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Vegetation survey and plant landscape mapping of the SCI IT9140002 "Litorale Brindisino" (Puglia, Southern Italy)

G. Veronico[1], S. Sciandrello[2], P. Medagli[3], V. Tomaselli[1]
[1]Italian National Research Council - Institute of Biosciences and Bioresources (CNR-IBBR), via G. Amendola 165/A, I-10126 Bari, Italy.
[2]CUTGANA - University Centre for the Protection and Management of Natural Environments and Agro-ecosystems, via Santa Sofia 98, I-95123 Catania, Italy.
[3]Department of Biological and Environmental Science and Technology, Ecotekne, University of Salento, via Provinciale Lecce-Monteroni, I-73100 Lecce, Italy.

Abstract
A vegetation survey of the SCI IT9140002 - "Litorale Brindisino" (Apulia Region, Italy), with a focus on the coastal environments, along with vegetation and habitat maps, are here presented. The SCI is a coastal site characterized by dunes and salt marshes and, landwards, by garrigues, maquis and grasslands. The coastal belt is characterized by a highly fragmented landscape, because of anthropogenic pressures and coastal erosion. The vegetation was studied according to the phytosociological method and the survey led to the identification of 22 plant communities belonging to 11 syntaxonomic classes. Vegetation and habitat maps were digitized in ArcGis 10.2 from recent orthophotos in combination with topographical maps, at a scale of 1:5,000. The presence of several complex vegetation mosaics was highlighted.

Key words: habitat map, Litorale Brindisino, Torre Canne, vegetation map, vegetation survey.

Introduction

Coastal environments (dune systems, wetlands and rocky coasts) of the Mediterranean area are among the most vulnerable and seriously threatened ecosystems. In the last decades the increasing of human pressures, such as intensification of agriculture practices, land reclamation for farming, tourism development and coastal urbanization, is causing severe alterations of coastal environments with loss, degradation and fragmentation of natural habitats (Levin *et al*., 2009; Sciandrello *et al*., 2015; Malavasi *et al*., 2016).

Apulia is the region of the Italian peninsula with the most extensive coastline (about 800 km) hosting, at present, several interesting areas of interest for the spontaneous coastal vegetation. An example is the site of Community importance (SCI) "Litorale Brindisino", which hosts important psammophilous vegetation cores with *Juniperus oxycedrus* subsp. *macrocarpa* / *J. phoenicea* subsp. *turbinata* and halophilous plant communities of salt marshes. This area was subject of detailed floristic studies that highlighted the remarkable plant biodiversity with the presence of 621 taxa, with several endemic, rare or threatened plant species (Mele *et al*., 2007).

Aim of this paper is to provide: a) a detailed vegetation survey of the coastal area, characterized by a significant diversity in terms of different phytocoenoses and b) an overview of this highly fragmented landscape through vegetation and habitat mapping.

Study area

The Site of Community Importance (SCI IT9140002) "Litorale Brindisino" is located on the Adriatic side of the Southern Apulia (S Italy) and covers a total area of 7256 hectares, including both terrestrial and sea area. The terrestrial area covers about 425 ha (Mele *et al*., 2007) and is included in the Regional Natural Park "Dune Costiere da Torre Canne a Torre San Leonardo" (Fig. 1). The coastal area is characterized by a system of dune belts with sporadic outcropping of carbonate rocks. The wetland behind the dunes is fed by a system of underground springs, determining the formation of numerous ponds. These pools have been used for fish farming since the end of nineteenth century and, then, restored in 2009 with the launch of an organically certified aquaculture. The inland area of the SCI consists of a carbonatic plateau, crossed by fluvial engravings, perpendicular to the coastline and locally called "lame", and is characterized by garrigues and pseudo-steppe vegetation interspersed with agricultural areas: the prevalent crops are centuries-old olive groves and cereal crops (Vita & Macchia, 1974).

The climate of the area is among the most arid of Apulia, with average annual rainfall of about 580 mm and average annual temperatures of 16.6°C. The bioclimate falls within the Mediterranean pluviseasonal oceanic with upper dry ombrotype (Rivas-Martinez *et al*., 2004).

Corresponding author: Giuseppe Veronico. *Italian National Research Council - Institute of Biosciences and Bioresources (CNR-IBBR), via G. Amendola 165/A, I-10126 Bari, Italy; e-mail: giuseppe.veronico@ibbr.cnr.it*

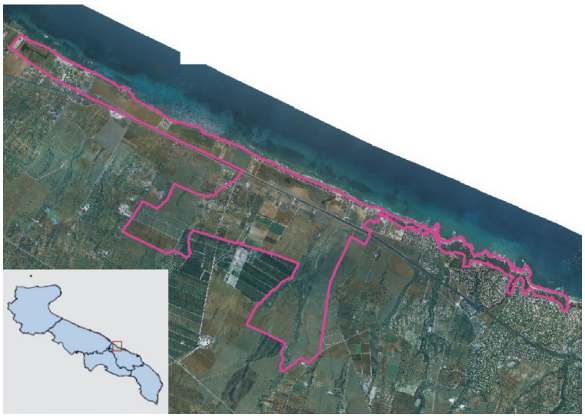


Fig. 1 - Localization of study area.

Materials and methods

The vegetation survey focused on the coastal area of the SCI, that is the part of environmental higher interest. Original vegetation data were sampled in field between 2007 and 2014. The vegetation relevés were performed according to the phytosociological approach (Braun-Blanquet, 1964).

A total of 75 original relevés were collected. For each relevé the geographic coordinates were recorded, by using a GPS (Global Position System). Names of the plant species follow Conti *et al.* (2005) and Conti *et al.* (2007), except for *Sarcocornia alpini* (Lag.) Rivas-Martínez (De la Fuente *et al.*, 2013). Vegetation units (of higher level respect to association) were assigned to the different syntaxa according to the recent "Prodromo della Vegetazione d'Italia" (http://www.prodromo-vegetazione-italia.org, Biondi *et al.*, 2014).

Similarity analysis of the relevés were carried out by using the SYN-TAX 2000 software (Podani, 2001). Braun-Blanquet sampling scale was transformed into the Van der Maarel ordinal scale (Westhoff & Van der Maarel, 1978). A cluster analysis based on the Bray-Curtis dissimilarity index and the UPGMA linkage method was performed.

The thematic maps of the study site were digitized in ArcGis 10.2 from recent colour orthophotos (2006) in combination with topographical maps (source: SIT-Puglia, http://www.sit.puglia.it/). Natural and semi-natural landscape elements were first defined as vegetation types on a 1:5,000 scale, which allowed the studied landscapes to be represented with 5 m resolution. When the adopted scale did not allow the representation of complex spatial pattern as in the case of highly fragmented areas, the "vegetation mosaics" were adopted. In vegetation mosaics, each unit (or class) includes two or more syntaxonomical units that, in the real landscape, are fragmented in small patches and interspersed with each other forming a chaotic spatial pattern (Pedrotti, 2013; Van der Maarel & Franklin, 2012).

Vegetation units were reclassified in habitat types according to the Annex I of the "Habitats" Directive 92/43 EEC (Council of the European Community, 1992), with the production of the habitat map of the site. For the correlation between vegetation types and habitat types, we referred to the Italian Interpretation Manual for the Habitats of Directive 92/43 EEC (Biondi *et al.*, 2009).

Results

Vegetation survey

The cluster analysis identified two main clusters, A and B (Fig. 2), which represent respectively annual and perennial plant associations of the dunal complex (A) and annual and perennial vegetation of salt marshes and of rocky coasts (B). "A" divides immediately into two sub-clusters: A1 and A2. The first one includes annual and perennial herbaceous plant communities of sand surfaces (*Cakiletea maritimae*, *Euphorbio paraliae-Ammophiletea australis*, *Alkanno-Maresion nanae* and *Frankenion pulverulentae*). A2 groups the juniper communities and the maquis of the dune systems (*Juniperion turbinatae* and *Oleo-Ceratonion*).

The cluster "B" splits in B1 and B2, with B1 including the annual halo-nitrophilous pioneer communities (*Thero-Suadetea*). B2 splits in B21, which includes the perennial halophilous vegetation of retro-dunal salt meadows (*Sarcocornietea fruticosae* and *Juncetea maritimi*) and B22, that combines the vegetated perennial complexes of sea cliffs, referable to both *Crithmo maritimi-Staticetea* and *Sarcocornietea fruticosae*

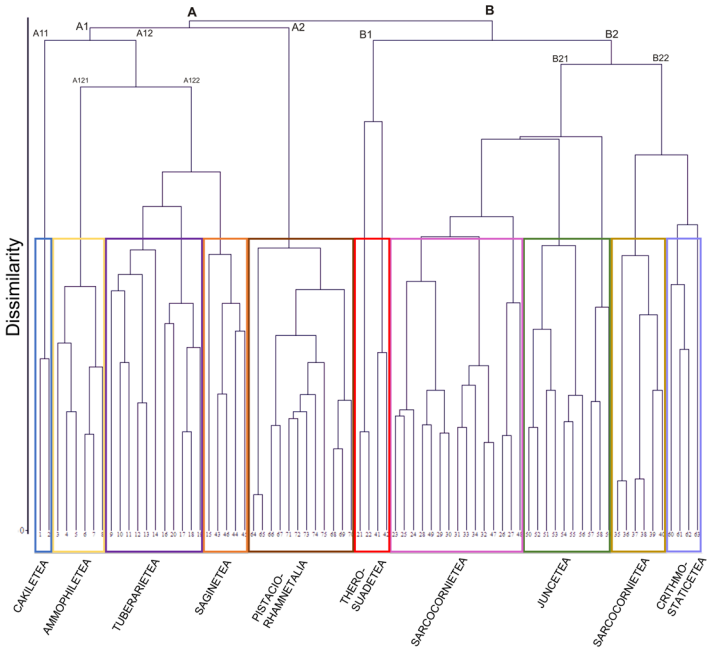


Fig. 2 - Cluster analysis.

classes.

A total of 22 plant communities, well differentiated under the floristic profile, were identified and characterized. A description of the plant communities is provided below.

Sandy coast – dunal complex *(Fig. 3)*

The coastal belt of the SCI "Litorale Brindisino" is characterized by a dune system among the most extended of the Puglia Region. The whole standard zonation, from the aphytoic zone to the shrub vegetation of the consolidated dunes, is rarely observed in the area, due to the high degree of disturbance and coastal erosion. The aphytoic zone corresponds to the area immediately next to the sea, washed by the waves and not colonised by plants. The first vegetation belt immediately over the aphytoic zone, subject to the overwash effects and to the accumulation of organic matter is represented by the psammophilous and sub-nitrophilous annual vegetation dominated by *Cakile maritima* and *Salsola kali*, that tolerates different halo-nitrophilous degrees also in dependence of the human pressure level (Corbetta *et al*., 1989). This vegetation corresponds to the association *Salsolo kali-Cakiletum maritimae* (Tab. 1). In the investigated area this vegetation occurs very discontinuously, due to the impact of the touristic activities and in particular of equipped lidos, that imply the implementation of practices such as the mechanical cleaning of beaches (Biondi, 1999). The perennial vegetation of embryonic shifting dunes, immediately following the *Salsolo-Cakiletum*, is characterized by the dominance of *Elymus farctus*, with other several plant species belonging to the *Ammophilion* (*Calystegia soldanella*, *Echinophora spinosa*, *Sporobolus virginicus*, etc.) and is ascribed to the *Echinophoro spinosae-Elymetum farcti* (Tab. 2, rels. 1-3). From and ecological-structural point of view, this vegetation is the first form of perennial vegetation that colonizes the sandy shores.

White dunes are colonized by perennial plant communities structurally characterized by *Ammophila arenaria* subsp. *australis*, species consolidating and stabilizing the dune (Brullo *et al*., 2001). Other psammophilous species are: *Echinophora spinosa*, *Pancratium maritimum*, *Matthiola sinuata*, *Euphorbia paralias*, *Lotus creticus*, etc. This vegetation is ascribed to the *Echinophoro spinosae-Ammophiletum australis* (Tab. 2, rels. 4-6). Both the *Echinophoro spinosae-Elymetum farcti* and the *Echinophoro spinosae-Ammophiletum australis* associations, in the study area, occur distributed in narrow and discontinuous patches, often

Tab. 1 - *Salsolo-Cakiletum maritimae*.

Relevé number	1	2
Surface (mq)	30	30
Cover (%)	60	50
Char. Ass., All. (*Euphorbion peplis*) and Cl. (*Cakiletea maritimae*)		
Cakile maritima Scop. subsp. maritima	3	3
Salsola kali L.	3	1
Polygonum maritimum L.	+	+
Other species		
Sporobolus virginicus Kunth	+	.
Elymus farctus (Viv.) Runemark ex Melderis subsp. farctus	.	+
Pancratium maritimum L.	.	+
Eryngium maritimum L.	.	+

Tab. 2 - *Echinophoro spinosae-Elymetum farcti* (rels. 1-3); *Echinophoro spinosae-Ammophiletum australis* (rels. 4-6).

Relevé number	1	2	3	4	5	6
Surface (mq)	70	80	70	60	50	40
Cover (%)	80	80	70	90	90	90
Diff. Ass.						
Elymus farctus (Viv.) Runemark ex Melderis subsp. farctus	5	3	3	1	1	+
Ammophila arenaria (L.) Link subsp. australis (Mabille) Laìnz	.	.	.	5	4	5
Echinophora spinosa L.	+	1	1	+	+	1
Char. All. (*Ammophilion australis*) and Cl. (*Euphorbio-Ammophiletea*)						
Lotus creticus L.	1	2	2	2	1	3
Euphorbia paralias L.	2	1	2	+	1	+
Sporobolus virginicus Kunth	+	+	1	+	+	.
Pancratium maritimum L.	.	1	+	1	+	.
Calystegia soldanella (L.) Roem.& Schult.	.	2	1	.	2	+
Eryngium maritimum L.	+	1	2	.	.	.
Other species						
Reichardia picroides (L.) Roth	2	1	+	+	+	1
Matthiola sinuata (L.) R. Br.	1	+	.	+	+	+
Sixalix atropurpurea (L.) Greuter & Burdet subsp. grandiflora (Scop.) Soldano & F.Conti	1	.	+	.	.	+
Limbarda crithmoides (L.) Dumort. s.l.	.	1	.	.	.	+

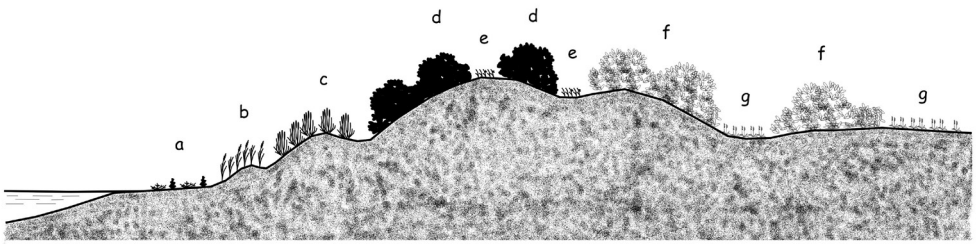


Fig. 3 - Sandy coast - dune complex. Plant communities distribution along a transect passing through the dune belt, from the sea to the inland facing slope of the dune: a) *Salsolo-Cakiletum maritimae*; b) *Echinophoro spinosae-Elymetum farcti*; c) *Echinophoro spinosae-Ammophiletum australis*; d) *Asparago acutifolii-Juniperetum macrocarpae*; e) *Vulpio-Romuletum rollii*; f) *Myrto-Pistacetum lentisci*; g) *Alkanno-Plantaginetum albicantis*.

interposed to each other, especially in correspondence of the southern coastal part of the SCI. In the Apulia region, as far as the study site, both the vegetation types have gone throught reduction and fragmentation of their distribution area, due to the extensive human activities and the associated pressures that have been exerted for decades on the coastal areas. (Biondi, 1999; Biondi *et al*., 2006; Tomaselli *et al*., 2012).

The most mature vegetation type of the dunes is the *Asparago acutifolii-Juniperetum macrocarpae* (Tab. 9, rels. 1-7), belonging to the *Juniperion turbinatae*, where *Juniperus oxycedrus* subsp. *macrocarpa* dominates the physiognomy of this vegetation. Other sclerophyllous shrub species are *Pistacia lentiscus*, *Phyllirea latifolia*, *Myrtus communis*, *Rhamnus alaternus*, etc. This association represents the completion of the psammophilious series throughout the Salento (southern Apulia) sandy coasts (Biondi *et al*., 2006). The *Asparago acutifolii-Juniperetum macrocarpae* develops along the dune belt for most of the study area, although it extents especially along the south-central part of the SCI (Fiume Morelli, Rosa Marina). In general, due to the strong erosion of the dune belt, the vegetation results fragmented and frequently mixed with other associations of *Cutandietalia* and of *Ammophiletea* classes.

In correspondence of small open spaces with bare sandy soil inside the shrub communities of the *Juniperion turbinatae* maquis, psammophilous ephemeral therophytic communities appear during springtime. The dominant species is a rare geophyte, *Romulea rollii*, which is accompanied by several other annual species belonging to the *Cutandietalia maritimae* order, such as *Silene niceensis*, *Vulpia fasciculata*, *Daucus pumilus*, *Medicago littoralis*, *Echium arenarium*, *Corynephorus divaricatus*, etc. (Tab. 3, rels. 1-7). This vegetation can be referred to the *Vulpio-Romuletum rollii*, association already identified for the Apulia Region in the sandy coast area next Brindisi (Tomaselli *et al*., 2010). In the case of the study area, this plant community has been identified throughout the dune complex but with a rather discontinuous distribution. In particular, it was detected in the north of the SCI (between Lido Bizzarro and Lido Tavernese), in the central area ("Fiume Morelli" beach), and also in the southern part near the village of Rosa Marina. Its presence and integrity is seriously compromised by the tourist pressure (mostly trampling).

Landwards, next to the vegetation of the *Asparago acutifolii-Juniperetum macrocarpae* and often in correspondence of the land-facing slope of the dunes, a shrub community dominated by evergreen sclerophyllous species and characterized by the abundance of *Pistacia lentiscus* and *Myrtus communis* occurs. This vegetation, including also various species of Mediterranean maquis, such as *Smilax aspera*, *Prasium majus*, *Rhamnus alaternus*, *Lonicera implexa*, etc., can be referred to the *Myrto-Pistacetum lentisci*. It represents the most mature vegetation in the study site and is in catenal contact with the *Asparago acutifolii-Juniperetum macrocarpae* towards the sea while, landwards, with several plant communities of the inland and retro-dune wetlands and salt marshes, such as halophilous shrub of the *Sarcocornietea fruticosae*, helophytic communities of salty and brackish meadows (*Juncetea maritimi*) and helophytic communities of marshes and swamps (*Phragmito-Magnocaricetea*). The *Myrto-Pistacetum lentisci* often forms complex mosaics with the therophytic plant communities of *Cutandietalia* and, depending on the degree of the dune erosion, with the *Asparago acutifolii-Juniperetum macrocarpae* or (in presence of severe dune erosion and vegetation fragmentation) with the perennial psammophilous plant associations of sandy dunes (*Ammophiletea*).

In correspondence with consolidated sand soils, between the land-facing slope of the dunes and the retro-dune wetland areas, a psammo-nitrophilous vegetation characterized by *Plantago albicans* occur, forming continuous carpets on the consolidated sandy substrate. Along with *P. albicans* a large contingent of therophytes of *Cutandietalia maritimae* order and *Tuberarietea guttatae* appear, such as *Silene colorata*, *Vulpia myuros*, *Polycarpon tetraphyllum* subsp. *alsinifolium*, *Medicago littoralis*, *Echium arenarium*, *Phleum arenarium*, *Alkanna tinctoria*, etc. This vegetation can be referred to the *Alkanno-Plantaginetum albicantis* (Tab. 3, rels. 8-12), association described for the protected area of Torre Guaceto (Brindisi) and that usually occurs in areas with more or less consolidated sandy soils within the shrub vegetation of the *Oleo-Ceratonion* and/or the *Juniperion turbinatae* (Tomaselli *et al*., 2011). This vegetation, that can be considered as the Adriatic vicariant of the *Anchuso hybridae-Plantaginetum albicantis* Corbetta & Pirone 1989 (distributed along the Ionian coast of the Apulia; Corbetta *et al*., 1989), represents a stage of the consolidation of the coastal sand soils (Marchiori *et al*., 2000). In the study area this plant community has been detected in the northern (between Lido Bizzarro and Lido Tavernese) and in the central ("Fiume Morelli" beach) part of the SCI.

Salt marshes *(Fig. 4)*

The wetland area behind the dune belt consists of a complex system of brackish water pools. Plant communities are spatially arranged in more or less concentric or parallel belts, depending on the shape of the water bodies, according to some ecological gradients related to soil topographic elevation, water regime, soil and water salinity.

In correspondence with the water bodies, but also in canals and pools in the retro-dune area, the *Enteromor-*

Tab. 3 - *Vulpio-Romuletum rollii* (rels. 1-7); *Alkanno-Plantaginetum albicantis* (rels. 8-12)

Relevé number	1	2	3	4	5	6	7	8	9	10	11	12
Surface (mq)	10	10	7	10	10	10	5	10	20	20	10	10
Cover (%)	60	40	50	60	80	50	70	80	70	80	70	75
Diff. Ass.												
Romulea rollii Parl.	.	1	+	+	+	1	.	+	1	+	2	+
Plantago albicans L.	.	1	2	1	2	.	.	3	3	3	2	3
Char. *Alkanno-Maresion nanae* and *Cutandietalia*												
Medicago littoralis Loisel.	1	+	2	+	1	1	1	1	1	1	1	2
Vulpia fasciculata (Forssk.) Fritsch	4	3	2	4	3	2	4	1	+	+	1	.
Daucus pumilus (L.) Hoffmanns. & Link	+	1	3	3	2	2	.	.	.	.	1	1
Silene nicaeensis All.	.	+	+	+	.	.	+	.	.	.	.	.
Alkanna tinctoria (L.) Tausch	.	.	.	.	.	.	.	.	+	1	1	+
Echium arenarium Guss.	.	.	.	1	.	.	.	.	+	+	+	.
Polycarpon tetraphyllum (L.) L. subsp. alsinifolium (Biv.) Ball	.	.	.	.	.	1	.	.	+	+	.	1
Erodium laciniatum (Cav.) Willd. subsp. laciniatum	.	.	.	1	.	.	.	.	.	.	.	.
Phleum arenarium L.	.	.	.	.	.	.	.	.	.	+	.	.
Char. *Tuberarietea guttatae*												
Silene colorata Poir.	2	1	1	1	3	1	1	2	1	1	1	2
Cutandia maritima (L.) Barbey	.	1	3	1	+	+	+	.	.	.	.	.
Vulpia myuros (L.) C. C. Gmel.	.	.	.	.	.	.	.	1	+	+	1	1
Corynephorus divaricatus (Pourr.) Breistr.	.	.	1	1	1	.	.	.	.	.	.	.
Cerastium pumilum Curtis	.	.	.	.	.	1	.	.	.	.	.	.
Hypochaeris achyrophorus L.	.	.	.	.	.	.	1	.	.	.	.	.
Arenaria serpyllifolia L.	.	.	.	.	.	+	.	.	.	.	.	.
Tuberaria guttata (L.) Fourr.	.	.	.	.	.	.	.	.	.	+	.	.
Linum trigynum L.	.	.	.	.	+	.	.	.	.	.	.	.
Valerianella eriocarpa Desv.	.	.	.	.	.	+	.	.	.	.	.	.
Trifolium campestre Schreb.	+	.	.	.	.	.	.	.	.	.	.	.
Euphorbia exigua L.	.	.	.	.	.	.	.	.	.	.	+	.
Cerastium semidecandrum L.	.	.	.	.	.	.	.	+	.	.	.	.
Trasg. *Saginetea maritimae*												
Catapodium balearicum (Willk.) H. Scholz	.	.	.	.	.	+	1	+	.	.	+	.
Parapholis incurva (L.) C. E. Hubb.	.	.	.	.	.	.	3	.	.	.	.	.
Plantago coronopus L. subsp. coronopus	.	.	.	+	.	.	.	.	.	.	.	.
Centaurium tenuiflorum (Hoffmanns. & Link) Fritsch	.	.	.	.	.	.	.	.	+	.	.	.
Other species												
Lagurus ovatus L. s.l.	1	.	+	1	1	+	2	.	+	.	+	+
Sixalix atropurpurea (L.) Greuter & Burdet subsp. grandiflora (Scop.) Soldano & F.Conti	+	1	+	.	.	.	+	+	+	2	1	+
Lotus creticus L.	1	1	1	1	1	+	1	.	.	.	.	+
Hedypnois rhagadioloides (L.) F.W. Schmidt	.	.	.	2	1	1	3	2	.	.	+	+
Crepis vesicaria L. subsp. vesicaria	1	+	+	.	.	+	.	1	.	.	+	.
Reichardia picroides (L.) Roth	.	.	.	.	.	.	+	.	1	1	+	.
Sulla capitata (Desf.) B.H. Choi & H. Ohashi	.	.	.	.	.	+	.	.	1	2	+	.
Crepis sp.	1	+	+	.	.	+	.	.	.	.	.	.
Sporobolus virginicus Kunth	.	1	+	.	.	.	.	.	.	.	+	1
Medicago marina L.	.	.	.	.	.	.	.	1	1	1	+	.
Pancratium maritimum L.	.	.	1	.	.	.	.	+	.	.	.	+
Rhagadiolus stellatus (L.) Gaertn.	.	.	.	2	1	1	.	.	.	.	.	.
Trifolium scabrum L. subsp. scabrum	.	.	.	+	+	.	2	.	.	.	.	.
Plantago lagopus L.	.	.	.	+	+	.	.	.	.	.	.	.
Anisantha madritensis (L.) Nevski subsp. madritensis	.	.	.	+	+	.	.	.	.	.	.	.
Euphorbia helioscopia L. subsp. helioscopia	.	.	.	1	+	.	.	.	.	.	.	.
Cyperus capitatus Vand.	.	.	.	.	.	.	.	.	+	2	.	.

pho-Ruppietum maritimae occur, even though discontinuously. This vegetation is distributed in brackish waters and is dominated by *Ruppia maritima*, species which tolerates fluctuations in water salinity (Murphy *et al*., 2003) and forms almost monophytic populations, sometimes associated with green algae such as *Enteromorpha intestinalis*.

During the summer season, water pools tend to dry up and some portions of bare soil at their edges can be colonized by halophilous therophytic communities dominated by *Salicornia emerici*. This species forms populations with discontinuous coverage and is accompanied by a few other salt-tolerant therophytes (Tab. 4). This annual vegetation can be referred to the *Salicornietum emerici*, that develops in depressions that are flooded for a long period and dry in summer. This association is rare in the Apulia region, distributed in coastal wetlands next to Taranto and some other sites

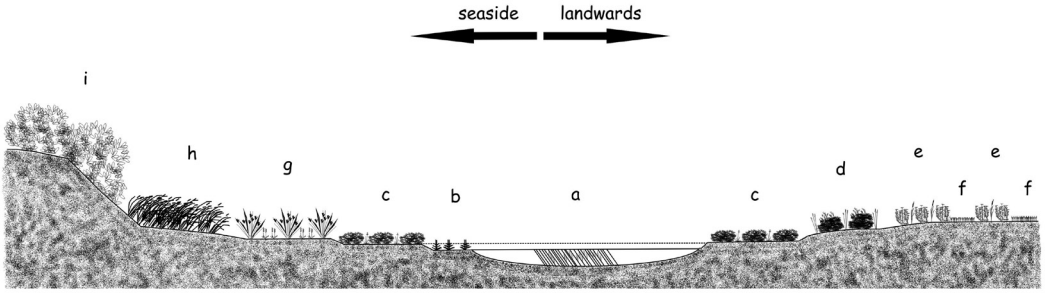


Fig. 4 - Sandy coast - salt marshes. Plant communities distribution along a transect passing through the retro-dune area occupied by coastal lagoons and salt marshes, from the sea to the inland: a) *Enteromorpho intestinalidis-Ruppietum maritimae*; b) *Salicornietum emerici*; c) *Puccinellio festuciformis-Sarcocornietum alpini*; d) *Arthrocnemo-Juncetum subulati*; e) *Agropyro elongati-Inuletum crithmoidis*; f) *Spergulario salinae-Hordeetum marini*; g) *Schoeno nigricantis-Plantaginetum crassifoliae*; h) *Spartino-Juncetum maritimi*; i) *Myrto-Pistacetum lentisci*.

Tab. 4 - *Salicornietum emerici*.

Relevé number	1	2
Surface (mq)	10	10
Cover (%)	70	50
Char. Ass.		
Salicornia emerici Duval-Jouve	3	3
Trasgr. *Saginetea maritimae*		
Spergularia salina J. & C. Presl	1	1
Parapholis filiformis (Roth) C.E. Hubb.	1	+
Other species		
Juncus hybridus Brot.	2	1
Symphyotricum squamatum (Spreng.) G.L. Nesom	1	+
Isolepis cernua (Vahl) Roem. & Schult.	+	1
Limonium narbonense Mill.	1	+
Limbarda crithmoides (L.) Dumort. s.l.	+	.
Carex viridula Michx.	.	+

in the Salento peninsula (Southern Apulia; Biondi, 1999; Corbetta & Pirone, 1999). In the study site, the *Salicornietum emerici* occurs only in small and fragmented patches in correspondence of the retro-dune area in the northern part of the SCI.

The areas immediately surrounding lagoons and water pools, subjected to prolonged flooding periods, host an halophilous shrub vegetation characterized by *Sarcocornia alpini*, shrubby chamaephyte with a reptant habit. Such vegetation can be considered as the first belt of perennial vegetation surrounding the water bodies. It is well differentiated by the presence of *Puccinellia festuciformis*, a markedly thermophilous species and thus can be referred to the *Puccinellio-Sarcocornietum alpini* (Tab. 5, rels. 1-3), association belonging to the *Sarcocornion alpini* alliance and usually colonizing areas subjected to long periods of submersion (Frondoni & Iberite, 2002; Sciandrello & Tomaselli, 2014). The association is widespread in the study site, although it covers large areas especially in correspondence of the retro-dunal area of the lagoon "Fiume Morelli". In the most raised part of the salt marsh, this vegetation takes contact with plant communities belonging to the *Arthrocnemion macrostachyi* alliance, and in particular with the *Arthrocnemo-Juncetum subulati* association (Tab. 5, rels. 4-5) that colonizes salt marshes in areas far enough from the sea, flooded for short periods of the year. This vegetation develops on surfaces elevated respect to those of the *Puccinellio-Sarcocornietum alpini* (Brullo *et al*., 1988). *Juncus subulatus* and *Arthrocnemum macrostachyum*, characteristic of the association, prefer soils that retain a certain degree of humidity even during the summer season and, in general, *Juncus subulatus* tends to dominate in the most humid stands (Biondi, 1992; Sciandrello & Tomaselli, 2014). In the study area, this association has been detected in the area of "Fiume Morelli" and, with very small patches, near "Lido Tavernese".

In the most peripheral and elevated parts of the salt marshes, as well as along the dikes of the canals, in areas not subject to submersion or only rarely flooded, the *Agropyro elongati-Inuletum crithmoidis* occurs (Tab. 5, rels. 6-12); association belonging to the *Inulion crithmoidis* alliance and structurally characterized by the dominance of *Limbarda crithmoides* and *Elymus elongatus* (Brullo *et al*., 1988). In drafting a standard zonation of the halophilous shrub communities around the water pools, this vegetation may represent the most peripheral belt. Within the study area, the *Agropyro elongati-Inuletum crithmoidis* is rather widespread, often forming an external belt in contact with the other plant communities of the *Sarcocornietea*. Landwards, on more mature soils, the association is in contact with the communities of the *Oleo-Ceratonion*.

The shrub communities of the *Sarcocornietea fruticosae* class, and especially those of *Agropyro elongati-Inuletum crithmoidis*, often form a mosaic with therophytic plant communities characterized by *Spergularia salina* and *Hordeum marinum*. This vegetation is referable to the *Spergulario salinae-Hordeetum marini* (Tab. 6, rels. 1-2), halo-nitrophilous association of clay-sandy soils completely dry during summer and frequently subject to trampling and which, in its typical context, is in mosaic with the perennial vegetation

Tab. 5 - *Puccinellio festuciformis-Sarcocornietum alpini* (rels. 1-3); *Arthrocnemo-Juncetum subulati* (rels. 4-5); *Agropyro elongati-Inuletum crithmoidis* (rels. 6-12); *Arthrocnemum macrostachyum communities* (rels. 13-14); *Limonio virgati-Arthrocnemetum macrostachyi* (rels. 15-18).

Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Surface (mq)	60	100	100	80	80	100	60	50	60	80	60	80	20	20	50	60	20	30
Cover (%)	100	100	90	100	100	100	100	100	100	100	100	100	100	100	80	90	40	30
Diff. Ass. and char. All. (*Sarcocornion alpini* and *Arthrocnemion macrostachyi*)																		
Puccinellia festuciformis (Host) Parl.	1	1	2	.	.	.	1	+	.	.	.	.	.	.	.	.	.	.
Sarcocornia alpini (Lag.) Rivas-Martínez	5	5	4	.	.	2	2	1	.	.	.	.	.	.	.	.	.	.
Arthrocnemum macrostachyum (Moric.) Moris	1	.	2	4	4	+	+	+	.	.	.	.	5	5	4	5	3	2
Elymus elongatus (Host) Runemark subsp. elongatus	.	+	.	.	.	3	3	4	1	+	1	.	.	.	.	.	.	.
Limonium virgatum (Willd.) Fourr.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	2	2	1	1
Char. *Inulion crithmoidis*																		
Limbarda crithmoides (L.) Dumort. s.l.	+	+	+	.	+	4	4	4	4	2	3	5	.	.	.	.	.	.
Char. *Sarcocornietea fruticosae*																		
Limonium narbonense Mill.	2	2	2	1	1	2	3	2	2	2	2	2	+	+	.	.	.	.
Atriplex portulacoides L.	1	1	1	2	2	.	1	2	.	+	.	+	1	.	.	.	.	.
Aeluropus littoralis (Gouan) Parl.	.	.	.	2	2	.	.	.	.	+	.	+	.	.	.	.	.	.
Triglochin bulbosa L. subsp. barrelieri (Loisel.) Rouy	1	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sarcocornia fruticosa (L.) A.J. Scott	.	.	.	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.
Trasgr. *Juncetalia maritimi* and *Juncetea maritimi*																		
Juncus acutus L. subsp. acutus	.	.	.	.	3	1	.	.	2	+	1	1	1	1	.	.	.	.
Juncus maritimus Lam.	.	+	+	2	3	2	+	+	1	1	1	1	.	.	.	.	.	.
Tripolium pannonicum (Jacq.) Dobrocz. s.l.	+	.	.	.	.	.	.	.	+	2	.	.	.	.	.	.	.	.
Juncus subulatus Forssk.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carex extensa Good.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
Other species																		
Parapholis filiformis (Roth) C.E. Hubb.	2	.	+	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.
Elymus athericus (Link) Kerguélen	.	.	.	.	.	.	.	.	3	2	4	2	.	.	.	.	.	.
Erigeron canadensis L.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.
Symphyotricum squamatum (Spreng.) G.L. Nesom	.	.	.	.	.	.	.	.	.	.	+	2	.	.	.	.	.	.
Crithmum maritimum L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	.	.
Frankenia laevis L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	.	.

of the *Sarcocornietea fruticosae* class (Biondi *et al*., 2001; Pisanu *et al*., 2014). In the study area, this association is distributed in correspondence of retro-dunal meadows in the southern part of the SCI, next to the Rosa Marina village.

In correspondence with hollowed areas behind the dunes or even in peripheral areas of salt marshes, flooded for much of the year, the *Inulo-Juncetum maritimi* (Tab. 7, rels. 1-3) association was identified. This association is dominated by *Juncus maritimus* and others halophytes, such as *Limbarda crithmoides*, *Limonium narbonense* and *Atriplex portulacoides*, that prefer sandy soils, flooded for long time. *Inulo-Juncetum maritimi* is limited to the southern Mediterranean areas characterized by a warmer and arid climate (Brullo *et al*., 1988; Biondi *et al*., 2001; Farris *et al*., 2007). It is quite rare in the study site, present only in small areas in the area of "Fiume Morelli" and with a very fragmented distribution.

In the retro-dune zone, but in areas slightly more raised than in the previous association, on compacted, sandy-gravelly more or less organic soils subject to short periods of flooding, the *Schoeno nigricantis-Plantaginetum crassifoliae* occurs (Tab. 7, rels. 4-10). It belongs to the halo-hygrophilous alliance *Plantaginion crassifoliae* and characterized by the dominance of *Schoenus nigricans* and *Plantago crassifolia*. It generally develops in micro-depression in the back dune area (Biondi *et al*., 2006). In the study area, this association is present only in correspondence with the retro-dunal area of the lagoon "Fiume Morelli".

The transition zone between the alluvial plains and the dunes is occupied by *Spartina versicolor* communities forming extended, dense and almost monophytic grasslands accompanied by *Juncus acutus* and *J. maritimus* (Frondoni & Iberite, 2002). It is the *Spartino-Juncetum maritimi* (Tab. 7, rels. 11-13), association that can be considered as the catenal contact between the halo-hygrophilous associations of *Juncion maritimi* and psammophilous communities of the dunes. These communities generally prefer retrodunal sandy lowlands with sandy wet soils, exceptionally flooded and low salinity, forming a more or less continuous strip bordering, seaside, the vegetation of the land facing slope of the dunes and, landwards, the salt marsh vegetation (Frondoni & Iberite, 2002; Tomaselli *et al*., 2010; Bertacchi & Lombardi, 2014). In the study site forms a belt of various width behind the dune belt, especially in correspondence of the retrodunal area of the lagoon "Fiume Morelli" and "Lido Tavernese".

Phragmites australis communities are distributed in various sections of the study area, especially in areas

Tab. 6 - *Spergulario salinae-Hordeetum marini* (rels. 1-2); *Parapholido incurvae-Catapodietum balearici* (rels. 3-6).

Relevé number	1	2	3	4	5	6
Surface (mq)	25	15	5	20	10	15
Cover (%)	65	70	70	65	70	70
Diff. Ass.						
Parapholis incurva (L.) C. E. Hubb.	1	1	3	3	2	3
Spergularia salina J. & C. Presl	3	2	.	1	+	.
Char. Cl. (*Saginetea maritimae*)						
Sagina maritima G. Don	+	3	.	.	+	.
Catapodium balearicum (Willk.) H. Scholz	.	.	1	+	1	.
Hordeum marinum Huds. subsp. marinum	1	+	.	+	.	.
Trasgr. *Tuberarietea guttatae*, *Alkanno-Maresion nanae* and *Cutandietalia maritimae*						
Medicago littoralis Loisel.	+	.	1	+	.	+
Silene colorata Poir.	.	.	1	+	1	1
Vulpia fasciculata (Forssk.) Fritsch	.	.	1	+	1	1
Lagurus ovatus L. s.l.	.	.	1	.	+	1
Silene niceensis All.	.	.	+	.	+	+
Daucus pumilus (L.) Hoffmanns. & Link	.	.	+	.	.	1
Polycarpon tetraphyllum subsp. diphyllum (Cav.) O. Bolòs & Font Quer	.	.	.	.	.	1
Alkanna tinctoria (L.) Tausch	.	.	.	.	.	1
Echium arenarium Guss.	.	.	.	.	.	1
Other species						
Rhagadiolus stellatus (L.) Gaertn.	.	.	1	1	+	2
Lotus creticus L.	.	.	1	1	+	1
Suaeda maritima (L.) Dumort.	+	+	.	+	+	.
Sporobolus virginicus Kunth	.	.	+	+	.	+
Reichardia picroides (L.) Roth	.	.	+	.	+	+
Vulpia sp.	.	.	1	.	.	+
Plantago lagopus L.	.	.	1	.	.	+
Lysimachia arvensis (L.) U. Manns & Anderb.	.	+	.	.	+	.
Romulea bulbocodium (L.) Sebast. & Mauri	+	+	.	.	.	.
Juncus hybridus Brot.	1	+	.	.	.	.

Tab. 7 - *Inulo-Juncetum maritimi* (rels. 1-3); *Schoeno nigricantis-Plantaginetum crassifoliae* (rels. 4-10); *Spartino-Juncetum maritimi* (rels. 11-13).

Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13
Surface (mq)	50	50	100	30	40	40	80	15	10	20	80	85	90
Cover (%)	100	100	100	100	90	95	95	90	90	80	100	100	100
Diff. Ass.													
Limbarda crithmoides (L.) Dumort. s.l.	2	2	4	+	+	+	1	.	.	.	.	.	.
Schoenus nigricans L.	.	.	.	4	2	4	3	4	2	4	.	.	.
Spartina versicolor Fabre	.	.	.	.	.	.	.	.	.	.	5	5	5
Char. All. (*Plantaginion crassifoliae*)													
Plantago crassifolia Forssk.	.	.	.	+	4	3	4	3	4	3	+	.	.
Char. All. (*Juncion maritimi*) and Cl. (*Juncetea maritimi*)													
Juncus acutus L. subsp. acutus	1	+	1	+	1	+	+	2	2	1	+	1	+
Juncus maritimus Lam.	3	4	4	2	2	+	+	.	.	.	2	2	1
Elymus elongatus (Host) Runemark subsp. elongatus	+	.	1	+	.	+	1	.	1	+	.	.	.
Carex extensa Good.	.	.	.	.	2	.	3	1	1	+	.	+	.
Tripolium pannonicum (Jacq.) Dobrocz. s.l.	1	+	.	.	.	.	.	1	1	1	.	.	.
Sonchus maritimus L. subsp. maritimus	.	.	.	.	.	.	.	+	.	.	.	.	.
Scirpoides holoschoenus (L.) Sojàk	.	.	.	.	.	.	.	.	.	.	.	.	2
Trasgr. *Sarcocornietea fruticosae*													
Limonium narbonense Mill.	3	1	3	+	2	+	2	.	.	.	1	1	.
Atriplex portulacoides L.	2	3	1	+	.	.	+	.	.	.	.	.	.
Sarcocornia alpini (Lag.) Rivas-Martínez	.	1	2	.	+	.	+	.	.	.	.	.	+
Aeluropus littoralis (Gouan) Parl.	+	+	.	.	.	.	.	.	.	.	+	.	.
Arthrocnemum macrostachyum (Moric.) Moris	.	1	.	.	+	.	.	.	.	.	.	.	.
Other species													
Limonium virgatum (Willd.) Fourr.	.	.	+	+	1	1	2	.	.	.	.	+	.
Elymus athericus (Link) Kerguélen	2	+	.	1	.	+	.	.	.	.	.	.	+
Parapholis filiformis (Roth) C.E. Hubb.	.	.	.	+	1	+	+	.	.	.	.	.	.
Daucus carota L. s.l.	.	.	.	+	.	+	.	.	.	.	+	+	.
Phragmites australis (Cav.) Trin. ex Steud. subsp. australis	.	.	.	.	+	.	.	.	1	.	1	.	+
Dittrichia viscosa (L.) Greuter s.l.	.	.	.	.	.	.	.	1	+	.	.	+	.
Juncus inflexus L.	.	.	.	.	.	.	.	1	2	+	.	.	.
Sporobolus virginicus Kunth	.	.	.	.	+	+	.	.	.	.	.	.	.

behind the dunes, favored by the presence of waters rich in nitrates originating from the surrounding agricultural areas. In some cases, this plant community forms vegetation mosaic with scrub communities of the *Myrto-Pistacetum lentisci* or with the perennial halophytic vegetation of salty soils (*Sarcocornietea fruticosae*). This vegetation, that can be referred to the *Phragmitetum communis*, colonizes fresh or brackish waters, often rich in nitrates, tolerates minor fluctuations in water level and tends forming extended and almost monospecific communities where common reed reproduces vegetatively (Landucci *et al*., 2013).

Rocky coast *(Fig. 5)*

The rocky coast is limited to the southern part of the SCI, along the stretch from Torre S. Leonardo to the Rosa Marina Village. The rocky coast is formed by low calcarenite horizontal cliffs, interposed with little sandy bays (Di Geronimo, 1970). The calcarenite cliffs are characterised by superficial karst microforms, called "corrosion basins" where different halophilous plant communities grow as described by Biondi *et al*. (2006) for the rocky coasts of Salento, describing a vegetation zonation that has been observed also in this study site.

In this zonation the first belt, immediately close to the coastline, is not colonised by vascular plants due to the high salt levels (the so called aphytoic zone). The second belt is characterized by pioneer communities of *Arthrocnemum macrostachyum* (Tab. 5, rels. 13-14) colonising the bottom of the "corrosion basins" covered by a thin layer of salt. Landwards, the "corrosion basins" are less influenced by the salt spray and a more complex vegetation, formed by *Arthrocnemum macrostachyum* and various elements of the *Crithmo-Staticetea* class, appears. This vegetation has been described as *Limonio virgati-Arthrocnemetum macrostachyi* Biondi *et al*. (2006) (Tab. 5, rels. 15-18). Further landwards, an halophilous chamaephytic community, referable to the *Crithmo-Limonietum apuli* (Tab. 8) colonises hollows and rifts in the rocky susbstrate and also corrosion basins, where present. The association is characterized by *Limonium apulum* Brullo, endemic of the Adriatic coast of the Puglia region, from Otranto (LE) to the Gargano (FG); it is localized on calcarenite rocks and limestones and tolerates the marine aerosols (Brullo *et al*., 1990; Biondi, 2007). In this vegetation zonation the *Crithmo-Limonietum apuli* can be considered as the geographic vicariant of the *Limonietum japigyci* of the Salento coasts (Biondi *et al*., 2006).

In the inner areas of the rocky coast, subject to frequent trampling, the *Parapholido incurvae-Catapodietum balearici* association was observed (Tab. 6, rels. 3-6). Dominant species are *Parapholis incurva* and *Catapodium balearicum*, halo-nitrophilous pioneer species growing on muddy-sandy substrates or consolidated sands, in brackish environments of the back dune areas or also, as in this case, on sandy deposits in coastal rocky areas, often subject to human disturbance and especially to trampling (Brullo & Giusso del Galdo, 2003; Biondi & Bagella, 2005).

The most mature vegetation of the rocky coasts is represented by the *Juniperetum macrocarpae-turbinatae* (Tab. 9, rels. 8-12), shrub vegetation dominated by the two junipers *Juniperus phoenicea* subsp. *turbinata* and *Juniperus oxycedrus* subsp. *macrocarpa*, which usually occupies the inner dunes with more coherent

Tab. 8 - *Crithmo-Limonietum apuli*.

Relevé number	1	2	3	4
Surface (mq)	10	30	50	50
Cover (%)	20	45	35	45
Char. Ass.				
Limonium apulum Brullo	+	1	1	3
Char. All. (*Crithmo maritimi-staticion*) and Cl. (*Crithmo-Staticetea*				
Limonium virgatum (Willd.) Fourr.	2	3	2	+
Frankenia hirsuta L.	.	1	+	+
Arthrocnemum macrostachyum (Moric.) Moris	1	+	.	.
Crithmum maritimum L.	.	.	1	2
Other species				
Plantago coronopus L. subsp. coronopus	.	+	+	+
Chenopodium album L.	+	.	.	.
Sporobolus virginicus Kunth	.	1	.	.
Reichardia picroides (L.) Roth	.	.	+	.

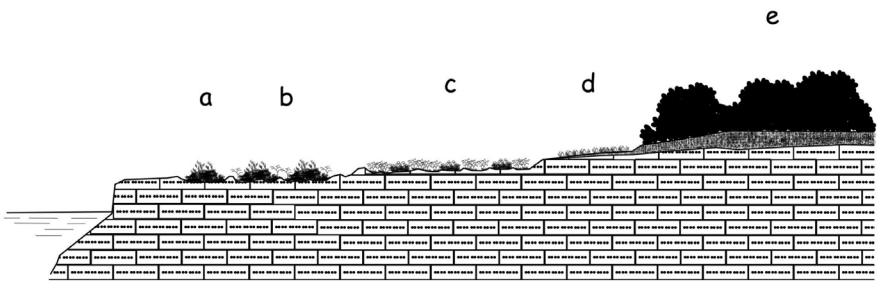


Fig. 5 - Rocky coast. Plant communities distribution along a transect passing through the rocky coast, from the sea to the inland: a) *Arthrocnemum macrostachyium communities*; b) *Limonio virgati-Arthrocnemetum macrostachyi*; c) *Crithmo-Limonietum apuli*; d) *Parapholido incurvae-Catapodietum balearici*; e) *Juniperetum macrocarpae-turbinatae*.

and consolidated soils rich in organic matter, widely distributed along the Apulian Adriatic coasts (Pirone, 2014). The association, occurring in the southern part of the SCI, between the inhabited area of Rosa Marina and the locality macchia Pilone (Vita & Macchia, 1974), prefers the calcarenite outcrops. Despite the presence of touristic structures, buildings and beach facilities, this vegetation shows a rather good conservation status.

Vegetation map *(Fig. 6)*

The cartographic representation in the vegetation map implies two main issues to be addressed: 1) the scale 1:5,000 is not sufficiently detailed to allow the representation of each single association. Therefore, in representing the different vegetation types, we stopped at the level of categories higher than association and, only in a few cases, it was possible to represent the individual associations; 2) due to the high degree of fragmentation and complexity of the landscape, the classes of "vegetation mosaics" were used and a total of 14 vegetation mosaics were represented, on a total number of 30 vegetation types (the "classes" of the map legend). The vegetation mosaics cover more than the 15% of the total area of the SCI and almost the 43% of natural and semi-natural vegetation.

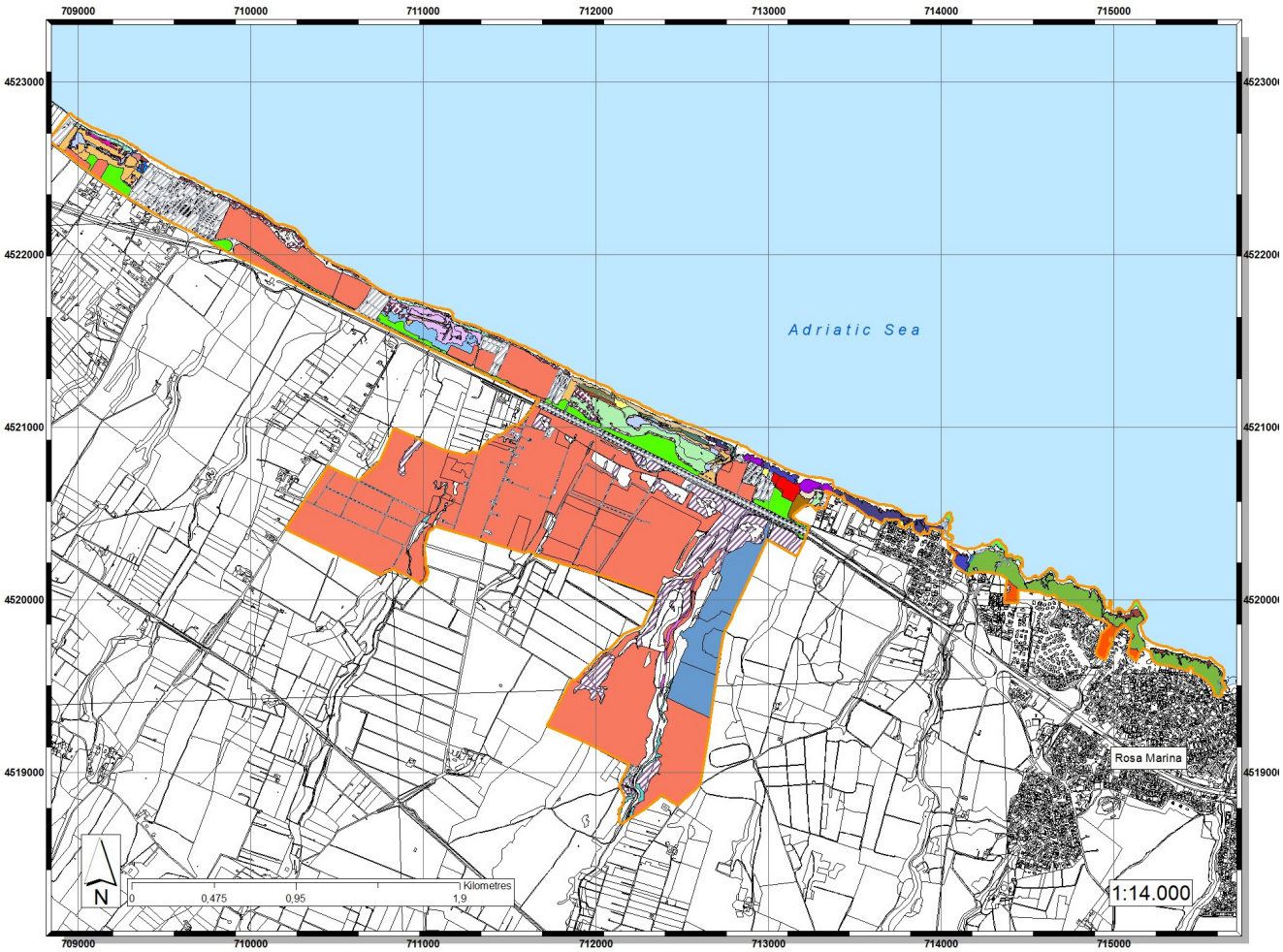
The different vegetation classes represented in the map with their relative cover values are listed in Table 10. The anthropized areas, as "Urbanization" and "Cultivated areas" are predominant, covering 10% and about 50%, respectively, of the whole area of the SCI.

The most extensive natural formations are those characterizing the inland: *Cisto-Micromerietea* garrigues (5.8%), *Lygeo-Stipetea* pseudo-steppe grasslands and *Tuberarietea guttatae* therophytic vegetation. These last two formations often form complex mosaics, interspersed with cereal crops and extensive olive groves, with an overall cover of more than 11% of the total area. This alternation of olive trees, in extensive cultivation and randomly arranged, according to the original location of wild olive trees, with natural and semi-natural areas, characterize the traditional agricultural landscape of the Mediterranean area.

Despite their scarce extent, the areas of greatest natural value are those falling along the coast. Here, however, because of both human pressure (mainly linked to tourist activities and agriculture) and intense coastal erosion, these areas have been undergoing severe alterations for the last decades; especially along the dune belt, shoreline erosion has caused a sort of "compression" of the coastal belt, with reduction and fragmentation of the dune vegetation types (intermixed with each other in complex mosaics) and, in some cases, with a reversion of the natural vegetation zonation (Doing, 1985). Likewise, the wet area behind the dunes, affected by the next proximity to agricultural

Tab. 9 - *Asparago acutifolii-Juniperetum macrocarpae* (rels. 1-7); *Juniperetum macrocarpae-turbinatae* (rels. 8-12).

Relevé number	1	2	3	4	5	6	7	8	9	10	11	12
Surface (mq)	80	150	100	100	80	50	50	100	150	100	100	150
Cover (%)	100	100	85	95	100	100	90	90	95	90	95	100
Exposure	SO	SO	-	-	-	-	-	-	-	-	-	-
Slope (°)	5	20	-	-	-	-	-	-	-	-	-	-
Diff. Ass. e Char. All. (*Juniperion turbinatae*)												
Juniperus oxycedrus L. subsp. macrocarpa (Sibth & Sm.) Neilr.	2	2	4	4	4	2	4	2	2	1	2	.
Juniperus phoenicea L. subsp. turbinata (Guss.) Nyman	.	.	.	1	.	.	.	3	4	4	3	5
Char. Ord. (*Pistacio-Rhamnetalia*) and Cl. (*Quercetea ilicis*)												
Pistacia lentiscus L.	4	4	3	3	2	2	2	2	2	2	3	2
Smilax aspera L.	3	4	2	3	3	3	3	3	2	4	2	1
Rhamnus alaternus L. subsp. alaternus	.	.	1	2	1	1	1	3	2	2	2	2
Phillyrea latifolia L.	.	.	2	1	1	2	1	1	1	3	2	1
Rubia peregrina L. s.l.	.	.	2	1	1	1	.	+	1	1	+	1
Myrtus communis L. s.l.	.	.	.	.	+	2	1	1	.	+	2	+
Calicotome infesta (C.Presl) Guss. subsp. infesta	.	.	1	+	+	.	.	.	1	.	.	+
Osyris alba L.	.	.	.	1	1	1	+	+	.	.	.	.
Prasium majus L.	.	.	1	.	.	.	+	.	+	.	.	+
Asparagus acutifolius L.	.	.	.	.	.	1	1	.	+	+	.	.
Lonicera implexa Aiton subsp. implexa	.	.	.	.	.	+	1	.	.	.	1	+
Daphne gnidium L.	.	.	.	.	1	1	1	.	.	.	.	.
Quercus ilex L. subsp. ilex	.	.	.	.	2	3	.	.	.	.	.	.
Olea europaea L.	.	.	.	.	.	.	.	.	.	.	+	.
Other species												
Reichardia picroides (L.) Roth	.	.	+	+	.	.	.	+	+	.	+	.
Sporobolus virginicus Kunth	.	.	+	+	.	.	.	+	+	.	.	.
Piptatherum miliaceum (L.) Coss. s.l.	.	.	+	.	.	.	.	.	+	+	+	.
Cistus creticus L. s.l.	.	.	.	.	+	+	+	.	.	.	.	.
Scirpoides holoschoenus (L.) Sojàk	.	.	.	.	+	+	+	.	.	.	.	.
Pinus halepensis Mill.	.	.	.	.	+	+	1	.	.	.	.	.
Matthiola sinuata (L.) R. Br.	.	.	+	+	.	.	.	.	.	.	.	.
Pancratium maritimum L.	.	.	+	+	.	.	.	.	.	.	.	.
Brachypodium retusum (Pers.) P.Beauv.	.	.	.	.	.	.	.	.	.	.	1	+



Vegetation map

Legend

- SCI buondaries
- Lagoons vegetation (Enteromorpho-Ruppietum maritimae)
- Phragmitetum communis
- Euphorbio-Ammophiletea communities
- Salsolo-Cakiletum maritimae communities
- Rocks with Crithmo-Staticetea vegetation
- Juncetea maritimi communities
- Sarcocornietea fruticosae communities
- Thero-Suadetea communities
- Asplenietea trichomanis communities
- Cutandietalia communities
- Thymbra capitata communities (Cisto-Micromerietea)
- Myrto-Pistacetum lentisci (Oleo-Ceratonion)
- Asparago acutifolii-Juniperetum macrocarpae
- Juniperetum macrocarpo-turbinatae
- Juncetea and Sarcocornietea fruticosae mosaic
- Juncetea and Echio-Galactition mosaic
- Juncetea and Oleo-Ceratonion mosaic
- Sarcocornietea fruticosae, Oleo-Ceratonion, Phragmitetea mosaic
- Sarcocornietea fruticosae, Juncetea maritimi, Oleo-Ceratonion mosaic
- Euphorbio-Ammophiletea, Oleo-Ceratonion, Cutandietalia mosaic
- Euphorbio-Ammophiletea and Oleo-Ceratonion mosaic
- Euphorbio-Ammophiletea, Juniperion turbinatae, Cutandietalia mosaic
- Juniperion turbinatae and Cutandietalia mosaic
- Oleo-Ceratonion and Echio-Galactition mosaic
- Lygeo-Stipetea and Tuberarietea mosaic
- Cutandietalia and Echio-Galactition mosaic
- Saginetea and Echio-Galctiotion mosaic
- Tuberarietea and Echio-Galactition mosaic
- Rubus ulmifolius communities
- Fallow lands (Echio-Galactition)
- Artificial tree stands
- Croplands
- Sandy shores without vegetation
- Water bodies
- Urbanization

Fig. 6 - Vegetation map.

areas and by the presence of numerous infrastructure, has been involved by similar processes of alteration and fragmentation.

In detail, the plant communities typical of the dune belt (*Salsolo-Cakiletum maritimae*, *Echinophoro spinosae-Elymetum farcti*, *Echinophoro spinosae-Ammophiletum australis*) cover very restricted areas. At the present scale, due to the high fragmentation of such environments, they have been represented as mosaics. Landwards, shrub communities rich in evergreen sclerophyllous species are present: on the stabilized dune, the juniper plant communities are represented by the *Asparago-Juniperetum macrocarpae* on the loose substrates, and *Juniperetum macrocarpae-turbinatae* on the more mature substrates. They cover more than 4% of the whole area, representing the most extended

Tab. 10 - List of vegetation types identified and detailed in the vegetation map. The relative area (percentage compared to the total area of the SCI) is reported.

Vegetation types and mosaics	Relative (%) area
Lagoon vegetation (Ruppietea maritimae)	0,62
Rocks with Crithmo-Staticetea vegetation	0,44
Sarcocornietea fruticosae communities	1,76
Thero-Suadetea communities	0,08
Spartino-Juncetum maritimi	0,11
Phragmitetum communis	1,67
Salsolo-Cakiletum maritimae	0,01
Euphorbio-Ammophiletea communities	0,5
Asparago acutifolii-Juniperetum macrocarpae	0,73
Juniperetum macrocarpae-turbinatae	3,31
Myrto-Pistacetum lentisci	1,56
Cutandietalia communities	0,38
Thymbra capitata communities (Cisto-Micromerietea)	5,84
Fallow lands (Echio-Galactition)	2,87
Rubus ulmifolius communities	0,18
Asplenietea trichomanis communities	0,32
Euhorbio-Ammophiletea, Juniperion turbinatae, Cutandietalia mosaic	0,4
Euhorbio-Ammophiletea, Oleo-Ceratonion, Cutandietalia mosaic	0,42
Euhorbio-Ammophiletea and Oleo-Ceratonoin mosaic	0,46
Juniperion turbinatae and Cutandietalia mosaic	0,33
Juncetea and Sarcocornietea fruticosae mosaic	0,96
Sarcocornietea fruticosae, Oleo-Ceratonion, Phragmito-Magnocaricetea mosaic	0,1
Sarcocornietea fruticosae, Juncetea maritimi, Oleo-Ceratonion mosaic	0,07
Juncetea and Oleo-Ceratonion mosaic	0,75
Juncetea and Echio-Galactition mosaic	0,26
Cutandietalia and Echio-Galactition mosaic	0,15
Saginetea and Echio-Galactition mosaic	0,36
Oleo-Ceratonion and Echio-Galactition mosaic	0,19
Lygeo-Stipetea and Tuberarietea mosaic	5,82
Tuberarietea and Echio-Galactition mosaic	4,94
Sandy shores without vegetation	3,16
Water bodies	0,09
Croplands	50,18
Artificial tree stands	0,83
Urbanization	10,14

natural woody vegetation in the study site and forming both homogenous formations and mosaics with other communities of the dune belt. The sclerophyllous shrub communities of the *Myrto-Pistacetum lentisci* are here restricted to a strip just behind the dune belt, often in fragmented patches and in mosaic with the juniper and other herbaceous communities and with a total coverage of approximately 2.5%.

Lagoons and brackish marshes characterize the wet areas behind the dunes. Here specialized halophilous shrubs plant communities, characterized by succulent chamaephytic to nanophanerophytic *Chenopodiaceae* and belonging to the *Sarcocornietea fruticosae* class, characterize such environments. They cover about 2.45%, including both homogeneous pure formations and complex mosaics with numerous other plant communities (especially herbaceous vegetation belonging to the *Juncetea maritimi* and the *Phragmito-Magnocaricetea* classes). During the summer season, annual plant communities, completing their life cycle by the end of the autumn, appear and form characteristic belts along the edges of the coastal lagoons. Such formations (*Thero-Suadetea* in the map) cover approximately 0.08%.

Habitats map *(Fig. 7)*

Within the SCI IT9140002, 13 habitat types were identified with a cover of about 30.5% of the total area of the SCI. Among these, habitats 1150 (Coastal lagoons), 2250 (Coastal dunes with *Juniperus* spp.) and 6220 (Pseudo-steppe with grasses and annuals of the *Thero-Brachypodietea*) are priority habitats. In Table 11, all the habitats are listed with their relative cover values.

The predominant habitat types, in terms of extent, are: 6220* (Pseudo-steppe with grasses and annuals of the *Thero-Brachypodietea*) (10.76%), 2260 (*Cisto-Lavanduletalia* dune sclerophyllous scrubs) (2.63%), 2250* (Coastal dunes with *Juniperus* spp.) (4.69%) and 1420 (Mediterranean and thermo-Atlantic halophilous scrubs (*Sarcocornietea fruticosae*)) (2.82%).

The dunal habitats are distributed throughout the coastline of the SCI, but have often scattered distribution, in mosaic with each other or with adjacent habitats. In particular, habitats 1210 (Annual vegetation of drift lines; *Salsolo-Cakiletum maritimae*), 2110 (Embryonic shifting dunes; *Cypero capitati-Agropyretum juncei*) and 2120 (Shifting dunes along the shoreline with *Ammophila arenaria*; *Medicagini marinae-Ammophi-*

Tab. 11 - List of habitat types identified in the habitat map. The relative area (percentage compared to the total area of the SCI) is reported.

Habitat type	Relative (%) surface
1150* Coastal lagoons	0,62
1210 Annual vegetation of drift lines	0,01
1240 Vegetated sea cliffs of the Mediterranean coasts with endemic Limonium spp.	0,44
1310 Salicornia and other annuals colonizing mud and sand	0,08
1410 Mediterranean salt meadows (Juncetalia maritimi)	1,12
1420 Mediterranean and thermo-Atlantic halophilous scrubs (Sarcocornietea fruticosae)	2,82
2110 Embryonic shifting dunes	0,16
2120 Shifting dunes along the shoreline with Ammophila arenaria (white dunes)	0,33
2230 Malcolmietalia dune grasslands	0,45
2250* Coastal dunes with Juniperus spp.	4,69
2260 Cisto-Lavanduletalia dune sclerophyllous scrubs	2,63
6220* Pseudo-steppe with grasses and annuals of the Thero-Brachypodietea	10,76
8210 Calcareous rocky slopes with chasmophytic vegetation	0,32

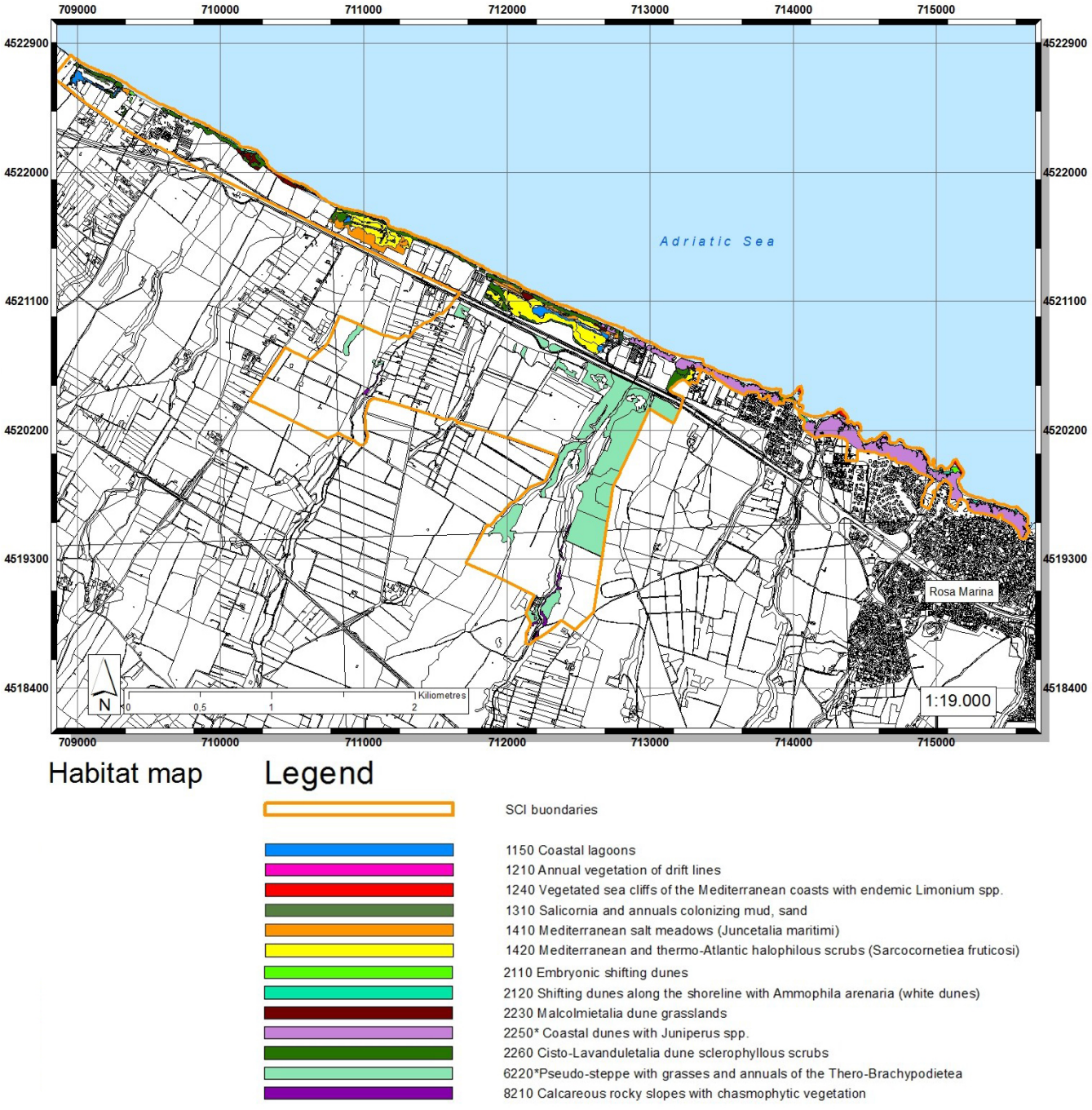


Fig. 7 - Habitat map.

letum australis) show a severe state of reduction and fragmentation of their distribution area.

The priority habitat 2250 (coastal dunes with *Juniperus* spp.), including the two associations *Asparago acutifolii-Juniperetum macrocarpae* and *Juniperetum macrocarpae-turbinatae*, is one of the best preserved in the whole study area. The *Myrto-Pistacetum lentisci* vegetation, included in the habitat 2260 (*Cisto-Lavenduletalia* dunes sclerophyllous scrubs), is often mixed with the *Euphorbio-Ammophiletea* communities (habitat types 2110 and 2120) and sometimes with those of *Cutandietalia* (habitat 2230), with which form extensive mosaics along the dune ridges. The numerous plant associations of the retrodunal wetlands are related to habitats 1420 (Mediterranean and thermo-Atlantic halophilous scrubs (*Sarcocornietea fruticosae*)) and 1410 (Mediterranean salt meadows of *Juncetalia maritimi*) and cover a large part of the investigated area.

In the SCI inland areas the priority habitat 6220* (Pseudo-steppe with grasses and annuals of the *Thero-Brachypodietea*) is represented by vegetation of *Hyparrenietum hirto-pubescentis* and ephemeral the-

rophytic meadows of *Tuberarietea guttatae*. The garrigues of the *Cisto-Micromerietea* class, despite their extent and their important functional role for the local fauna, cannot be included in any habitat listed in the Annex I of the Directive, according to the EU and the Italian interpretation manuals.

Discussion and Conclusions

The analyses (vegetation survey and mapping) carried out in the present study have highlighted the high level of plant diversity within the SCI IT9140002, in terms of both plant communities and habitats. Despite its limited extent, this is an area of considerable naturalistic interest due the presence of typical coastal environments that have been undergoing, especially in the last decades, a progressive fragmentation and a general alteration of structure and processes. In fact, even though a SCI and a protected area have been established, numerous pressures and threats such as coastal erosion, touristic pressure, invasive agricultural and pastoral activities have been affecting the area for a long time. In Tab. 12, a list of threats and pressures affecting the study site is reported, according to the Article 17 code list. Over time, such pressures have caused progressive reduction and fragmentation of the natural habitats, producing deep changes in the vegetation pattern. For example, a complete sequence of sand dune communities, the so called standard zonation, could be observed in undisturbed areas (Acosta *et al*., 2007; Doing, 1985). However, along the whole extension of the coastline of the site the ideal sequence is rarely complete and, in case of strong disturbances, especially of severe coastal erosion, regression effects have also been observed with different zones become mixed or inverted.

The status of the sandy coast is severely altered due both to the tourism activities (equipped beaches, residential complexes) and to the accentuation of marine erosion, which, in many places, has severely reduced the extent of the emerged beach and eroded the dune belt. Coastal erosion and the associated loss of land are among the main threats of sand coasts and are expected to increase due to both local (imbalance in sediment deposition; urbanization) and global (climate change, rising of the sea level) drivers (Leatherman *et al*., 2000; Hall, 2006). It is widely recognized that tourism is the main driver of urbanization in areas with specific vocation for leisure activities, such as coastal sites. The leveling of the dune belt, which is made to obtain flat areas for the purpose of tourism and beach activities, along with cleaning or grooming, causes drastic and irreversible alterations of dune environments. In large parts of the Adriatic and Tyrrhenian coasts, this practice has caused the almost complete loss of the dune series (Biondi, 1999; Defeo *et al*., 2009). In the study site, where this pressure emphasizes the effects of coastal erosion, there are large sections of the sandy coast where the dune zonation has disappeared up to the shrub vegetation. Besides the loss of some significant species or entire plant communities, the alteration of the dune systems results also in the appearance of species indicating degradation or alteration. *Cyperus kalli* is a psammophilous species which is spreading at the level of the mobile dunes subject to alteration and eutrophication (Biondi, 1999). In retrodunal in areas subjected to continuous trampling (e.g., rest areas, parking areas, footpaths, etc.) some resistant species such as *Cynodon dactylon* are spreading forming thick communities replacing the original natural vegetation (e.g. the *Cutandetalia maritimae* or *Frankenietalia pulverulentae* communities).

As for the wetland environments, the peripheral belts and the surrounding areas are particularly subject to various types of changes, also in this case producing extensive modifications in the expected vegetation pattern. It is well known that eutrophication and land reclamation are among the major threats (Lindeboom, 2003). In the study site, at present, the water bodies result partially reclaimed, cultivated, subject to partial undergrounding and eventually damaged by the construction of the expressway SS16-379. Degradation and quantitative reduction of the water sources is an additional concern about the availability of groundwater resources, now depleted by uncontrolled uptaking.

As for the rocky coasts, the main threats is represented by the presence of touristic building and infrastruc-

Tab. 12 - Main threats and pressures affecting the study area. Each threat or pressure is associated to a code according to the Reporting under the Article 17 of the Habitats Directive (http://bd.eionet.europa.eu/activities/Reporting/Article_17/reference_portal).

Coastal erosion	(K01.01) Erosion [Intense erosion of the sandy coastline with a generalized retreat of the shoreline and loss of dune systems. Main causes are: A) Natural (rise of the sea level); B) Anthropic (depletion of the sediment supply; the so-called 'hardening' of the coast caused by settlements and urbanization)]			
Exploitation of the beach (tourism)	(G05.01) Trampling	(G01.08) leisure activities (excavation and breaching in the dunes)	(D01.03) car parcs and parking areas (parking areas behind the dunes)	(G02.10) leisure complexes
Agricultural activities	(J02.05) modification of hydrographic functioning	(J02.07.01) groundwater abstractions for agriculture	(K01.05) soil salinization	(H02.06) diffuse groundwater pollution due to agricultural and forestry activities
Other critical issues	(A02.03) grassland removal for arable land	(A04.02.05) non intensive mixed animal grazing	(J01.01) burning down	(H05.01) garbage and solid waste

tures that may severely affect such environments.

The general complexity of the landscape, resulting from both the high plant diversity and the severe landscape fragmentation, is well highlighted in vegetation and habitat maps by the presence of several vegetation mosaics. Usually, the two main factors leading to the presence of vegetation mosaics are a) temporal dynamics of disturbance and succession and b) environmental variability (Van der Maarel & Franklin, 2012). In the case of the studied area, the anthropogenic disturbance is the main factor underlying presence and distribution of mosaics and plays a major role in the landscape complexity and patchiness of this area. Habitats fragmentation has been affecting, in last decades, not only Torre Canne, but also the large part of the coastal areas of the Adriatic side of the Apulia region (Tomaselli *et al*., 2012; Tomaselli *et al*., 2016). Urgent measures of conservation should be adopted as soon as possible, aimed at the control of tourism activities, the launch of environmentally friendly agricultural policies, and the regeneration of the dunes. The issue of coastal erosion, including both local/regional and global drivers and human factors on a larger scale, remains of complex solution.

Syntaxonomic scheme

RUPPIETEA MARITIMAE Tuxen ex Den Hartog & Segal 1964
RUPPIETALIA MARITIMAE Tuxen ex Den Hartog & Segal 1964
Ruppion maritimae Br.-Bl. ex Br.-Bl., Roussine & Négre 1952
Enteromorpho intestinalidis-Ruppietum maritimae Westhoff ex R.Tx. & Böckelmann 1957

PHRAGMITO AUSTRALIS-MAGNOCARICETEA ELATAE Klika in Klika & Novák 1941
PHRAGMITETALIA AUSTRALIS Koch 1926
Phragmition communis Koch 1926
Phragmitetum communis (Koch 1926) Schmale 1939

EUPHORBIO PARALIAE-AMMOPHILETEA AUSTRALIS Géhu & Rivas-Martínez in Rivas-Martínez, Asensi, Díaz-Garretas, Molero, Valle, Cano, Costa & Díaz 2011
AMMOPHILETALIA AUSTRALIS Br.-Bl. 1933
Ammophilion australis Br.-Bl. 1933 em. Géhu & Géhu-Franck 1988
Ammophilenion australis (Br.-Bl. 1921) Rivas-Martínez & Géhu in Rivas-Martínez, Lousã, Díaz, Fernández-González & Costa 1990
Echinophoro spinosae-Ammophiletum australis (Br.-Bl. 1933) Géhu, Rivas-Martinez & R. Tx. 1972 in Géhu *et al*. 1984
Agropyrion juncei (Tüxen in Br.-Bl. & Tüxen 1952) Géhu, Rivas-Martínez & Tüxen 1972 in Géhu, Costa, Scoppola, Biondi, Marchiori, Peris, Franck, Caniglia & Veri 1984
Agropyrenion farcti Rivas-Martínez,Costa, Castroviejo & Valdés 1980
Echinophoro spinosae-Elymetum farcti Géhu 1987

CAKILETEA MARITIMAE Tüxen & Preising ex Br.-Bl. & Tüxen 1952
EUPHORBIETALIA PEPLIS Tüxen 1950
Euphorbion peplis Tüxen 1950
Salsolo-Cakiletum maritimae Costa & Mansanet 1981 corr. Rivas-Martínez *et al*. 1992

CRITHMO MARITIMI-STATICETEA Br.-Bl. in Br- Bl., Roussine & Nègre 1952 em. Biondi 2007
CRITHMO MARITIMI-STATICETALIA Molinier 1934
Crithmo maritimi-staticion Molinier 1934
Crithmo-Limonietum apuli Bartolo, Brullo & Signorello 1989

JUNCETEA MARITIMI Br.-Bl. in Br.-Bl., Roussine & Nègre 1952
JUNCETALIA MARITIMI Br.Bl. ex Horvatic 1934
Juncion maritimi Br.Bl. ex Horvatic 1934
Inulo-Juncetum maritimi Brullo in Brullo, De Sanctis, Furnari, Longhitano & Ronsisvalle 1988
Spartino-Juncetum maritimi O. Bolòs 1962
Plantaginion crassifoliae Br.-Bl. in Br.-Bl., Roussine & Nègre 1952
Schoeno nigricantis-Plantaginetum crassifoliae Br.-Bl. in Br.-Bl., Roussine & Nègre 1952

SARCOCORNIETEA FRUTICOSAE Br.-Bl. & Tüxen ex A. Bolòs & O. Bolòs in A. Bolòs 1950 em. Biondi, Casavecchia,

Estrelles & Soriano, 2013
SARCOCORNIETALIA FRUTICOSAE Br.-Bl. 1933 nom. mut. propos Rivas-Martínez, T.E. Díaz, Fernandez-Gonzales, Izco, Loidi, Lousã & Penas 2002
Sarcocornion alpini (Rivas-Martínez, Lousa, T.E. Diaz, Fernández-González & J.C. Costa 1990) Brullo, Giusso del Galdo, Minissale, Siracusa & Spampinato 2002
Puccinellio festuciformis-Sarcocornietum alpini Castroviejo & Cirujano 1980
Arthrocnemion macrostachyi Rivas-Martínez 1980 nom. mut. propos. Rivas-Martínez, T.E. Díaz, Fernandez-Gonzales, Izco, Loidi, Lousã & Penas 2002
Arthrocnemum macrostachyium communities
Limonio virgati-Arthrocnemetum macrostachyi Biondi, Casavecchia & Guerra 2006
Arthrocnemo-Juncetum subulati Brullo & Furnari 1976
Inulion crithmoidis Brullo & Furnari 1988
Agropyro elongati-Inuletum crithmoidis Br.-Bl. (1931)1952

THERO-SUADETEA SPLENDENTIS Rivas-Martinez 1972
THERO-SALICORNIETALIA Tüxen in Tüxen & Oberdorfer ex Géhu & Géhu-Franck 1984
Salicornion patulae Géhu et Géhu-Franck ex Rivas-Martínez 1990
Salicornietum emerici (O. de Bolòs 1962) Brullo & Furnari 1976

SAGINETEA MARITIMAE Westhoff, Van Leeuwen & Adriani 1962
FRANKENIETALIA PULVERULENTAE Rivas-Martínez ex Castroviejo & Porta 1976
Frankenion pulverulentae Rivas-Martínez ex Castroviejo & Porta 1976
Parapholido incurvae-Catapodietum balearici Rivas-Martínez, Lousã, Díaz, Fernandez-Gonzales & Costa 1990 corr. Brullo & Giusso 2003
Spergulario salinae-Hordeetum marini Biondi, Filigheddu & Farris 2001

TUBERARIETEA GUTTATAE (Br.-Bl. in Br.-Bl., Roussine & Nègre 1952) Rivas Goday & Rivas Martínez 1963 *nom. mut. propos*. Rivas Martínez, Diaz, Fernández-González, Izco, Loidi, Lousa & Penas 2002
CUTANDIETALIA MARITIMAE Rivas-Martínez, Díez Garretas & Asensi 2002
Alkanno-Maresion nanae Rivas Goday ex Rivas Goday & Rivas-Martínez 1963 corr. Díez-Garretas, Asensi & Rivas-Martínez 2001
Vulpio-Romuletum rollii Brullo & Scelsi 1998
Alkanno-Plantaginetum albicantis Tomaselli, Di Pietro & Sciandrello 2011

QUERCETEA ILICIS Br.-Bl. in Br.-Bl., Roussine & Nègre 1952
PISTACIO LENTISCI-RHAMNETALIA ALATERNI Rivas-Martínez 1975
Oleo sylvestris-Ceratonion siliquae Br.-Bl. ex Giunochet & Drouineau 1944
Myrto-Pistacetum lentisci (Molinier 1954 em. O.Bolòs 1962) Rivas-Martinez 1975
Juniperion turbinatae Rivas-Martínez 1975 corr. 1987
Asparago acutifolii-Juniperetum macrocarpae (Molinier et R. Molinier 1955) O. Bolòs 1962
Juniperetum macrocarpae-turbinatae Pedrotti & Cortini-Pedrotti ex Pedrotti *et al*. 1976 corr. 1982

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Appendix I: Sporadic species

Tab. 2 - Rel. 1: Cachrys sicula L. (+), Lagurus ovatus L. s.l. (+); rel. 3: Spartina versicolor Fabre (+); rel. 5: Cutandia maritima (L.) Barbey (+); rel. 6: Silene colorata Poir. (1).
Tab. 3 - Rel. 1: Sonchus oleraceus L. (+), Phragmites australis (Cav.) Trin. ex Steud. subsp. australis (+); rel. 2: Calystegia soldanella (L.) Roem. & Schult. (1); rel. 3: Cakile maritima Scop. subsp. maritima (+), Matthiola sinuata (L.) R. Br. (+); rel. 4: Anchusa hybrida Ten. (1); rel. 6: Valantia muralis L. (2), Hymenocarpos circinnatus (L.) Savi (2), Trachynia distachya (L.) Link (+), Romulea bulbocodium (L.) Sebast. & Mauri (+); rel. 7: Vulpia sp. (3), Euphorbia terracina L. (1), Daucus carota L. s.l. (+), Blackstonia perfoliata (L.) Huds. s.l. (+), Plantago crassifolia Forssk. (+); rel. 8: Elymus farctus (Viv.) Runemark ex Melderis subsp. farctus (+).
Tab. 5 - Rel. 11: Piptatherum miliaceum (L.) Coss. s.l. (+), Pistacia lentiscus L. (+); rel. 17: Suaeda vera J.F. Gmel. (+), Frankenia hirsuta L. (+).
Tab. 6 - Rel. 1: Melilotus siculus (Turra) Steud. (+), Phragmites australis (Cav.) Trin. ex Steud. subsp. australis (+); rel. 2: Medicago rigidula (L.) All. (+); rel. 3: Daucus carota L. s.l. (1); rel. 6: Raphanus raphanistrum L. (+), Trifolium scabrum L. subsp. scabrum (1).
Tab. 7 - Rel. 5: Blackstonia perfoliata (L.) Huds. s.l. (+); rel. 7: Pistacia lentiscus L. (+); rel. 10: Elymus repens (L.) Gould. subsp. repens (+), Plantago coronopus L. subsp. coronopus (+).
Tab. 8 - Rel. 4: Lotus creticus L. (+), Parapholis incurva (L.) C. E. Hubb. (+), Suaeda maritima (L.) Dumort. (+).
Tab. 9 - Rel. 1: Phragmites australis (Cav.) Trin. ex Steud. subsp. australis (+); rel. 7: Lotus cytisoides L. s.l. (+), Prunus spinosa L. subsp. spinosa (+), Silene vulgaris (Moench) Garcke s.l. (+); rel. 12: Carex flacca Schreb. subsp. serrulata (Biv.) Greuter (+).

Appendix II: Locality and date of relevés

Tab. 1 - *Salsolo-Cakiletum maritimae*, rel. 1: 33T 712468 4521031, Fiume Morelli beach, Ostuni (BR), 18-07-2007; rel. 2: 33T 711834 4521328, near "Lido Kypos", Torre Canne, Fasano (BR), 18-07-2007.
Tab. 2 - *Echinophoro spinosae-Elymetum farcti*, rels. 1-3: 33T 715141 4519919, 33T 715110 4519926, 33T 714913 4520024, Rosa Marina beach, Ostuni (BR), 01-07-2008; *Echinophoro spinosae-Ammophiletum australis*, rels. 4-5: 33T 712298 4521080, 33T 712210 4521083, Fiume Morelli beach, Ostuni (BR), 18-07-2007; rel. 6: 33T 712955 4520812, C.da Fiume Morelli, Ostuni (BR), 02-10-2007.
Tab. 3 - Vulpio-Romuletum rollii, rels. 1-3: 33T 0712649 4520917, 33T 0712649 4520931, 33T 0712166 4521144, Fiume Morelli beach, Ostuni (BR), 09-05-2008; rels. 4-5: 33T 0713100 4520700, 33T 0713084 4520714, C.da Fiume Morelli, Ostuni (BR), 09-05-2008; rel. 6: 33T 0713725 4520477, Pilone beach, Ostuni (BR), 09-05-2008; rel. 7: 33T 0712086 4521169, between "Lido Bizzarro" and "Lido Tavernese" beaches, Fasano (BR), 09-05-2008; *Alkanno-Plantaginetum albicantis*, rels. 8-11: 33T 0710072 4522214, 33T 0710187 4522135, 33T 0710244 4522134, 33T 710200 4522137, between "Lido Bizzarro" and "Lido Tavernese" beaches, Torre Canne, Fasano (BR), 29-04-2013; rel. 12: 33T 0712697 4520910, C.da Fiume Morelli, Ostuni (BR), 02-05-2013.
Tab. 4 - *Salicornietum emerici*, rels.1-2: 33T 709112 4522679, 33T 709121 4522668, wetland between "Lido Verde" and camping "Le Dune", Torre Canne, Fasano (BR), 29-04-2013.
Tab. 5 - *Puccinellio festuciformis-Sarcocornietum alpini*, rels. 1-3: 33T 712651 4520855, 33T 712188 4520972, 33T 712579 4520968, C.da Fiume Morelli, Ostuni (BR), 18-07-2007; *Arthrocnemo-Juncetum subulati*, rel. 4: 33T 711106 4521523, wetland close to "Lido Kypos", Torre Canne, Fasano (BR), 02-10-2007; rel. 5: 33T 712488 4520906, wetland behind Fiume Morelli beach, Ostuni (BR), 02-10-2007; *Agropyro elongati-Inuletum crithmoidis*, rels. 6-8: 33T 712619 4520865, 33T 712651 4520829, 33T 712685 4520835, C.da Fiume Morelli, Ostuni (BR), 18-07-2007; rels. 9-12: 33T 711123 4521489, 33T 711141 4521503, 33T 711100 4521500, 33T 711086 4521472, wetland near "Lido Tavernese", Torre Canne, Fasano (BR), 02-10-2007; *Arthrocnemum macrostachyum communities*, rels. 13-14: between Torre Canne and Lido Morelli (Biondi *et al*., 2006, tab. 8); *Limonio virgati-Arthrocnemetum macrostachyi*, rels. 15-16: 33T 705687 4525700, 33T 705760 4525689, rocky coast at the northern boundary of the SCI, Forcatella, Fasano (BR), 31-08-2001; rel. 17: 33T 714000 4520452; Torre S. Leonardo, Rosa Marina, Ostuni (BR); rel. 18: 33T 715175 4519908; Rosa Marina, Ostuni (BR), 29-04-2013.
Tab. 6 - *Spergulario salinae-Hordeetum marini*, rels. 1-2: 33T 0712086 4521169, 33T 0712096 4521155, near "Lido Macchia Mediterranea" beach, Torre Canne, Fasano (BR), 09-05-2008; *Parapholido incurvae-Catapodietum balearici*, rel. 3: 33T 712170 4521137, near "Lido Macchia Mediterranea" beach, Torre Canne, Fasano (BR), 09-05-2008; rel. 4: 33T 713103 4520698, C.da Fiume Morelli, Ostuni (BR), 09-05-2008; rels. 5-6: 33T 0713115 4520581, 33T 0713141 4520612, C.da Fiume Morelli, near "Onda Blu" bathing area, Ostuni (BR), 02-05-2013.
Tab. 7 - *Inulo-Juncetum maritimi*, rels. 1-2: 33T 712253 4521075, 33T 712348 4521025, wetland be-

hind Fiume Morelli beach, Ostuni (BR), 18-07-2007; rel. 3: 33T 711035 4521585, near “Lido Tavernese”, Torre Canne, Fasano (BR), 18-07-2007; *Schoeno nigricantis-Plantaginetum crassifoliae*, rels. 4-5: 33T 712599 4520869, 33T 712600 4520870, C.da Fiume Morelli, Ostuni (BR), 18-07-2007; rels. 6-7: 33T 712317 4521053, 33T 712291 4521060, wetland behind Fiume Morelli beach, Ostuni (BR), 18-07-2007; rels. 8-10: 33T 712336 4521044, 33T 712468 4520981, 33T 712391 4521022, wetland behind Fiume Morelli beach, Ostuni (BR), 01-07-2008; *Spartino-Juncetum maritimi*, rel. 11: 33T 711177 4521559, near “Lido Kypos”, Torre Canne, Fasano (BR), 02-10-2007; rels. 12-13: 33T 712719 4520885, 33T 712760 4520862, C.da Fiume Morelli, Ostuni (BR), 02-10-2007.

Tab. 8 - *Crithmo-Limonietum apuli*, rel.1: 33T 714046 4520487, Torre S. Leonardo, Rosa Marina, Ostuni (BR), 02-10-2007; rel. 2: 33T 714308 4520325, near the camping "Il Pilone", Rosa Marina, Ostuni (BR), 02-10-2007; rel. 3: 33T 714396 4520250, near the camping "Il Pilone", Rosa Marina, Ostuni (BR), 29-04-2013; rel. 4: 33T 715040 4519941, Rosa Marina cove, Ostuni (BR), 29-04-2013.

Tab. 9 - *Asparago acutifolii-Juniperetum macrocarpae,* rels. 1-2: 33T 712349 4521032, 33T 712358 4521056, Fiume Morelli beach, Ostuni (BR), 18-07-2007; rels. 3-5: 33T 713048 4520749, 33T 713273 4520664, 33T 713419 4520618, C.da Fiume Morelli, Ostuni (BR), 02-10-2007; rels. 6-7: 33T 713720 4520499, 33T 713703 4520482, Pilone beach, Ostuni (BR), 02-10-2007; *Juniperetum macrocarpae-turbinatae*, rels. 8-12: 33T 714576 4520093, 33T 714646 4520072, 33T 714624 4520045, 33T 714571 4520095, 33T 714624 4520059, along the Rosa Marina beach, Ostuni (BR), 02-10-2007.