-saline to freshwater).

The protection of the natural environment and of the landscape is one of the major issues in economical regional planning and must thus avail itself of an interdisciplinary kind of territorial planning. Nature conservation is therefore a very challenging topic, as it involves all environmental compartments and an array of different expertises (Doccioli 1970).

In an over-populated country like Italy, today's landscape is the result of a series of slow but profound modifications that have occurred through time and that are the result of changes in human conditions and needs (housing typologies, food demand, farming, leisure activities, tourism, etc.). However, these environmental changes

have varied greatly from one region to another resulting in a great variety of different situations, ranging from almost pristine to totally impacted ecosystems (Barsanti and Rombai 1986; Maniglio Calcagno 2006).

In the Mediterranean, the alluvial plains, formed by nearby rivers, represent one of the environments that have been best able to cope with human impacts. This has mainly occurred on account of the unfavourable life conditions (risks of malaria) that in the past were present in those areas and also because of the absence of adequate technological means. This has been the case for the Grosseto Plain, in which the presence of large private estates, characterised by an enduring ultra-conservatism and of politically strong local hunting associations (with a long tradition in water fowl hunting) have contributed to the conservation of the marshlands. For these reasons a consistent part of the wetlands have reached our days almost in their original state and have been preserved from important historical interventions such as land reclamation.

6.2 Origins and Evolution of the Grosseto Plain

6.2.1 Geomorphologic Characteristics

The Ombrone River basin is subdivided in four sub-basins: the Ombrone, Albegna, Bruna rivers and the Osa stream, covering a total of 4,768 km^2. All systems are included within the territory of the Tuscany Region.

The main river of the basin, from which it takes its name, is the Ombrone River that is also the largest in southern Tuscany, with a catchment area of approximately 3,500 km^2. Flowing on Pliocene loamy-sandy sediments, this river has the greatest suspended sediment load as compared to other rivers in Tuscany. Its fluvial regime is influenced by seasonal rainfall and during the period of highest precipitations, it causes abundant erosion throughout the landscape (Matina et al. 2005).

During the last glacial interval, the Ombrone and Bruna rivers cut two valleys into the Late Pleistocene deposits on opposite sides of the present alluvial plain, leaving in the middle a ridge protruding towards sea. Due to post-glacial warming and the consequent rise in sea-level, the sea invaded the coastal valleys and formed a large gulf with two inlets. Later these inlets were filled up by the sediments carried by the two rivers, the southern of the two inlets filling more rapidly because of the higher loads of clastic material carried by the Ombrone. During the first post-glacial phase mainly coarse sediments were deposited and formed the gravel layers of groundwaters. Subsequently, as the temperature increased, finer alluvial sediments were carried, forming silt and clay deposits. In the southern part of the plain, formed by the Ombrone, gravels and sandy layers are thicker and more abundant, whereas in the northern area of the Bruna silt and clay deposits are mainly to be found (Innocenti and Pranzini 1993; Carboni et al. 2002; Bellotti et al. 2004; Biserni and van Geel 2005).

The Ombrone River originates from the south-eastern Chianti hills near San Gusmè (Siena). After a relatively complex course of about 165 km through narrow and steep valleys, it runs out into the Tyrrhenian Sea in an area south-west the city of Grosseto. The final section of the river has a meandering course and has a typical lentic environment characterised by very slow water flow.

The Grosseto Plain is thus an alluvial plain formed by the progressive build up of sediments, especially by the Ombrone River (Bellotti and Davoli 2001). In the sixth century BC, during the Etruscan period, dune formations along the coast created a vast lagoon that gradually was transformed into a large lake, the so called Prile Lake, that received waters from the Bruna River. In more recent times, the progressive and gradual input of sediments carried by the Bruna or deposited during floods by the Ombrone rivers filled up the lake and formed extensive marshlands.

6.2.2 Erosion and Salinisation

Nowadays, the delta of the Ombrone River is undergoing a strong erosion process that began during the second half of the nineteenth century after a long period of accretion that occurred more or less rapidly according to the different climatic conditions and the historical events (Pranzini 2001; Ciampi 2007) (Fig. 6.1). The relatively recent change in this trend was triggered by the beginning

Fig. 6.1 The Ombrone River mouth (Photo L. Chelazzi)

of the land reclamation process, through artificial aggradation (filling up technique, the 'Colmata', Zanchi and Cecchi, this volume). This process continued until the fifties of the last century and resulted in a great decrease of fluvial sediments to the sea. However, the phenomenon of erosion continued even after the end of the land reclamation processes and today, it is still affecting wider and wider areas of the delta. The sedimentary deficit of the littoral can be attributed to the low quantity of sediments that are now carried by the Ombrone River caused by human interventions on the river banks and bed. In fact, river bed quarrying is an important activity still going on in several locations along the river.

As a result of the strong erosion, the advancing sea has caused marine water intrusion into coastal groundwater and has invaded the surface of vast bordering areas.

In the Grosseto Plain, the salinisation of the water table is a complex phenomenon (Bencini and Pranzini 1992; Pranzini 1996; Grassi and Netti 2000). In fact, marine water intrusion is seasonal (proceeding in summer and receding in winter) and progressive, as it tends to advance towards land through time. Also pumping groundwater for crop irrigation worsens the situation and attracts marine water to wells. Furthermore, in some areas mineral water of deep layers naturally reaches the surface and mixes with sea water. Another phenomenon contributing to ground water salinisation is the extraction of salt water from clay layers of marine and lagoon origin.

6.2.3 Land Reclamation and the Rural Property Act

The alluvial origin of the Grosseto Plain has determined the presence of extensive marshlands, a characteristics that distinguishes the area. These marshes were once fed by the waters from the Bruna River and by the floods from the Ombrone River. Ever since the Etruscan-Roman period, the first attempts to reclaim land for agricultural purposes were made and interventions were carried out to favour water outflow. However, it was not until the Medicean period, during the seventeenth century, that the first water infrastructures were built. These aimed to ameliorate the water quality of the Prile Lake exploited, at the time, for fishing activities. When important cities arose in the area, several navigable channels were built. These fostered trade and thus merchandise could be easily transported to the port of Castiglione della Pescaia. It should be recalled that only during this period land reclamation interventions started to be successful. In fact, besides the construction of channels, it was necessary to raise the river banks of the Ombrone to prevent water from invading the newly reclaimed lands during river floods (Barsanti and Rombai 1986). However, the territory on the left hand side of the Ombrone did not receive the same attention as the one on the right. In fact, given the presence of important centres on the river's right bank, the first interventions to contain the river waters and the building of channels occurred on this side. Interventions (river embankment and the construction of channels) on the other side of the river were

carried out only later in time and it was not before the first decade of the twentieth century that some real results were achieved.

Besides the channels built to drain the plain, during the nineteenth century another series of channels were constructed to convoy the waters to the plain during flooding of the Ombrone River. This technique of aggradation, namely the filling up of the lands with fluvial sediments for their reclamation, when used systematically, gave important results similar to the ones that had originated the plain itself. This technique, used until the beginning of the 1950s, aimed at reclaiming land for agriculture and at solving the plague of malaria. Once the disease was wiped out, also thanks to DDT, both the end of the land reclamation process and the pressures on behalf of the local hunting associations led to the conservation of some wetlands of the Grosseto Plain. In fact, ever since the mid-seventies of the last century, the Diaccia Botrona Provincial Nature Reserve and the Maremma Regional Park were declared protected areas by the Grosseto Province and Tuscany Region respectively. In the Maremma Regional Park several levels of protection were established with some areas declared as 'integrally protected'.

From the period of the Habsburg-Lothringen dynasty, in 1737, to the first decades of the last century, the image of the Maremma has always been associated with a fertile and rich farming area thanks to the choices in cultivations and to the reorganisation of its lands. After the rural property Act of (Riforma agraria) dating back to the first years of the 1950s, owners of small properties transformed traditional farming into intensive and specialised farming and in a very short period of time were able to obtain the best results both from a social and economic point of view.

Today, the Grosseto Plain is heavily impacted by a network of highly productive farms. Here, standards of living are quite high and all kinds of problems regarding the social disequilibrium between city and countryside have been solved. Farming, today, is seeking larger markets also thanks to the processing and enhancement of typical local products. Furthermore, it may also be stated that besides farming, tourism has also become a highly competitive activity that can take advantage not only of sea-side tourism (sun bathing, swimming, sailing, tracking, etc.) but also of cultural activities that can be carried out along the coast and in the more inland areas of the territory.

6.3 Diaccia Botrona Provincial Nature Reserve

6.3.1 Ecosystem Description: General Features and Water Quality

Near the town of Castiglione della Pescaia, on the western part of the Grosseto Plain, lies a wetland area that includes the Padule of Castiglione, a portion of the Padule Aperto, the pinewoods and the coastal dunes (Fig. 6.2). The entire area (about 3,000 ha, 0–5 m above sea level) is considered an IBA (Important Bird Area)

Fig. 6.2 Diaccia Botrona Provincial Nature Reserve: map of the area (Modified from Google Maps)

and it is delimited by the Bruna River to the north-west, by the Affacciato bank and San Leopoldo Emissary channel to the east and by the coast to the south-west. Within the area lies the Diaccia Botrona Provincial Nature Reserve of about 1,000 ha that was declared a SPA (Special Protection Area, EC Directive) by a national law. The Reserve is subdivided in two main wetlands from which it takes its name: the Serrata of the Diaccia and that of the Botrona.

Furthermore, about 80% of the IBA is made up of reclaimed land for farming and a fish farm.

Within the area there is a system of channels interconnected by a complex network of secondary channels that spread out into the wetlands collecting and draining freshwater run-outs originating from rain (Fig. 6.3). The wetlands receive fresh water from the Molla drainage channel to the north and from the Cernaia pumping infrastructure to the east. With the tides, sea water reaches the wetlands, passing through the Castiglione della Pescaia Port channel that is connected to the Molla channel through the Bruna River. From here, sea water passes on to the Tanaro ditch, to the Bilogio channel and to the Antico Navigabile channel and then into the wetlands with a rich system of smaller channels.

The Diaccia Botrona Provincial Nature Reserve, declared as a nature reserve in 1991, encompasses four different landscapes: a dune with wood vegetation and the nearby relict areas of hygrophilous woodlands; the Serrata of the Diaccia and Botrona (salt marshes, salt pastures e salt steppes) that make up almost 70% of the

Fig. 6.3 Network of channels and wetlands of the Diaccia Botrona Provincial Nature Reserve (Photo L. Chelazzi)

entire Reserve; the channels built to reclaim land together with the section of the Bruna River within the Reserve; the grounds of the 'border' areas.

In the Reserve, landscape features and ecological characteristics have rapidly changed within a decade. In particular these changes occurred when the area was protected from waterfowl hunting and when management by the hunting associations suddenly ended. Once the new local administration (the Grosseto Province) took charge, the Reserve was subjected to endless legal procedures that determined a long period in which all kinds of interventions in the wetlands were rendered impossible. This led to a decisive change in the functioning of the entire ecosystem. As a matter of fact, from a typical stable freshwater environment there was a rapid change towards a brackish, unstable one, as demonstrated by previous studies on the flora and the fauna.

As to the chemical and physical characteristics of the waters of the Reserve, today, there are two different situations according to the season: during the winter-spring period there is a freshwater tendency whereas during the summer the water becomes saline or hypersaline. In the first case, the abundant rainfall on the entire basin to the north of the Reserve causes a consistent decrease in water salinity values that may reach oligohaline conditions. In the second case the scarce precipitations and the increase in temperature together with marine water intrusion, due to the tides, cause an increase in salinity values that, sometimes, may reach hyperhaline conditions. This phenomenon appears particularly evident in the so-called 'chiari', located at the centre of the wetlands. In fact, these areas are not subjected to abundant water exchanges with external sources and receive fresh water from rain during the winter season and salt water during the summer. Furthermore, the ground surface of the

marshes is saturated with salt so it is clear that when evaporation takes place in the hottest period of the year there is a consistent increase in water salinity (even over 60‰). When hyperhaline conditions occur in association with anaerobiosis massive deaths of aquatic organisms take place, changing chemical characteristics including the ones in wetland border areas. In the last decades, scarce water exchange in the channels, due to their filling up because of floods, to natural biological sedimentation and to the absence of routine maintenance, have played a key role in favouring the above cited phenomenon.

6.3.2 Botanical Features

During the winter season macroalgal biomass is not particularly developed in the waters of the Reserve, except for a scarce presence of *Enteromopha linza*. Contrarily, during the summer, blooms of macroalgae can appear along the channels and in the larger basins near Ponti di Badia.

From a botanical point of view in the Diaccia Botrona Provincial Nature Reserve eight units can be distinguished according to their physiognomy: flooded areas and water-courses; riparian formations; 'lamineti' with succulent halophytes; halophytes with *Halimione*, *Suaeda* and *Limonium*; Juncetum associations; hygrophilous woodland; pinewoods; cultivated lands (Tomei et al. 1991; Tomei and Guazzi 1993).

1. Flooded areas and water-courses. Along the watercourses and in the permanent water pools, especially in the southern section, *Ruppia spiralis* occurs together with algae of the *Enteromorpha* and *Chaetomorpha* genus. The presence of these species is related to the high levels of salinity and to the eutrophication processes that characterise the waters of the Reserve.
2. Riparian formations. Generally these areas host hygrophilous species not adapted to salt water conditions. These entities, not particularly rare in freshwater wetlands, were once widely distributed also in the Reserve. Today these species are restricted to small elevated areas that can not be reached by salt water inundation. For this reason, these areas of the Reserve are considered particularly relevant for their flora.
3. 'Lamineti' with succulent halophytes. These are halophytes inhabiting the salt pans that remain submerged from autumn to spring.
4. Halophytes with *Halimione*, *Suaeda* and *Limonium*. These formations develop in areas slightly more elevated compared to those of the 'lamineti' with succulent halophytes and are subject to periodical salt water inundation.
5. Juncetum associations. In the Reserve several species of the genus *Juncus* are widely represented. *J. maritimus* is generally located on less salty grounds, while *J. acutus* can be found in the more halophilous formations together with *Salicornia*. In a section to the north of the Reserve a vast and continuous vegetation cover of *J. subulatus* occurs. This species is typical of brackish bogs and is important from a phytogeographic point of view.

6. Hygrophilous woodland (Fig. 6.2). In the southern section of the Reserve, to the south of the Tanaro ditch, there is a remnant hygrophilous woodland mainly composed by *Ulmus minor* and *Fraxinus oxycarpa*.
7. Pinewoods. The 'Pineta Granducale' (Fig. 6.2) is a pinewood on the consolidated dune extending from the town of Castiglione della Pescaia to that of Principina a Mare. This pinewood was originally planted between 1831 and 1848 by the Lorena Family when interventions were made to reclaim land along the coast. The pinewood is mainly composed by the stone pine tree (*Pinus pinea*) and in a smaller percentage by the maritime pine tree (*P. pinaster*) in areas closer to the sea. The pinewood plantation, that today hosts pines of different ages, is quite valuable from a landscape point of view. In the large sunny openings of the forest many Mediterranean maquis shrub species appear.
8. Cultivated lands. Cultivated lands are mainly located to the east of the Arginone and in some areas of the Botrona. These lands, fit to be sown, are sometimes left unplanted and are thus invaded by spontaneous species and consequently grazed.

It must be noted that some plant species of the Diaccia Botrona Provincial Nature Reserve have been included in the 'red list' of Tuscany's regional plants because they have been declared as 'endangered plants'. These are *Althenia filiformis* found in flooded areas and water-courses, *Aeluropus litoralis* of the 'lamineti' with succulent halophytes, *Halimione portulacoides* and *Oenanthe acquatica* of the halophytes formations and *Eryngium maritimum, Euphorbia paralias* and *Medicago marina* of the psammophilous formations.

The existence of many plant species present in previous studies has not been recently confirmed. These are mainly freshwater plant species that were present in the Diaccia Botrona until 1993 and that today have disappeared because of the environmental changes that have occurred in the water salinity of the wetland (from freshwater to brackish).

Today the Diaccia-Botrona's landscape is almost entirely composed by brackish water plants. The non-halophilous plant formations (riparian formations, including reed thickets of *Phragmites australis*) are extremely rare, limited in extension and are found in the more elevated areas of the wetlands. However, these formations seem to maintain a good capacity in invading new grounds when the salinity values decrease, as was demonstrated by the recent colonisation of some pools near the Ponti di Badia. Hence, the presence and distribution of the plant formations in the marshes is strongly determined by the quality of circulating water that causes the withdrawal of the freshwater formations in favour of the 'lamineti' with succulent halophytes and/or other halophilous formations.

6.3.3 Faunal Features

The community structure of the vertebrates of the Diaccia Botrona Provincial Nature Reserve has been well studied (Aminti et al. 1995; Puglisi et al. 1995a, b). The same can not be said for the invertebrate community for which studies are poor

and episodic (Cognetti and Maltagliati 2000; Cognetti 2002). There is, however, an unpublished work by Cognetti et al. (1998) on the aquatic fauna, that today could be useful as a comparison for new studies. The work showed that in the inner channels and especially in the 'chiari' invertebrates were quite scarce and mainly represented by some oligochaetes, chironomid larval flies, gastropod and by crustacean species.

In the waters of the entire area of the Reserve the fish community is subdivided in two clear sub-communities: a freshwater and a marine-brackish water community. In fact, in the waters of the larger channels the fish community is similar to that of the Bruna River and is characterised by the presence of euryhaline species. However, there is also a rich number of freshwater species surviving in the channels thanks to a surface freshwater current. Furthermore, it should be noted that some freshwater species of the larger channels, such as *Gasterosteus aculeatus*, appear seasonally and are related to winter floods and thus to changes in the water salinity. On the other hand, when there is marine water intrusion, due to particular tidal conditions, freshwater species are pushed to the north outside the boundaries of the Reserve. These species do not directly come from an upstream migration of the Bruna River but have probably originated from the internal network of channels.

Instead, the waters of the Serrata of the Diaccia are inhabited by a restricted number of fish species. Here, except for eels (*Anguilla anguilla*), other freshwater entities are totally absent even during periods of heavy rains.

Near the mouth of the Molla channel a typical marine-brackish fish community occurs and, when proceeding inland towards the Serrata of the Diaccia, the community remains more or less the same, except for some marine species (Blennidae) typical of ports and other rocky areas.

In the most internal areas of the Reserve there is a constant composition of species namely *A. anguilla*, *Aphanius fasciatus*, *Gambusia affinis*, together with mullets and *Pomatoschistus canestrini*. The presence of *Dicentrarcus labrax* in this habitat is probably related to individuals coming from the nearby fish farm. In terms of diversity, two species must be mentioned: *A. fasciatus* an important species because quite rare and *G. affinis* a very competitive and allochthonous species that was introduced during the middle of the last century to contrast malaria.

The fish population of the Serrata of the Botrona is quite poor and is composed almost exclusively by very dynamic populations of *G. affinis*. In fact this is the only species capable of a seasonal re-colonisation of the environment after the summer droughts.

As to amphibians the Reserve does not have a particularly rich array of species and probably the populations have been negatively impacted by the general increase in water salinity of the area. Ditches, channels of farming areas and low lands occurring along the northern margins of the coastal woods are the most favourable areas for the amphibians.

Contrarily, the Reserve has several reptiles some of which occurring in very small populations or rapidly declining if not already locally extinct (European pond turtle *Emys orbicularis*).

Even if limited in space, the Diaccia Botrona Provincial Nature Reserve has a considerable number of heterogeneous habitats making it a suitable environment for a great number of bird species. It has been estimated that more than 250 species exploit the environment during spring and autumn migrations and over 30 species use it as wintering and nesting grounds.

The Reserve, together with the entire 'Maremma wetland complex' of Tuscany's littoral wetlands (Baccetti et al. 1996), is one of the best studied sites regarding birds (Rome' et al. 1981; Arcamone et al. 1994; Aminti et al. 1995; Corsi and Giovacchini 1995; Puglisi et al. 1995a, b; Puglisi and Baldaccini 1997; Baccetti et al. 2002).

The recent modifications that have occurred in the Reserve have completely changed the quality of the habitat and have determined different spaces available to birds. In this respect, the waterfowl community has had the greatest benefits. These birds, in fact, have very much increased in the Reserve thanks to the large ponds that have been recently created at the Serrata of the Diaccia and that are ideal areas for birds to rest during daytime hours. However, if the entire 'Maremma wetland complex' is considered, it is clear that the zone has not increased its reception capacity but has simply redistributed the species over the wetland areas along the coast of southern Tuscany (Diaccia Botrona, Ombrone River mouth, Orbetello Lagoon).

Similar considerations can be made for the Greater Flamingo (*Phoenicopterus ruber*). This species has had an exponential increased in the Reserve due to two interconnected factors. The first depends on the geographical distribution of the species that has expanded greatly in the entire Tyrrhenian area, while the second is related to the modifications that have occurred in the habitat. Here, an abundant number of low water pools, with high salinity values and rich zooplankton have been created and have attracted birds. The recent modifications that have occurred in the Reserve have completely changed the quality of the habitat and have determined different spaces available to birds. In this respect, the waterfowl community has had the greatest benefits. These birds, in fact, have very much increased in the Reserve thanks to the large ponds that have been recently created at the Serrata of the Diaccia and that are ideal areas for birds to rest during daytime hours. Now the Greater Flamingo stably inhabits the Reserve with seasonal fluctuations tied to migratory or simple dispersal movements, with a mean annual presence of several hundreds of individuals (more than 600 in January 2002).

Another important nesting species that has benefited from the ecological transformation of the habitat is the Black-winged Stilt (*Himatopus himatopus*). At the beginning of the 1990s, this wader was already present in the Reserve with about 80 nesting pairs. Today its number has doubled. Two areas are colonised by this species and are located in sections to the north of the Diaccia and between the Bilogio and Diversivo channels.

Today, the 'Maremma wetland complex', including the Diaccia Botrona Provincial Nature Reserve, has reached international renown because during the winter season it receives a great number of water bird populations.

If changes towards brackish or salty habitats have favoured a certain number of aquatic birds, the changes in vegetation type with the drastic decrease of areas with *Phragmites australis*, *Bolboschoenus maritimus* and *Juncus* spp have caused the sudden decrease of some bird species such as the Marsh Harrier (*Circus aeruginosus*).

In other cases, the progressive loss of habitat has led to the extinction of species such as the Moustashed Warbler (*Acrocephalus melanopogon*) and the Great Bittern (*Botaurus stellaris*) with the first species becoming extinct more rapidly as compared to the second.

Among mammals, all species that typically occur along the central Tyrrhenian coast can be found in the Reserve. Generally, no relevant species inhabit these wetlands except for the extinct European otter (*Lutra lutra*) that during the 1970s used to live in its waters.

6.3.4 Aquaculture

To the south of the Diaccia Botrona Provincial Nature Reserve there is the so called 'Azienda ittica Il Padule', a fish farm that is directly connected to the waters of the Reserve (Fig. 6.2). Today, this farm has a high annual production of about 400 tonnes of Sea bass (*Dicentrarchus labrax*). The farm arose in the 1950s to produce *Gambusia affinis* to contrast malaria and was maintained for 10 years; later the farm was converted to the production of eels (*Anguilla anguilla*) and then to that of Sea bass. The farm has an area of 65 ha of which 80% is made up of water basins. Of these, about 15 ha are occupied by basins in which the water pumped from the Tanaro channel undergoes a purification treatment. A similar area, subdivided into 15 water basins, is used for intensive aquaculture, whereas the remaining 35 ha are used to convey waste waters into other basins where processes of natural sedimentation and phytopurification occur (Saroglia et al. 2002). After the phytopurification process, the water is let into the Antico Navigabile channel and then into the channels connected with the marshes of the Reserve. With this system a good circulation in the waters is guaranteed in the entire area. The breeding basins are covered with nets to protect them from fish-eating birds, whereas the other basins are free and are colonised by natural fish populations. Many water birds take advantage of the situation feeding on the zooplankton, zoobenthos and on natural fish populations according to their trophic niche (Dell'Angelo 1999). In the breeding ponds, fish density is always kept lower than 1 kg/m^2. Feed is of high quality and its supply is interrupted when fish are still actively searching for food items (Saroglia et al. 2002). This best management practice minimises the risks of accumulation of nitrogen and phosphorus in the ponds and guarantees a high quality of the exiting waters. Furthermore, high standards in fish production are also obtained with this method. Liquid oxygen is added to the waters of the breeding basins when particular conditions occur so as to obtain concentrations never lower than 70% of the saturation, even in out flowing waters.

6.4 The Maremma Regional Park

6.4.1 Ecosystem Description: General Features, Water Quality and Coastal Erosion

The Maremma Regional Park was established by the Region of Tuscany in 1975, fostered by the convictions and studies of respected scientists of the University of Florence. Its territory is administrated by the Province of Grosseto is to be found in the municipalities of Grosseto, Orbetello and Magliano in Toscana. The Park includes 8,902 ha of 'Protected Area' and 9,097 ha of 'Border Area'. The area includes a coastal plain (0–15 m above sea level) and the hills of the so called Monti dell'Uccellina (Poggio Lecci 414 m above sea level). The Ombrone River and many other the channels built during the land reclamation flow, in the sandy plain to the north. The agricultural plain, delimited to the east by a chain of hills, is made up of the lands that were once reclaimed from the freshwater lake of Alberese and the wetlands of Talamone. The coast is low and sandy to the north and high and rocky to the south. The Ombrone River flows out into the sandy plain and in the past its sediments have caused progradation of the coast towards the west (Ciampi 2007). Recently there has been an inversion in trend and an erosion process of about 11 months/year is now taking place at the river mouth. Instead, to the south there has been an accretion of the coastline (Colombini et al. 2007), due to sediments eroded at the river mouth and transported southwards by the dominant sea currents.

Both to the north and east of the mount ridge, the plains are under the influence of salt water intrusion. Between 1984 and 1995 studies (Matina et al. 2005) on groundwater salinity were conducted in the northern section of the Park. These revealed that salt water intrusion had reached Spergolaia, a locality at about 5 km from the sea. A different situation appeared in the plain located to the east of the Monti dell'Uccellina where in 1984 no salt water intrusion had been recorded in the water table. Instead, in 1995 this phenomenon was widely distributed on the entire area. In this case, the salinity of the water table is probably not associated to marine water intrusion but to the salt water trapped between the sediments or to the exchange of ions with clay sediments.

The plain within the Park has an array of different levels of wetland environments including: a sandy coast with a retrodunal pinewood, the Ombrone River with its areas between the river and its flood banks, the channels built to reclaim lands, the marshlands, the pastures and lands reclaimed for agriculture close to the sea.

Between Principina a Mare, on the right hand side of the Ombrone River, and Collelungo the sandy coast is undergoing a strong process of erosion that has reached its highest level in the area immediately to the south of the Ombrone River mouth (Fig. 6.4). In this area, up to a distance of 3 km from the river mouth, the dune, that once reached 4–5 m above sea level, has been completely destroyed. The destruction of the dune not only has had a negative effect on the retrodunal pinewood because of the salt spray reaching the pine trees but also because sea water reaches the interdunal depressions of the 'Pineta Granducale' storms. At about 4 km from

Fig. 6.4 Wetlands of the Maremma Regional Park: map of the area (Modified from Google Maps)

the river mouth there is an area in which the phenomenon of erosion and accretion of the beach is in equilibrium. From here onwards, and especially after Collelungo, there is a slow but progressive accretion of the beach. About 200 years ago this area was a marine gulf as testified by the topographical names (Porto Vecchio – Cala Francese – Cala Rossa). Now the area presents a very low dune belt (1–1.5 m above sea level) due to the positive sedimentation process still in progress (Colombini et al. 2007).

At about 500 m to the south of Collelungo, in an area where the process of aggradation reaches its highest level, there is a retrodunal shallow depression where a dune slack occurs. In fact this area, only about 50 m in width, can be periodically flooded by heavy rain or can be invaded by marine water during violent sea storms.

Within the Park there are several water-courses (the final section of the Ombrone River and many channels built to reclaim land) that are important for their environmental and landscape features.

The Ombrone River flows into the Park's territory for less than 10 km, starting from the 'Pian di Barca' meandering to its river mouth. Here the river environment is typically lentic, characterised by a very slow water flow. Furthermore, in this section sea water tends to mix more or less with fresh water of the river according to the river flow rate and to the conditions of the sea. Consequently, there is a progressive increase in salinity values as the waters reach the mouth of the river.

In the Maremma Regional Park a great number of channels were constructed to reclaim land. These are located in the plains to the north of the Ombrone River course and to the east of the Uccellina hills. Some of the larger channels and those receiving water from the network of secondary channels bear water all year long. Of these in the Trappola plain, on the right hand side of the Ombrone River, there is the Collettore Morelle channel that runs into the Ombrone itself whereas, on the left hand side, there are the Essiccatore of Alberese and Scoglietto-Collelungo channels.

In the plain to the east of the Uccellina hills there are three main channels: Piscina Statua, constructed to dry up the Alberese Lake and the Collettori Orientale and Occidentale channels, that flow in the Talamone plain and are connected to the sea through a pumping system. Except for the Scoglietto-Collelungo channel, all these channels are subject to periodical and frequent cleaning operations that permit the constant outflow of the water. For this reason their banks are exclusively covered by herbaceous plants.

6.4.2 Botanical Features

On the first dune belt, the vegetation (Arrigoni 2007) is dominated by species characteristic of sand dune systems (*Ammophila arenaria*). In the retrodune *Juniperus oxycedrus macrocarpa* and *Juniperus phoenicea* can also be found.

The retrodunal depression, dune slack, located in the southern section of the beach, has a typical marshland vegetation due to its particular conditions. Here the main plants include *Juncus acutus*, *Schoenus nigricans* and *Limonium etruscum*. *L. etruscum* was described as a new endemic plant by Arrigoni and Rizzotto (1985) and at the time this plant also occurred in the nearby wetland areas of the Trappola and Talamone. Today, this species has become extinct in these two localities because of habitat loss or misguided management strategies. In fact, at the Trappola an erosion process has wiped out the population whereas at Talamone a parking lot for summer tourists has been built directly over its environment.

The marshlands close to the Ombrone River are what remains of the larger wetlands that were once to be found in the Grosseto plain. Thus what results today is a system that has been constantly transformed by variations of the coastline, interventions for land reclamation, water canalisation, reforestation, exploitation for pasture and agriculture. The low valley of the Ombrone is thus made up of a seminatural environment with a complex system of continuously changing freshwater and brackish wetlands and by an artificial agricultural landscape.

The Trappola, an area to the north of the Ombrone River mouth, is characterised by pools with marshland vegetation (Figs. 6.5 and 6.6), by interdunal areas with *Salicornia* or *Juncus* formations and by woodlands with stone pines (*Pinus pinea*) and junipers (Fig. 6.7). To the south of the river mouth on the Marina di Alberese plain, pinewood (*P. pinea* and *P. pinaster*) formations prevail but in areas closer to the river mouth saline meadows and uncultivated lands also are conspicuous (Fig. 6.8).

Fig. 6.5 Wetlands of the Trappola: aerial view of the Porciatti marshes (Photo L. Chelazzi)

Fig. 6.6 Wetlands of the Trappola: pools with typical marshland vegetation (Photo L. Chelazzi)

The marshland vegetation of the Maremma Regional Park is a complex mosaic of plants due to variations in water quality (fresh or salty), duration of submersion and to substrate type (sand, mud and clay). The marshland vegetation mainly occurs in areas of the Trappola, in those close to the Ombrone River mouth and at the 'Paduletto' at Collelungo. In wetland areas, tree formations are scarce and limited

Fig. 6.7 Wetlands of the Trappola: aerial view of the interdunal wetland area (Photo L. Chelazzi)

Fig. 6.8 Wetlands to the south of the Ombrone River mouth (Photo L. Chelazzi)

to some populations of *Fraxinus oxycarpa* and *Ulmus minor*. Other formations including *Phragmitetum communis* and *Cladietum marisci* have limited distributions in relation to winter submersion and water salinity, while Juncetum and Salicornietum formations are largely dominant in the Park.

The Salicornietum formation is the halophilous marshland vegetation that is best represented at the Trappola and at the mouth of the river. The species that compose the formation appear very similar morphologically speaking because of their succulent aspect but in phytosociological terms three almost monospecific associations occur: *Salicornietum radicantis* species with the widest distribution that inhabits areas subjected to prolonged winter submersion, *Arthrocnemetum glauci* occupying areas with shorter hydroperiods and *Halocnemetum strobilacei* in particularly saline areas.

The 'lamineti' are located in low-lying land with depressions containing permanent water and are colonised by *Scirpus maritimus* and *Salicornia litoralis* together with *Ruppia maritima* and algae of the *Chara* genus.

The Juncetum formation is the most evident and abundant helophytic vegetation of the Park and includes *Juncus maritimus* and *J. subulatus* in more or less saline water and *J. acutus* in freshwater pools.

The marsh grasslands are characterised by grasses and hygrophilous or hygro-halophilous shrubs subjected to seasonal submersion. *Carici extensae–Schoenetum nigricantis* is the dominant association in the marsh grasslands of the Park.

Along the river banks there is a riparian woods with hygrophilous tree species such as *Populus alba* and *Fraxinus oxycarpa*. Instead, in areas closer to the river mouth xerophilous or halo-resistant species such as *Tamarix gallica* are dominant.

From late-spring throughout the entire summer period, large sections of the Scoglietto-Collelungo channel are covered by stems of *Myriophyllum spicatum*, whereas the muddy river banks are characterised by *Juncus acutus*, *Phragmites australis* and *Spartium junceum*.

6.4.3 Faunal Features

In the entire territory of the Maremma Regional Park the faunal component has been accurately studied especially for birds and mammals (Arcamone et al. 1994; Baccetti et al. 1996, 2002). Instead, for invertebrate species and in particular for those of wetland environments, studies are scarce and in some cases totally absent. Only recently, within the WADI Project, more accurate studies were carried out on the diversity of arthropod populations of the beach-dune area and dune slacks of a section of the beach to the south of Collelungo and of the meadows that from the river run up to the embankments and which are subject to temporary submersions.

As to amphipod species, besides the talitrid *Talitrus saltator*, typical of sandy littoral environments, there are also populations of *Orchestia gammarellus* along the Ombrone River banks. This talitrid is very common also inland, in the wetland areas of the Paduletto and of the Serrata dei Cavalleggeri that are not necessarily

and/or permanently submerged. This amphipod during the dry period takes shelter at the base of the vegetation (*Juncus acutus*), where high levels of moisture are found. In the marshes near the Ombrone River mouth, there is a small array of lepidopteran species typical of these environments (Fabiano et al. 2007).

In the dune slack to the south of Collelungo the diversity values calculated for invertebrate species are quite high if compared to the bordering beach-dune system or to other similar wetland areas. This makes it an ecotone rich in species (over 200) belonging to both wetland and Mediterranean maquis areas. This is mainly due to the peculiar characteristics of the environment that permit the existence of a marshland vegetation strictly in between the dune belt and the retrodunal Mediterranean maquis (Colombini et al. 2007).

In the Maremma Regional Park many other invertebrate species are known but rarely do these strictly belong to wetland habitats.

As previously mentioned, the Ombrone River has lentic features in the section flowing within the Park. Thus, the fish inhabiting this section belong to some species that are strictly fluvial and others that are euryhaline, marine and brackish. The first group includes typical fluvial species and many other fish introduced for fishing practices at the beginning of the last century.

In the Scoglietto-Collelungo channel, but also in other channels with permanent water, there are a great number of fish species, this also thanks to the connection with the Ombrone River that generally occurs during the periods of greater outflow.

In the Park certain amphibian species are quite common in freshwater wetland areas, but these are to be found especially in those areas where water occurs during their reproductive phase.

Because of the great variety of habitats that are present within the Park, reptiles are generally very abundant both in species and in numbers. The European pond turtle *Emys orbicularis* inhabits the channels where mechanical cleaning is not carried out as in the case of the Scoglietto-Collelungo channel. In fact, the cleaning of channels and banks can severely damage this species especially during the earlier life stages.

As already mentioned, when speaking about the Diaccia Botrona Provincial Nature Reserve, the wetland areas of the Maremma Regional Park are included in the 'Maremma wetland complex' of Tuscany, making it one of the best studied sites for birds (Aminti et al. 1995; Arcamone et al. 1994; Baccetti et al. 1996, 2002; Puglisi et al. 1995a, b). In the low-lying lands of the Park more than 200 different bird species have been recorded. Of these, almost half are considered 'emergent fauna' at a regional, national and international level.

The wetlands of the Maremma Regional Park are not undergoing radical changes in their environmental characteristic (from freshwater to brackish) like those of the Diaccia Botrona, however, important changes have occurred in the areas close to the river mouth. Coastal erosion has determined salt water intrusion especially in the older interdunes and nearby channels. However, the local names ('Saline' on the right side of the Ombrone River; 'Campo Salino' and 'Saline di S. Paolo' in on the left) and the presence of a typical halophilous marshland vegetation (*Salicornietum radicantis, Arthrocnemetum glauci* and *Halocnemetum strobilacei*) indicate an older condition with typical saline characteristics.

Thanks to the lentic characteristics of the Ombrone River, all areas closer to the sea together with those of meadows and farmlands within and outside the Ombrone embankments, make up the most important wintering site in Tuscany for geese (the Greylag Goose, *Anser anser* and the Greater White-fronted Goose, *Anser albifrons*) and ducks.

From 1975 when the area was first protected, the colonisation of this site by the Greylag Goose has been gradual (Baccetti 2007). Vast areas of pastures and fields, where hunting was suddenly prohibited, became available to the geese. The 'Macchiozze' was the first area to attract the birds. Successively, the number of individuals increased to almost 700 units indicating that habitat conditions permitted longer stopovers. In 1991 when the Diaccia Botrona was declared as a Reserve, the potential foraging areas was doubled. This led to a splitting up of the bird flock into two groups that initially were divided only during the daytime but then, later on, became two distinct flocks. In 2004, more than 2,000 Greylag goose individuals were recorded between the Maremma Regional Park and the Diaccia Botrona Provincial Nature Reserve making the area an internationally important one according to the Ramsar convention (Baccetti et al. 2002). Furthermore, the presence of such a large flock attracted other birds such as the Greater White-fronted Goose and the Common Crane (*Grus grus*).

The entire area, including the coastal sandy zone, has become important also for the overwintering and the nesting of several wader species.

The wetlands of the Park also host a conspicuous number of resident or overwintering birds of prey. Today an Interreg III project of the European Regional Development Fund (ERDF) is aiming at reintroducing the Osprey, *Pandion haliaetus*, in the Maremma Regional Park. It's been 80 years, since the last couple was seen nesting in the area of the Tuscan Archipelago. Now, this project wants to be an attempt at fostering the nesting of this species within the Park itself. Two strategies have been adopted: the use of artificial nests and bird models on the one hand and the translocation of hatchlings from donator countries (Corsica Regional Park) using the locking method on the other.

Given the heterogeneity of habitats and its state of protection, the Maremma Regional Park also represents an extremely favourable environment for mammal species and in recent years it has even been recolonised by the wolf (*Canis lupus*). This species that had become extinct in the area before the establishment of the Park, has now reached a small population of seven resident individuals. It has been suggested that the species has probably used the woodlands of the Ombrone River banks as a corridor to reach the Park. These, in fact, connect the inland wild Chianti hills of Tuscany to the Park without directly crossing important towns or cities.

Besides being an important water source for most mammal species, the channels and river of the Park have become a favourite site for the coypu (*Myocastor coypus*), a typical invasive species. Instead, many herbivorous species have been attracted to the Juncetum and Salicornietum formations and to the saline meadows for their trophic needs. Here, wildlife species such as boars (*Sus scrofa*) and fallow deers (*Dama dama*) feed together with the typical local cattle species ('vacca maremmana')

which is commonly bred in the wild. Furthermore, the Lesser white-toothed shrew (*Crocidura suaveolens*) has been recently recorded in the periodically submerged Juncetum formations and nearby areas.

6.4.4 Management Plan

Most of the 'Protected Area' of the Maremma Regional Park is considered a Special Protection Area (SPA) and is subdivided into four levels of protection: Integral Reserves, Oriented Reserves, Protected Zones and Promotional Areas. Integral Reserves are areas with highly valuable environmental and landscape characteristics due to the presence of significantly important plant and animal species and to the presence of particularly fragile ecosystems. Oriented Reserves are areas with valuable environmental and landscape features that host important plant and animal species that have been characterised by man-made ecosystems or areas that throughout history have been impacted by human intervention. Protected zones are man-made areas characterised by landscape and environmental values connected to traditional cultivations and breeding practices. These are important also on account of the presence of historical sites and architecture. Finally, Promotional Areas are man-made areas characterised by landscape and environmental values connected to local farming and towns (e.g. Alberese).

The wetlands classified as Integral Reserves are: the 'Marshes of the Trappola and of the mouth of the Ombrone', the 'Paduletto at Collelungo' and the 'Coastal Area of Porto Vecchio-Cala Francese-Cala Rossa'.

From a morphological point of view, the 'Marshes of the Trappola and of the mouth of the Ombrone' consist in flat, low-lying areas (at sea level or in some cases even below) occupying the delta of the Ombrone River. These are characterised by a sandy-muddy substrate originating from wetlands and consolidated dunes, which, at the moment, are experiencing a strong process of erosion on the side of the sea. These include the last section of the Ombrone River that in this part has a meandering course and quite a large width.

To the south of the Collelungo promontory, the 'Paduletto at Collelungo' is a plain more or less all at sea level, located between the coastal dune and the Uccellina hills. Water levels and abundance vary greatly according to the season, and the area represents an important ecological continuum with the 'Coastal Area of Porto Vecchio – Cala Francese – Cala Rossa'.

The 'Coastal Area of Porto Vecchio-Cala Francese-Cala Rossa' is an area with a well preserved dune and a retrodunal wetland area that hosts interesting plant and animal species.

The following areas belong to the Oriented Reserves: pastures and farming areas of the Trappola on the right hand side of the Ombrone River, the Ombrone River itself and the marshlands on the left hand side of the river located at the San Paolo pumping station, at Campo al Pino and the wetlands and pastures at the Macchiozze.

The pastures and farming areas of the Trappola are flatland areas where, in the past, human intervention has been very strong. Here, ground surface is slightly higher in level as compared to the sea because of several strategies that were implemented in the past such as land reclamation and water management. Pasture lands are, at intervals, mixed with pinewoods and marshlands and together with the neighbouring farming areas make up a very important habitat for birds and a buffer zone between the Integral Reserves and more external areas.

The Ombrone River itself and its river mouth, is an extremely important element of the landscape not only on account of the botanical and faunal communities it hosts but also because it constitutes an ecological corridor between the wetland areas of the coast and those of the inland.

The Saline di S. Paolo are plains to the left of the Ombrone River occurring at the same or, in some cases, beneath the level of the sea. These areas are characterised by a helophytic marshland vegetation and by a great number of bird species, especially of migratory species.

Proceeding inland, the areas of Campo al Pino and of the Macchiozze are the other two wetlands found close to the Saline di San Paolo. These areas are located on a plain of alluvial origin at a few meters above sea level and are part of the meadows and farmlands included within the Ombrone embankments. In the past, these lands have been reclaimed as clearly shown by the presence of water channels built during the implementation of the rural property Act. The entire zone, apart from the temporarily submerged areas, is mainly exploited for pasture and is characterises by the presence of both wild and domestic ungulate species. Because if its vicinity to the river and to the marshes, the zone is important for conservation purposes. The Macchiozze is an internal wetland area, which is interesting for its fauna and which has recently been undergoing a process of environmental rehabilitation.

Finally the reclaimed low-lands at Talamone are considered Protected zones. All these lands are subject to submersion and are undergoing salt water intrusion. Especially during the winter season, the area has the potential to host important aquatic migratory birds species and thus is considered relevant for its faunal components.

6.5 The Other Coastal Wetlands of the ‘Maremma Wetland Complex’

In the past, the entire southern coast of Tuscany, from Castiglione della Pescaia to Capalbio (at the border with Latium Region) was once occupied by large marshlands, small freshwater lakes and extensive floodplain woodlands characterised by a hydrophilous vegetation. After land reclamation interventions and the increase in agricultural activities during the first half of the last century, today some vestiges of the original wetland areas still remain. Besides the large Orbetello lagoon, important for its natural environment and the economic role of its fishing activities, other areas testifying previous situations are Campo Regio, Burano Lake and San Floriano Lake.

Campo Regio lies on the coastal plain delimited to the north by the Osa River and to the south by the Albegna River. This area, located in the municipality of Orbetello, at about 20 km south of the city of Grosseto and at 1.5 km from the coast, has a surface of about 20 ha. This area is what remains of a formerly much larger wetland area in which small nuclei of thermo-hygrophilous floodplain woodlands still occur. These represent the spontaneous vegetation of the Maremma coastal plain in which the water table is close to the surface. Even if today this area is not that extensive and has encroaching farmlands all round, it has maintained wetland plant species that have progressively become quite rare elsewhere.

The entire Orbetello Lagoon is considered a Wetland of International Importance and was declared a Ramsar site in 1977 essentially to protect the rich and important bird species of the area (Fig. 6.9). The Provincial Nature Reserve of the Orbetello Lagoon (1,522 ha) is located in the western part of the lagoon itself and called Laguna di Ponente. In this Reserve there is a very small National Nature Reserve covering about 30 ha, and the WWF 'Oasis' which includes land alongside the lagoon. The Laguna di Ponente is separated from the sea by a sandbar, Tombolo della Giannella, linking the mainland to the Monte Argentario, whereas in the centre of the lagoon the town of Orbetello, lying on an incomplete sandbar linked to the mainland by a causeway, divides it from the Laguna di Levante.

The area encompasses a variety of different coastal habitats including the sandy littoral, sandbar formations, the brackish lagoon, small temporary freshwater pools, Mediterranean maquis shrubs, farmlands and an artificial pinewood plantation.

Its geographic position together with the presence of brackish wetlands are of crucial importance for resting and nesting of many endangered bird species.

Fig. 6.9 The Orbetello Lagoon with resident Greater Flamingos (Photo L. Chelazzi)

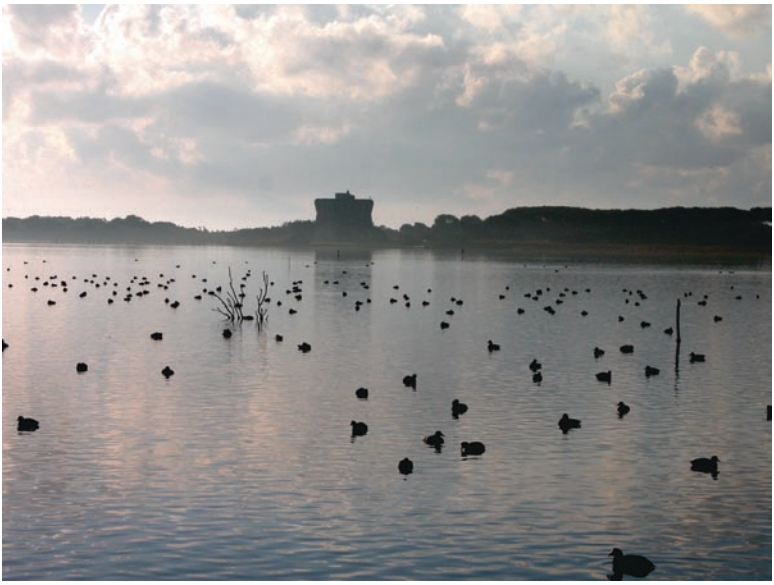

Fig. 6.10 The Burano Lake with over wintering Eurasian Coots (Photo L. Chelazzi)

From a botanical point of view the brackish water displays a rich population of blue, red, brown, and green algae that in the past (1992–1993) bloomed extensively on account of excessive nutrient accumulation in underwater sediments and lack of oxygen in the water.

The National Nature Reserve of the Burano Lake was declared in 1980 (Fig. 6.10). The Reserve is located in the southern section of the Grosseto Province in the Capalbio Municipality. The area includes 410 ha of private land and has been managed by WWF-Italia for many years. According to the Ramsar convention, the Reserve was designated Wetland of International Importance and is included among the 'Sites of Community Importance' and in the 'Special Protection Areas'

The National Nature Reserve of the Burano Lake lies along the Maremma coast between the promontory of Ansedonia to the north and the Chiarone ditch to the south, which represents the border line between Tuscany and Latium regions.

The Burano Lake is what remains of an extensive lagoon that once occupied the area. In the past this has progressively dried up and filled in with sediments coming from small water courses. Later on the land reclamation processes further reduced its size. Today it is a brackish lake of 140 ha (about 1.5 m in depth), separated from the sea by two sand dune belts. An artificial channel connecting the lake to the sea is filled up at its mouth but can be periodically opened for the management of fishing activities. The Reserve includes a variety of habitats of ecological value characteristic of the Maremma area such as the coastal dune, the retrodune with a Mediterrenean maquis, remnant hygrophilous woodlands, a water-fringe cane bed, a brackish lake and temporarily submerged meadows.

Today, on the plain at the foot of the hills behind the Burano Lake, there are still some perennial freshwater pools that have survived land reclamation, thanks to their importance as water reservoirs for agricultural requirements. These areas have become important resting grounds for waterfowl species. Of these the San Floriano Lake is the most relevant and it has been considered a Site of Community Importance (SCI). The lake, of about 7.5 ha, occupies a lowland of a karst valley. Although most of its banks are artificial and the area is surrounded by farmland, this lake is considered highly valuable for its plant and animal community.

6.6 General Considerations on Management Strategies and Conclusions

Before the European directives on wetlands, issued in the last decades of the last century which provided for the protection of particular environments, a small group of scientists had become aware of the enormous environmental value still existing in the low Grosseto Plain. The group was able to convince a more or less uninterested management community to make plans and take actions for the protection and conservation of this particular habitat. However, this decision by the local administration to enact conservation measures probably arose from an opportunistic idea that envisaged future economic benefits rather than from a real belief in a conservation strategy. In fact, today the environment is considered a good economic investment in the long-term as it attracts tourism for both leisure and educational activities. After the agricultural crisis of the 1970s, an environmental awareness was starting to emerge and more and more people were becoming attracted by the exclusiveness and quality of that particular environment that had long been forgotten and which at that time was exclusively exploited by rich landlords (Doccioli 1970). At the beginning, the wilderness of this area became an attraction for an élite of cultured individuals and in particular for people with a major influence over the masses. In fact, the whole Province of Grosseto became a hot spot for politicians, entrepreneurs, actors and learned people that frequently visited and spent their summer holidays in this area. As a consequence this led to great economic benefits for the locals, who were literally invaded by tourists and also to a great boom in ‘agritourism’. Today, this activity is not only restricted to the summer but extends over a longer period of time, bringing additional revenues to local farming families. However, the massive invasion of summer tourist has strongly impacted the environment as it has led to landscape changes through the construction of visitor centres, parking lots and other residential settlements.

As already mentioned, along the southern coast of Tuscany there is a system of protected wetlands, all included in the Grosseto Province, ranging from the Diaccia Botrona Provincial Nature Reserve to the north, to the National Nature Reserve of the Burano Lake to the south. These wetlands, to which the Maremma Regional Park and the Provincial Nature Reserve of the Orbetello Lagoon also belong, occupy

almost two thirds of the entire territory, with a coastline of 60 km. However, the 'Maremma wetland complex', as indicated by some ornithologists (Baccetti et al. 1996), should not be considered a mosaic of wetlands, important only for birds (sometimes ornithologists are somewhat fundamentalists) or for plant species but its importance should be based on the contemporary existence of both abiotic and biotic components. Furthermore, the Maremma wetland complex is best considered as a whole rather than as a series of different sites and thus should be managed as one. Centralised management should be carried out by experienced personnel (and not simply by architects who frequently have no expertise on ecological matter) and local managers should take into account and respect the opinion of experts such as biologists, ecologists, engineers, economists, geographers, etc. Also local stakeholders (farmers and tourist operators) should be informed and involved in decision making processes and their needs should be considered by managers, without involving destructive political conditioning. A centralised management of the wetland complex, besides aiding in protecting the environment, could also guarantee the sustainable use of natural resources, by redistributing tourist loads in space and time and it could address tourists to cultural and natural sites as an alternative to leisure activities (sunbathing and swimming).

In the Grosseto Plain the management of protected areas and of wetland areas in particular, presents an array of many other different problems ranging from foreseen interventions to contrast coastal erosion, to project management for conservation purposes, to conflicts among local authorities and for achieving the correct use of the natural resources.

Today, the erosion process that the mouth of the Ombrone River is undergoing, is undoubtedly a fact. This phenomenon, occurring entirely within the Maremma Regional Park, has been mainly caused by human activities further inland that have drastically reduced sediment transportation. The foreseen actions to contrast or slow down the process are, in our opinion, inadequate and can severely damage the natural environment. These actions are targeted to contrast surface marine water intrusion in areas where soils have already saline characteristics, as demonstrated by the place-names (Campo Salino, Saline di San Paolo) and by the presence of an halophilous vegetation and where, nowadays, pasturelands are only partially exploited. In northern Europe, when similar problems occur, local authorities buy the lands undergoing erosion and interventions are made only in the case that cities, towns or important roads are directly threatened (Speybroeck et al. 2006). In the case of the Maremma Regional Park the land involved in erosion is already a regional property (Region of Tuscany) so it appears clear that the choice of certain actions is governed by a totally different political strategy.

In the Park the proposal of beach nourishment to rebuild a beach and improve the site for tourist has not been approved because of the severe impacts that sand withdrawal from the marine deposits or, worse, from the areas close to the promontory of Collelungo would have caused on the entire coastal ecosystem. However, the foreseen construction of a revetment parallel to the sealine will in any case severely modify the wetland area at the mouth of the Ombrone River. This embankment will prevent sea water from reaching the saline low-lying grounds during the occasional

storms and the areas will soon be transformed into a freshwater environment or, in the worse of cases, will dry up. In fact recently, with the authorisation of the Park, the Consorzio di Bonifica (Consortium for Land Reclamation) has started new works to reactivate the mobile sluice-gates of the Chiavica bridge at the mouth of the Essiccatore di Alberese channel (built the last century as a draining channel). This will prevent marine water intrusion in the channel during sea storms and the reactivation of the pumping system at Idrovora San Paolo will favour saline water outflowing towards the sea. Among the foreseen interventions, there is a plan for the desalination of the marshland near the mouth of the Ombrone River (Integral Reserve according to the Park's legislation and proposed as a Ramsar site by the Region of Tuscany) by introducing freshwater in the existing channels. According to the Consortium this operation will probably recharge the water table with freshwater and lower the salt water in the water table. All these interventions will cause a severe modification of the wetland habitat and will lead to the loss of another wetland area of international importance going against EU directives. Furthermore, for the construction of the revetment the existing roads will be enlarged and consolidated. These will permit trucks to bring into the Park the necessary material coming from inland area mines and the whole ecosystem will be further impacted by the construction of the construction yard itself. Perhaps in order to stop or at least slow down the erosion process, it might have been sufficient to forbid river bed quarrying from the Ombrone, which today represents one of the main factors causing the decrease in sediment loads. An off-shore breakwater, parallel to the shore, to dissipate part of the incident wave energy before it reaches the shore, might also have slowed down the erosion process. For the moment only several submerged concrete groynes perpendicular to the shoreline will be installed with the hope of giving rise to a local beach reconstruction process. Another action that might limit the sedimentary deficit could be the stocking of earthy excavation materials in certain areas along the course of the Ombrone River (160 km, 3,494 km^2, Provinces of Siena and of Grosseto, 44 municipalities) that could be thrown into it when the strongest floods occur. Furthermore, in order to limit the damaging effects on the 'Pineta Granducale' of surface sea water intrusion in the old interdunal areas, it would be necessary to maintain operational or to strengthen the pumping system at the Idrovora San Paolo that has not been working for many years.

The cited interventions are in some way in contrast with other projects of the Park. For example, there is an ongoing project in which an attempt for the reintroduction of the Osprey in the area is being made. In fact, some individuals actually visit the areas close to the mouth of the Ombrone River and the Diaccia Botrona Provincial Nature Reserve indicating that the two areas are adequate at least as feeding grounds for the birds. When 80 years ago the nesting population of Osprey disappeared from the islands of the Tuscan Archipelago, changes in the environment or habitat loss had been considered as the main causes of its disappearance. Also poaching of adult individuals and of their eggs for trophies or collections had also contributed to the drastic decrease in its population. Today, the absence of a nesting population in the Maremma Regional Park that is directly protected is, in our opinion, probably due to other factors such as the disturbance of the encroaching

city of Grosseto and to the heavily impacted surrounding areas. The foreseen interventions at the river mouth will cause further disturbance to the birds and only worsen the situation. Furthermore, reintroduction projects have recently been criticised and discussed (Frankham et al. 2004) and alternative strategies such as environmental rehabilitation should be considered as a better strategy. Generally, these lead to a spontaneous choice on the part of the natural populations to select the area as breeding grounds. Something very similar has occurred for the wolf that recently has spontaneously recolonised the woodlands of the Park.

In the last few years there have been many projects, also supported by the European Community, that have had wetland areas as a target. Unfortunately, in many cases, once the project has ended all structures (pathways, information panels, sheds for visual protection, island for bird reproduction, etc.) built during the course of the project are abandoned without receiving further attention by the local authorities that sometimes have also actively participated in these projects.

The absence of centralised management of the wetlands that are still to be found today along the coastal littoral of the Grosseto Plain (also including those of the southern part of the Grosseto Province and bordering on the Latium Region) can bring to dangerous conflicts among local authorities and stakeholders (Region, Province, Municipalities, Land Reclamation Consortium, River Basin Authorities, Environmental Associations, Non Governmental Organisations, Ownerships). These conflicts lead to a total absence of actions or to disorganised and sometimes contrasting initiatives. For example, in the case of the Maremma Regional Park, the Region of Tuscany is both owner of the local farm (Azienda Regionale Agricola di Alberese) and manager of the Park itself and frequently the actions planned by the Farm do not have nature maintenance or biodiversity protection as a priority. On the other hand, actions undertaken by the Park to reach its objectives do not always coincide with the interests of the Farm. Furthermore, conflicts among local administrations for the jurisdiction over wetland areas often lead to compromises that are in favour of local interests such as the removal of hunting and fishing restrictions in sites declared as SCI (Site of Community Importance).

As to the problem of the water salinisation occurring at the Diaccia Botrona the local fish farm has been unjustly (Saroglia et al. 2002) accused to be its main cause. In our opinion this problem could be partially solved by the reactivation of the mobile sluice-gates of the Giorgini bridge located at the mouth of the Bruna River at Castiglione della Pescaia. As a matter of fact, these gates had been constructed to permit the outflow of freshwater toward the sea but at the same time to prevent sea water intrusion in inland areas through the drainage channels. However it should be recalled that the wetlands of Diaccia Botrona are continuously in evolution and from a primitive situation with saline characteristics (relict of the ancient marine gulf) the area has evolved towards freshwater conditions. However, this trend has started to reverse when at the beginning of the last century the last section of the Bruna River was deviated from the wetlands directly into the sea. Today the salinisation process can only worsen because of the construction of a mobile barrier on the Molla channel that is being built by the Consorzio di Bonifica. This barrier can be inflated to prevent surface salt water from reaching the Idrovora Cernaia from

which local farmers pump water for irrigation. This will bring to a decrease of freshwater into the marshes of the Diaccia Botrona and will exacerbate the problem of the salinisation process.

Another quite important problem regarding the management of wetland areas that is to be considered in our opinion is the way in which these protected areas are to be exploited. This becomes particularly relevant especially when these are naturally or artificially small in size as in the case of sandy littorals and their bordering wetland areas.

The wetlands of the Grosseto Plain have always been of economic importance even when these areas were not protected. In fact, until the end of the eighteenth century the pools for the production of salt were located in these coastal wetlands and their location changed in relation to the evolution of the plain. The production of salt was the major local income before the land reclamation process. Furthermore, in the past, these wetland areas were used as pasture grounds during the winter and plant species were collected for the construction of roofs and the production of mats. Also the use of aromatic plants and medical herbs was widely disseminated among the local population (Bencivenni 2007). Before the land reclamation process and the implementation of the rural property Act the economy of the low Grosseto Plain was quite poor and the main source of proteins was guaranteed by fishing and hunting activities within the wetlands. The importance of fishing goes all the way back to the Etruscan-Roman period when in the area there was the Prile Lake. This activity reached its peak during the period of the Medici dynasty when fishing became a monopoly of the landowners. This activity was developed on the lake as it was safer and more profitable compared to fishing at sea. For this reason all hydrological actions made during that period had the intent of ameliorating the water quality of the lake more than that of reclaiming the land. After the gradual filling up of the lake and the formation of the wetlands, the area was still used as a trophic resource and snails and frogs were also gathered. Successively, the new marshlands attracted a great number of water birds and hunting became an important source of food and of income for the local population. This occurred especially during the Second World War when also the residents of the town of Grosseto exploited the wetlands. When standards of living improved after the land reclamation process and the implementation of the rural property Act, traditional hunting and fishing in the marshlands lost its original nutritional value and became an important recreational activity. This attracted fishermen and hunters also from other parts of the country and continued more or less until protection measures were taken. Today these areas have a twofold value, one regarding conservation and the other having an economic function in attracting tourists:

Environmental protection should simply mean bestowing particular attention on an environment, so that its landscape, its high biodiversity levels, the presence of species or of their peculiar association are not damaged by external factors that might alter their state. Problems in environmental conservation emerge when, in the name of false populism, the concept of conservation is confused with an economic investment that may yield a rapid return. This occurs when the real reasons for which an environment is protected (small and fragile ecosystems in particular) are forgotten.

In fact, in the name of everyone's fundamental right to freely enjoy Nature (Doccioli 1970), today's trend goes in the direction of fostering recreational tourism in these protected environmental areas (including school trips), which is often of very low level, not very educational and enriching. In parks a very different type of tourism should be aimed for, based upon truly educational purposes and on an understanding of the real value of conservation.

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