



VEGETATION LANDSCAPE MANAGEMENT OF "NATURAL RESERVE OF CHIARONE", MASSACIUCCOLI LAKE BASIN (TUSCANY, IT)

ANDREA BERTACCHI¹, TIZIANA LOMBARDI¹, IACOPO TOMEI¹, MARCELLO LABATE², ANDREA FONTANELLI², LUCIA PICCHI²

¹Department of Agriculture, Food and Environment (DAFE), University of Pisa, Via del Borghetto 80, 56124 Pisa, Italy;
²<http://www.oasipumassaciuccoli.org> - Via del Porto 6, loc. Massaciuccoli 55050 Massarosa (LU)

The Massaciuccoli Lake basin is located in NW of Tuscany (Italy) (43°50'N 10°19'E) and it is integral part of the Regional Park of San Rossore, Migliarino and Massaciuccoli (SIR-pSIC-ZPS n° 25 "Lago e Padule di Massaciuccoli" (ITS120017)). This endorheic lake and the surrounding marshlands, with over 2,000 hectares of surface, form the largest reedland wetland of Tuscany. The lake covers about 690 hectares. The origin is probably related to a lagoon lateral of the mouth of the protohistoric Auser river, transformed into a closed basin and isolated from the sea by the advance towards the interior of the dune systems. Currently the lake presents a depth that, in the areas not affected by the quarries, is between 1 and 2.5 m. The average level of the surface of the lake remains for long periods of the year below the marine one. Over the last century this ecological system has undergone profound changes both because of land drainage, both because of the industrial and agricultural development of the surrounding areas that have heavily polluted lake, whose waters are still affected by serious eutrophication and ecological degradation.

Since the '50s and '60s the human settlement in the territory of the Massaciuccoli basin has grown in all its forms, since the urban impact due to tourism, particularly in the municipalities of Viareggio and Massarosa and the intense work of mechanical reclamation for the acquisition of farmland, they have a negative impact on the ecosystem, causing a gradual deterioration of water quality. The presence of a large amount of nutrients (N, P, C), show that the lake has undergone a major change going from the clear waters and complex trophic nets are characterized by the presence of submerged macrophytes and zooplankton, to a situation of algal blooms and simpler trophic nets, resulting in the loss of biodiversity.

The characteristic climate of the area is Mediterranean humid and is characterized by average winter temperatures of 7 ° C and summer average of 22 ° C. The rainfall (800 mm per year) is greater in autumn - winter, coinciding which the waters of the lake reached the highest levels

In order to preserve the great natural value of the lake in 1979, with the birth of the regional protected area, was established in the marshy area around the village of Massaciuccoli, the "Natural Reserve of Chiarone" (47 ha of mainland and 53 of lake). Since 1985 the association LIPU (Italian League for Bird Protection) has obtained the management of the reserve, and its activity is directed to purposes of environmental education, environmental restoration, monitoring and conservation of specific habitats.

Massaciuccoli lake basin habitats (*sensu* Directive 92/43/EEC) are:

- 1- Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae* H7210;
- 2- Depressions on peat (floating) substrates of the *Rhynchosporion* H7150;
- 3- Mediterranean tall humid herb grasslands of the *Molinio-Holoschoenion* H6420;
- 4- Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition*-type vegetation H3150;
- 5- Natural dystrophic lakes and ponds H3160.



Fig. 1 Geographic location of study area.

This report shows the results of several years of investigation on the main vegetational types (Tab. 1-9) (Phytosociological surveys of vegetation - using Braun-Blanquet method - and floristic detections are carried out in 2014-2015), the presence and distribution of endemic/rare/protected species, the changes on the structure of floating islands of peats and the main actions of conservation and management of these wetlands.

Tab. 1 Vegetation of *Phragmites australis* (Gams 1927) Shmalzer 1939 (Fig. 2 A) (*Frangula alnus* facies (rel 13); *Periploca graeca* facies (rel 14))

Rel. no.	2	6	8	10	12	13	14
Surface (m ²)	25	25	25	25	25	25	25
Coverage (%)	100	100	100	100	100	100	100
n° species	10	7	10	12	11	9	7

Charact. sp. of <i>Phragmites australis</i>	4	5	5	4	4	4	4
<i>Phragmites australis</i> (Cav.) Trin. ex Steud.	+	+	+	+	+	+	+
sp. <i>Phragmites-Phragmitetalia</i>	+	+	+	+	+	+	+
<i>Calystegia sepium</i> L.	+	+	+	+	+	+	+
<i>Solanum dulcamara</i> L.	+	+	+	+	+	+	+
<i>Eupatorium cannabinum</i> L.	+	+	+	+	+	+	+
<i>Euphorbia palustris</i> L.	+	+	+	+	+	+	+
<i>Lycopus europaeus</i> L.	+	+	+	+	+	+	+
<i>Stachys palustris</i> L.	+	+	+	+	+	+	+
<i>Lythrum salicaria</i> L.	+	+	+	+	+	+	+
<i>Hibiscus palustris</i> L.	+	+	+	+	+	+	+
<i>Typha angustifolia</i> L.	+	+	+	+	+	+	+
<i>Cladium mariscus</i> L.	+	+	+	+	+	+	+
<i>Scheuchzeria palustris</i> L.	+	+	+	+	+	+	+
<i>Menyanthes aquatica</i> L.	+	+	+	+	+	+	+
<i>Osmunda regalis</i> L.	+	+	+	+	+	+	+
<i>Iris pseudacorus</i> L.	+	+	+	+	+	+	+
<i>Oenanthe aquatica</i> L.	+	+	+	+	+	+	+
<i>Hydrocotyle vulgaris</i> L.	+	+	+	+	+	+	+
<i>Hypericum tetrapetrum</i> Fr.	+	+	+	+	+	+	+
<i>Lysimachia vulgaris</i> L.	+	+	+	+	+	+	+
sp. <i>Alnus-Quercion roboris</i>	+	+	+	+	+	+	+
<i>Periploca graeca</i> L.	+	+	+	+	+	+	+
sp. <i>Salicetum cineraceae</i>	+	+	+	+	+	+	+
<i>Frangula alnus</i> Mill.	+	+	+	+	+	+	+
<i>Salix cinerea</i> L.	+	+	+	+	+	+	+

Tab. 2 Vegetation of *Cladium mariscus* (Allorge 1922) Zobrist 1935 a *Phragmites australis* facies (rel 13); *Periploca graeca* facies (rel 14))

Rel. no.	20	21	22	23	24
Surface (m ²)	25	25	25	25	25
Coverage (%)	80	80	100	80	80
n° species	9	7	7	9	9

Charact. sp. of <i>Cladium mariscus</i>	3	2	3	3	3
<i>Cladium mariscus</i> (L.) Phol	+	+	+	+	+
sp. <i>Phragmites-Phragmitetalia</i>	+	+	+	+	+
<i>Phragmites australis</i> (Cav.) Trin. ex Steud.	+	+	+	+	+
<i>Calystegia sepium</i> L.	+	+	+	+	+
<i>Solanum dulcamara</i> L.	+	+	+	+	+
<i>Hibiscus palustris</i> L.	+	+	+	+	+
<i>Typha angustifolia</i> L.	+	+	+	+	+
<i>Scheuchzeria palustris</i> L.	+	+	+	+	+
<i>Menyanthes aquatica</i> L.	+	+	+	+	+
<i>Osmunda regalis</i> L.	+	+	+	+	+
<i>Iris pseudacorus</i> L.	+	+	+	+	+
<i>Oenanthe aquatica</i> L.	+	+	+	+	+
<i>Hydrocotyle vulgaris</i> L.	+	+	+	+	+
<i>Gallium palustre</i> L.	+	+	+	+	+
<i>Hypericum tetrapetrum</i> Fr.	+	+	+	+	+

Tab. 3 Vegetation of wet meadows (Fig. 2 F)

Rel. no.	31	32	33	34
Surface (m ²)	9	4	9	9
Coverage (%)	50	20	60	20
n° species	10	11	12	10

Charact. sp. of <i>Phragmites-Phragmitetalia</i>	1	+	+	+
<i>Phragmites australis</i> (Cav.) Trin. ex Steud.	+	+	+	+
<i>Calystegia sepium</i> L.	+	+	+	+
<i>Panicum dysentericum</i> L.	+	+	+	+
<i>Eupatorium cannabinum</i> L.	+	+	+	+
<i>Euphorbia palustris</i> L.	+	+	+	+
<i>Lycopus europaeus</i> L.	+	+	+	+
<i>Juncus acutiflorus</i> Ehrh.	+	+	+	+
<i>Juncus articulatus</i> L.	+	+	+	+
<i>Carex distachya</i> Sm.	+	+	+	+
<i>Carex elata</i> All.	+	+	+	+
<i>Carex lasiocarpa</i> L.	+	+	+	+
<i>Lythrum salicaria</i> L.	+	+	+	+
<i>Hibiscus palustris</i> L.	+	+	+	+
<i>Hydrocotyle vulgaris</i> L.	+	+	+	+
<i>Menyanthes aquatica</i> L.	+	+	+	+
<i>Anagallis tenella</i> (L.) L.	+	+	+	+
<i>Iris pseudacorus</i> L.	+	+	+	+
<i>Gallium palustre</i> L.	+	+	+	+
<i>Lysimachia vulgaris</i> L.	+	+	+	+
<i>Solanum dulcamara</i> L.	+	+	+	+

Tab. 4 Vegetation of *Nymphetum albae* Valm. 1947 (Fig. 2 G) and *Myriophyllo-Nupharctum* Koch 1926 *Najas marina* facies (rel 37) (Fig. 2 H)

Rel. no.	35	36	37
Surface (m ²)	4	4	4
Coverage (%)	100	100	100
n° species	2	1	2

Charact. sp. of <i>Nymphetum albae</i>	5	5	5
<i>Nymphaea alba</i> L.	+	+	+
Charact. sp. of <i>Myriophyllo-Nupharctum</i>	+	+	+
<i>Myriophyllum spicatum</i> L.	+	+	+
<i>Najas marina</i> L.	+	+	+

Tab. 5 Vegetation of *Eleocharietum palustris* Schenn. 1919 (Fig. 2 E)

Rel. no.	28	29	30
Surface (m ²)	1	2	2
Coverage (%)	80	50	50
n° species	4	4	3

Charact. sp. of <i>Eleocharietum palustris</i>	3	3	3
<i>Eleocharis palustris</i> (L.)	+	+	+
<i>Samolus valerandi</i> (L.)	+	+	+
<i>Holcus lanatus</i> L.	+	+	+
<i>Hydrocotyle vulgaris</i> (L.)	+	+	+

Tab. 6 Vegetation of *Sphagnum palustris* mown meadows (Fig. 2 M)

Rel. no.	42	43	44
Surface (m ²)	1	2	2
Coverage (%)	100	100	100
n° species	6	5	3

Tab. 7 Vegetation of *Nymphetum albae* Valm. 1947 (Fig. 2 G) and *Myriophyllo-Nupharctum* Koch 1926 *Najas marina* facies (rel 37) (Fig. 2 H)

Rel. no.	38	39	40	41
Surface (m ²)	100	70	100	70
Coverage (%)	100	100	70	100
n° species	11	11	6	4

Tab. 8 Vegetation of wet groves : *Osmunda regalis-Alnion glutinosae* (Br.-Bl., P. Silva & Rozeira 1956) Dierschke & Rivas-Martinez in Rivas-Martinez 1975 (rell. 38-39) (Fig. 2 I); *Salicetum cineraceae* Müller & Görs 1958 (rell. 40, 41) (Fig. 2 L)

Charact. sp. of <i>Osmunda regalis-Alnion glutinosae</i>	4	3	3	3
<i>Alnus glutinosa</i> (L.) Gaertn.	+	+	+	+
<i>Osmunda regalis</i> L.	+	+	+	+
<i>Iris pseudacorus</i> L.	+	+	+	+
<i>Carex otrubae</i> Podp.	+	+	+	+
<i>Rubus spp.</i>	+	+	+	+
<i>Calystegia sepium</i> L.	+	+	+	+
<i>Periploca graeca</i> L.	+	+	+	+
<i>Hibiscus palustris</i> L.	+	+	+	+
<i>Gallium palustre</i> L.	+	+	+	+
<i>Lysimachia vulgaris</i> L.	+	+	+	+
<i>Solanum dulcamara</i> L.	+	+	+	+
sp. <i>Salicetum cineraceae</i>	+	+	+	+
<i>Frangula alnus</i> Mill.	+	+	+	+
<i>Salix cinerea</i> L.	+	+	+	+
<i>Phragmites australis</i> (Cav.) Trin. ex Steud.	+	+	+	+
<i>Solanum dulcamara</i> L.	+	+	+	+
<i>Thelypteris palustris</i> Schott.	+	+	+	+
<i>Lythrum salicaria</i> L.	+	+	+	+
<i>Typha angustifolia</i> L.	+	+	+	+
<i>Scheuchzeria palustris</i> L.	+	+	+	+

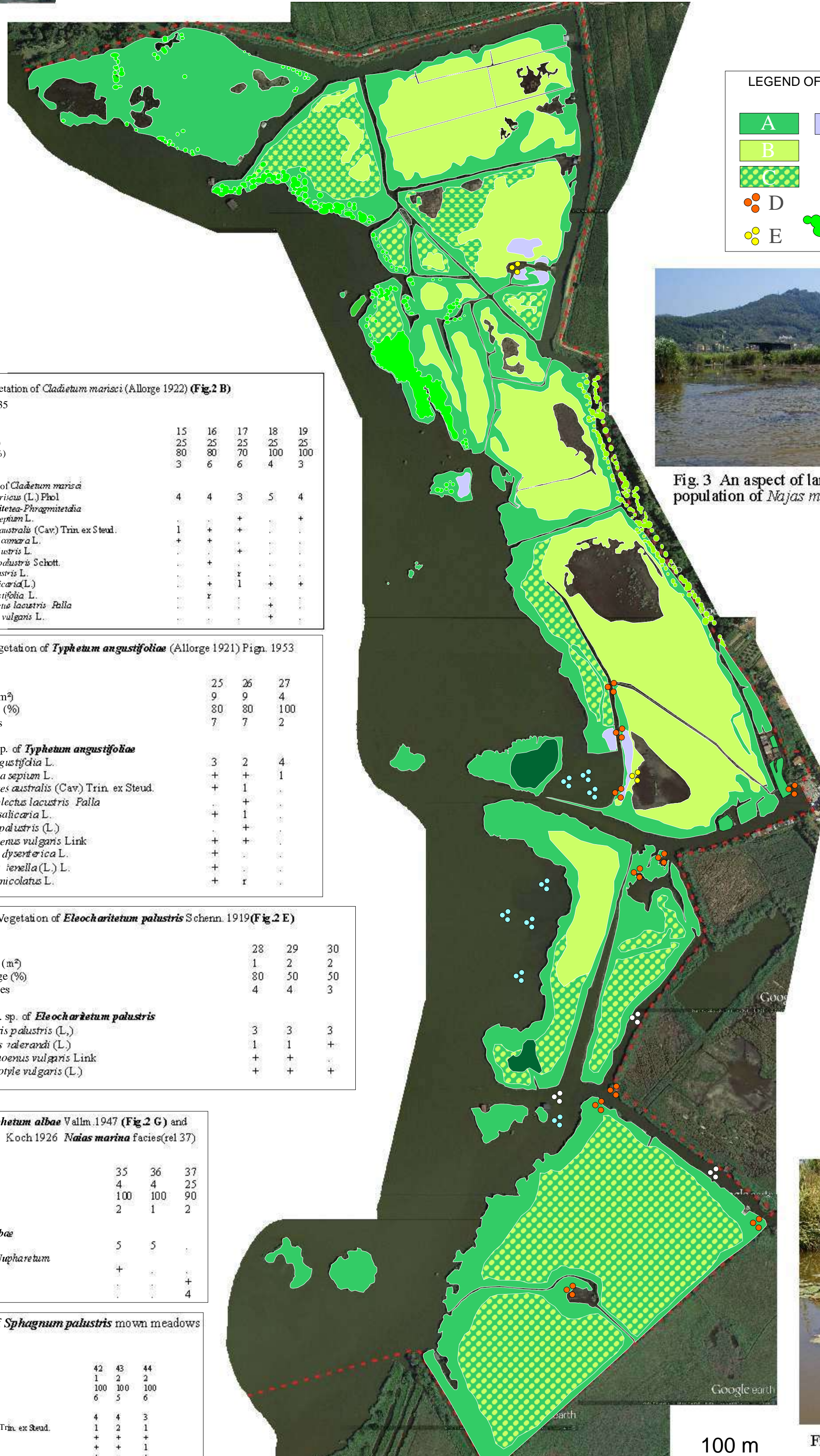


Fig. 2 Map of vegetation landscape

The vegetation landscape is mainly formed by a mosaic of *Phragmites australis*, *Cladium mariscus*, *Typhetum angustifoliae*, with patches of *Myriophyllo-Nupharctum*, *Nymphetum albae*, *Eleocharietum palustris* and a large spread of microwoods of hygrophilous phanerophytes as *Alnus glutinosa*, *Frangula alnus*, *Salix* sp.pl. (*Osmunda regalis-Alnion glutinosae*, *Salicetum cineraceae*) A particular aspect of this lake environment are the "aggallati", floating islands of peat incurred by intertwining rhizomes of straws. Above these peatlands often develop communities of *Sphagnum* sp.pl. *Osmunda regalis* L. and *Thelypteris palustris* Schott (Fig. 3,4,5,6,7,8)

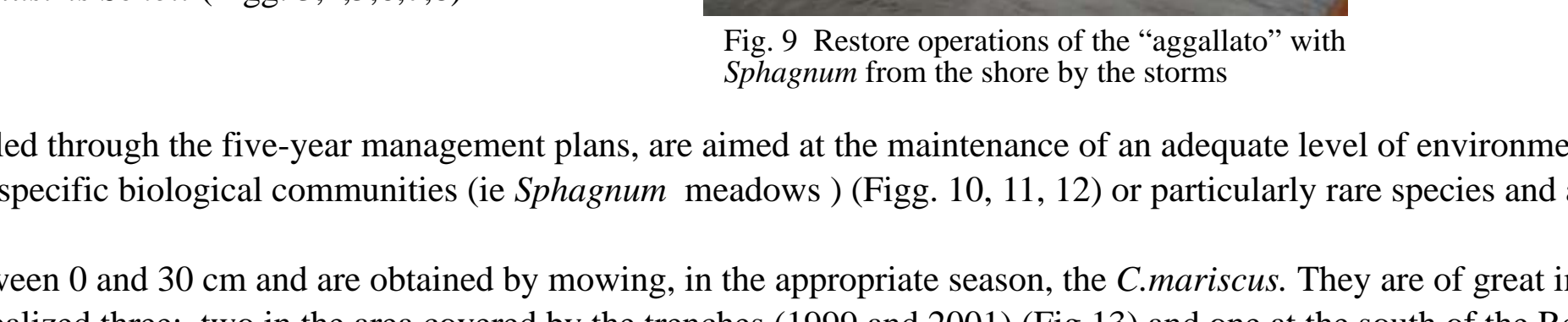


Fig. 9 Restore operations of the "aggallato" with *Sphagnum* from the shore by the storms

The actions of environmental management within the Reserve, scheduled through the five-year management plans, are aimed at the maintenance of an adequate level of environmental heterogeneity (presence of "canneti" and "falaschetti", "chiaro" wet meadows, alder woods), the conservation of specific biological communities (ie *Sphagnum* meadows) (Fig. 10, 11, 12) or particularly rare species and are mainly functional requirements related to human use and accessibility for birds.

The "chiaro" are water mirrors vegetation free with varying depth between 0 and 30 cm and are obtained by mowing, in the appropriate season, the *C. mariscus*. They are of great importance for the nesting of some birds. In 1998 there were no "chiaro" within the Reserve since then have been realized three: two in the area covered by the trenches (1999 and 2001) (Fig. 13) and one at the south of the Reserve (2011) (Fig. 13). From 2011 due to heavy grazing nutria, concomitant with an unusually high water levels during the summer, the density of sedge in the north of the reserve began to decrease until the appearance of a large "chiaro" and some more small.

The wet meadows habitats are quite rare in the reservoir lake due to the hike of the water levels, but are also very important areas because they support a wide floristic diversity and they are rest and nesting areas for different species of small waders and passerines. The areas of floating marsh recreate the physical conditions of the wet meadows, but on the other hand require frequent maintenance (3-4 mowings per year) to prevent the growth of helophytes. The *Sphagnum* meadows covers an area of about 5,000 sqm within an "aggallato", the management is to complete helophytes mowing and removal of the cut material once a year in February and began in 1998. The smaller channels need of interventions of cleaning at the end of the summer season to prevent the closure. In two cases, has also been performed the excavation of two channels that were buried.

The floating islands ("aggallati") that surrounded almost completely the area of Chiarone and the surrounding areas along the eastern shore of the lake were the result of a man management aimed at hunting and exploitation of land resources: the islands carried by wind were blocked are planted the poles that held him. The abandonment of the management and intense weather events have resulted in the time the detachment and the loss of numerous islands also widespread (Fig. 9). The objective is to keep the existing and to restore, as far as possible that which was lost.

Fig. 3 An aspect of landscape vegetation of the reserve: aquatic population of *Najas marina* and *Phragmites* on the shore



Fig. 4 *Phragmites* in the foreground and *Cladium* in the background



Fig. 5 *Eleocharietum palustris*

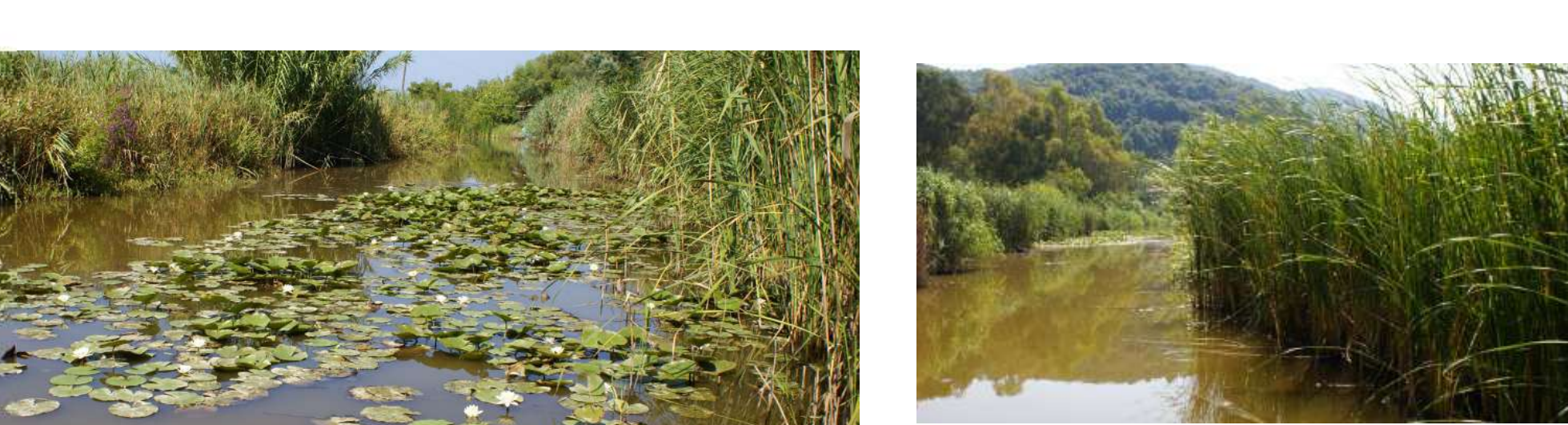


Fig. 6 Vegetation of wet groves : *Osmunda regalis-Alnion glutinosae*



Fig. 8 Vegetation of *Typhetum angustifoliae*

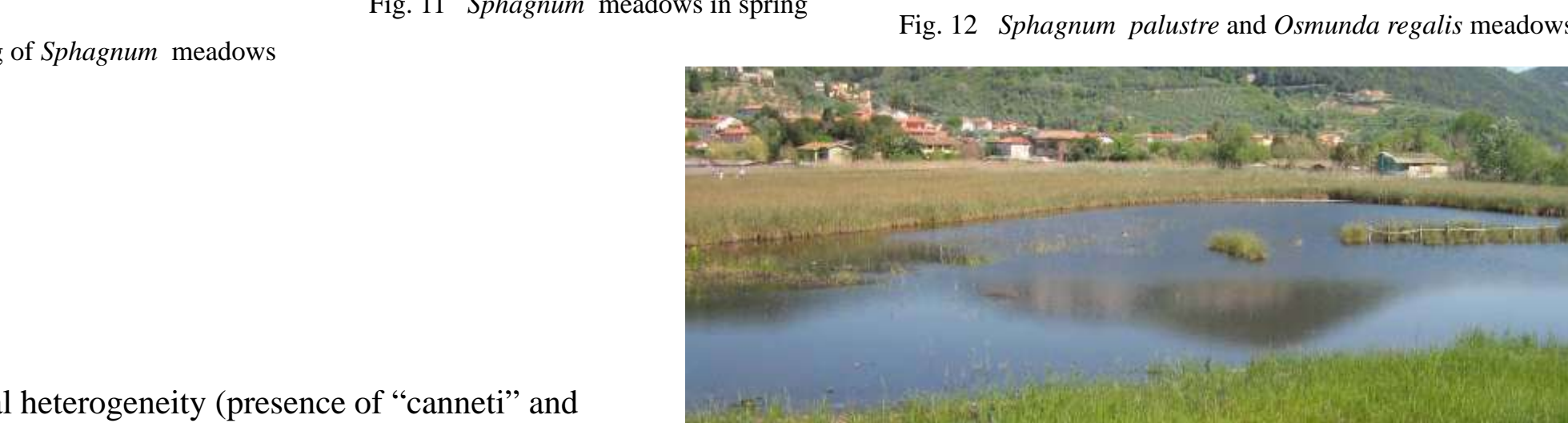


Fig. 12 *Sphagnum palustre* and *Osmunda regalis* meadows

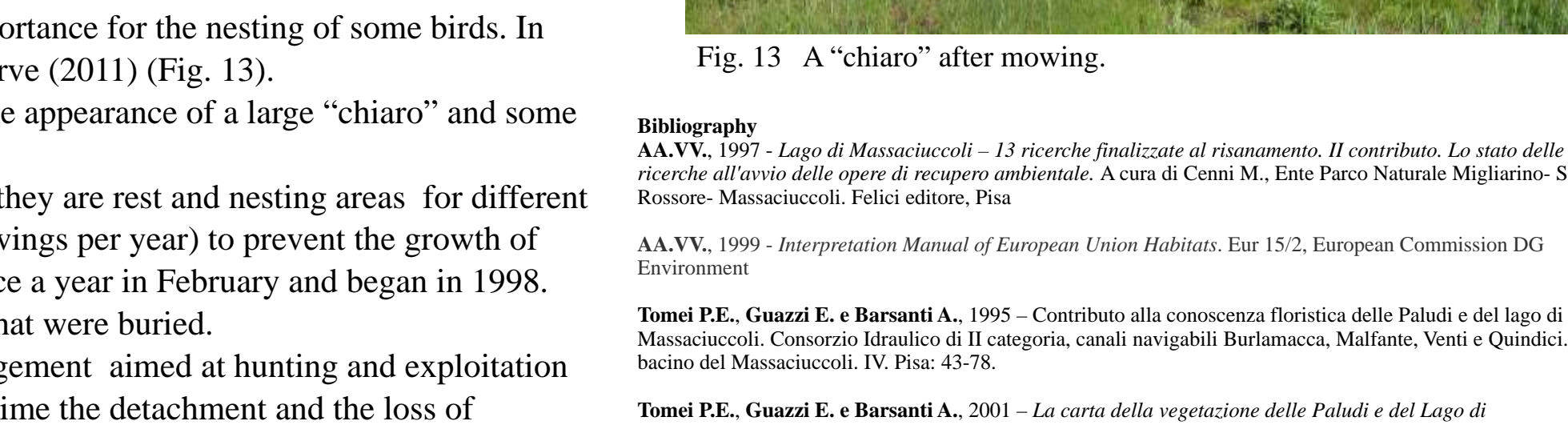


Fig. 11 *Sphagnum* meadows in spring



Fig. 13 A "chiaro" after mowing.

FLORISTIC LIST (*) rare and protected species L.R. Tuscany 2000 n.56

1. <i>Alisma plantago-aquatica</i> L. Alismaceae	2. <i>Alnus glutinosa</i> L. Betulaceae
3. <i>Athaea officinalis</i> L. Malvaceae	4. <i>Anagallis tenella</i> L. Myrsinaceae (*)
5. <i>Arundo donax</i> L. Poaceae	6. <i>Calystegia sepium</i> L. Ranunculaceae
7. <i>Carex davalliana</i> Sm. Cyperaceae (*)	8. <i>Carex elata</i> All. Cyperaceae (*)
9. <i>Carex paniculata</i> L. Cyperaceae (*)	10. <i>Carex otrubae</i> Podp. Cyperaceae
11. <i>Cladium palustris</i> L. Asteraceae	12. <i>Cladium mariscus</i> L. Cyperaceae (*)