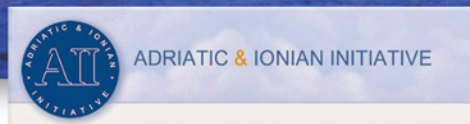


PLANT SOCIOLOGY

formerly **FITOSOCIOLOGIA**

Volume 51 (2) - Suppl. 1 - December 2014

RIVISTA SEMESTRALE - POSTE ITALIANE S.P.A. - SPED. ABB. POST. - D.L. 353/2003 - (CONV. IN L. 27/02/2004 N. 46) ART. 1, COMMA 2, DCB ANCONA TASSA RISCOSSA-TAXE PERÇUE-CMPP AN
EDITO DALLA SOCIETÀ ITALIANA DI SCIENZA DELLA VEGETAZIONE ONLUS - PAVIA - DIRETTORE RESPONSABILE PROF. E. BIONDI - SUPPLEMENTO 1 - VOLUME 2 - II° SEMESTRE 2014



Journal of the Italian Society for Vegetation Science

The endangered or extinct vegetal communities along the Abruzzo coast

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Abstract

After a brief introduction on the causes of the degradation and the conservation status of Abruzzo coast, we highlight the dynamics of the coastal vegetation systems in Abruzzo over the past 35 years. This is provided through a comparison between the previous situation, as documented by the data in the literature, and the current situation. The study highlights a worrying loss of phytocoenotic biodiversity that affects large sections of the coast, with the extinction of very rare halophilic plant associations not only for Abruzzo, but also throughout the central-southern Adriatic coast. On a positive note, we highlight the presence of newly established plant communities for some of the coastal segments.

Key words: coast of Abruzzo, extinction, monitoring, phytocoenotic biodiversity

Introduction

The coastal systems, and particularly the sandy ones, are characterised by high plasticity, and as a consequence, they are also very sensitive to natural and anthropogenic perturbations. In the middle of the last century, Braun-Blanquet (1951) warned of the danger of the imminent disappearance of the flora and the psamphylic communities along the coasts of the Mediterranean because of the profound alterations that had been occurring, which were mainly of anthropogenic origin. In Italy, the risks to the coastal environments have been widely reported over the years by several authors, such as, for example Cederna (1975), Arrigoni (1981), Garbari (1984), Géhu & Biondi (1994), and Audisio *et al.* (2002). The same arguments can be found in the recent reports from the Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA; 'Natura 2000 conservation status and trends') and World Wildlife Fund for Nature (WWF) Italy ('Cement from coast to coast: 25 years of nature lost from the finest Italian coasts'). The latter report noted that the Adriatic coast is the most urbanised of the entire Mediterranean basin.

The degradation of the coastal systems arises from indirect human actions (greenhouse effect with rising sea levels and increased coastal erosion, removal of material from the beds of rivers, construction of dams, ports, breakwaters, and other coastal infrastructure) and direct human actions (urbanisation, tourism, pollution, flattening of dunes, introduction of exotic species, man-made pine forests, among others) (Géhu & Biondi, 1994). In terms of artificial pine forests, it

should be stressed that they can compromise the existence of the native dune vegetation (albeit not in such a drastic way as happens for construction, tourism and reclamation activities) only when they are created on dunes and in other areas that are potentially recoverable; they can, on the other hand, contribute to the creation of semi-natural or anthropic environments that are of particular socio-cultural, ecological and historical interest.

The erosion of the dunes destroys the normal topographic sequence of the plant communities, with the loss of phytocoenotic diversity and the triggering of the submersion of the retrodunal formations by the sand. The eutrophication of the sand and the degradation of the habitats favour the development of nitrophilous-ruderal species (*Cynodon dactylon*¹, *Bromus spp.*, *Lobularia maritima* subsp. *maritima*, *Erigeron spp.*, *Avena barbata*, *Raphanus raphanistrum*, ecc.) and exotic species (*Xanthium orientale* subsp. *italicum*, *Ambrosia coronopifolia*, *Cenchrus incertus*, *Carpobrotus spp.*, *Oenothera spp.*, and others), which often become invasive. Due to the profound human effects, in the Mediterranean basin it is difficult today to find dune systems that are still fully intact, and indeed, they have often been totally destroyed. When the intensity of the disruption is not high (e.g., trampling by visiting tourists, proximity to roads and cultivated fields), the effects on the phytocoenoses mainly relate to their specific composition, with the ingression of ruderal and exotic species, or of those with a wide distribution. If the intensity of the disruption increases (e.g., flattening of the dunes, fires, felling), there is the emergence of

¹The nomenclature of the plant species generally agrees (with some exceptions) to that reported in Conti *et al.* (2005).

replacement phytocoenoses that take the place of those potential. Finally, for intense and protracted impact, there is first the fragmentation and the gradual deterioration in the phytocoenotic toposequence, then the loss of some plant communities, and in the end, the total extinction of the dune vegetation (Ercole *et al.*, 2007).

The state of the Abruzzo coast

Also in Abruzzo, the coastal environments are among the most degraded. Along the shoreline, the geomorphology is generally altered, and unfortunately, segments with the complete phytotopographic sequence of the typical plant communities cannot be found any more. These are often fragmented, impoverished and ruderalised, with an increasingly invasive presence of exotic species. Several contributions have been published on this topic (e.g., Tammaro & Pirone, 1979, 1981; Pirone, 1982, 1983, 1985, 1987, 1988, 1997; Acosta *et al.*, 2007), in which the risks and the interference have been highlighted, with particular attention to the flora and the vegetation. These problems are related to the sandy coast, as the inherent geomorphological features of the high coast (e.g., the cliffs of Ortona, Rocca San Giovanni and Vasto) make them much less vulnerable to such anthropogenic disturbance.

In Abruzzo the role of substitution is taken mainly by the therophytic communities (in particular, the associations *Sileno coloratae-Vulpietum membranaceae*, *Sileno coloratae-Ononidetum variegatae*, *Ambrosio coronopifoliae-Lophochloetum pubescentis*, and *Xanthio italici-Cenchretum incerti*, and the *Cutandia maritima* community), with the replacement of perennial plant communities such as *Echinophoro spinosae-Elymetum farcti* and *Echinophoro spinosae-Ammophiletum arundinaceae*. These communities have become always more established, often as the only traces of the psammophytic vegetation. The process of fragmentation has become more and more damaging: from an original situation characterised by a wide variety of natural environments with some small 'islands' of degraded environment, this has moved to a framework in which this degradation has become dominant, within which there are increasingly small 'islands' of the natural environment.

According to monitoring carried out at the end of the 1990's (Pirone, 1997), there were 25 coastal plant communities that were degraded or endangered out of a total of about 50. Also, in these same years, there were some reports of extinct or endangered plant species along the coast (Conti & Pirone, 1996; Pirone & Conti, 1996). These studies indicated that about 30 species were considered to be extinct, and more than 60 species were strongly endangered or threatened with extinction.

There are only a few stretches of coast in Abruzzo that

still retain dunal systems with their typical vegetation. The segment of the Province of Chieti is the one that has best preserved its natural value, which has been confirmed by the presence of four Sites of Community Interest and six Regional Natural Reserves. For this part of the coast, the quality of the environment has been analysed through floristic-vegetation parameters (Frattaroli *et al.*, 2007).

Materials and methods

This report highlights the dynamics of the coastal vegetation systems in Abruzzo, which are generally regressive, through a comparison between the situation of the past few decades, as documented by reliable data in the literature, and the present situation.

Excluding the few generic and fragmentary details of the vegetation in past reports (Razzi, 1574; Tenore, 1831; Cesati, 1872; Rigo, 1877; Villani, 1921, Anzalone, 1955; and others), the beginnings of systematic studies of the coastal vegetation that were implemented according to phytosociological methods date from the second half of the last century. These studies were dedicated to particular segments (Tammaro & Pirone, 1979, 1981; Pirone, 1983, 1985, 1988; Géhu *et al.*, 1984; Stanisci & Conti, 1990), with subsequent overviews that covered the whole coast (Pirone, 1995, 1997; Pirone *et al.*, 2001). The investigations into the forest vegetation have included the "Pineta D'Annunziana" (Pescara) and the "Lecceta di Torino di Sangro" natural reserves. In the pine woods of Pescara, the only natural forest now surviving, are small nuclei with a dominance of the common elm. The remains of the pine forest of *Pinus halepensis* are mostly man-made or have been altered over time, except for some opposite cases due, most likely, to the surviving nuclei of the ancient pine forest that covered the dune ridges (Tammaro & Pirone, 1981; Pirone *et al.* 2003; Cianfaglione *et al.*, 2014). The holm oak forest of Torino di Sangro does not cover the dune areas, but has developed on the conglomerate-arenaceous cliff, a location that has probably allowed this phytocoenosis to survive to date (Tammaro & Poldini, 1988; Ciaschetti *et al.*, 2004), albeit with reduced surface area, and with periodic cutting and sections also rearranged over time.

Results

The comparison between the bibliographic data and the current situation is given in Table 1. These data show that in the past 35 years, the following plant communities have become extinct along the Abruzzo coast:

Suaedo maritimae-Salicornietum patulae, a pioneer association of alophylic annual species, dominated by *Salicornia patula*, which develops on sandy-loam soils

that are temporarily flooded, generally in clearings or in the small depressions of perennial salt prairies with *Salicornia*.

Sarcocornietum deflexae, an association with a dominance of *Sarcocornia fruticosa* var. *deflexa*, linked to areas that are periodically flooded, dry in summer, and with high salinity.

Suaedetum maritimae, an association of annual species with a dominance of *Suaeda maritima*, which develops on moist and salty soils with an accumulation of organic detritus, often modified for anthropogenic causes.

Salsoletum sodae, a thermo-halonitrophilous association built up by *Salsola soda*, which is established in the depressions with accumulation of organic material beached during storms.

Limonio serotini-Artemisietum caerulescentis, a xero-halophytic association that in its classic physiognomy has a dominance of *Limonium narbonense* (= *Limonium serotinum*) and *Artemisia caerulescens* subsp. *caerulescens*.

The most endangered communities, because they have become very rare or degraded, are:

Echinophoro spinosae-Ammophiletum arundinaceae, an association that is typical of the high but still mobile dunes, based on *Ammophila arenaria* subsp. *australis*, spread in the north-western Mediterranean.

Sporobolietum arenarii, a markedly pioneering vegetation of the sands, in tufts or embryonic dunes.

Allietum chamaemoly and *Romulea rollii* community, as dry retrodunal meadows of therophytes and geophytes, and with a dominance of *Allium chamaemoly* and *Romulea rollii*.

Spartina versicolor community, a compact halopsammophytic community, which typically occupies the strip between the dune phytocoenoses and those halo-hygrophilic and interdunal, in more or less depressed areas.

Schoeno nigricantis-Erianthetum ravennae, an association with a weakly halophilic character of the wet depressions of the dune systems, with temporary contributions of brackish and fresh water, and with a top layer of soil that is rich in organic matter.

Caricetum otrubae and *Carex otrubae* community, as grasslands of large sedges with a dominance of *Carex otrubae*.

Schoenoplectus tabernaemontani community, a marshy vegetation, in water that is generally still or slow moving.

Scirpetum compacto-littoralis, low marshy reed thicket, in the retrodunal lagoons and depressions, with a dominance of *Bolboschoenus maritimus*.

Juncetum acuti, an association linked preferentially to the base of the dunes, between the psammophytic communities and the halophilic depression communities.

Suaedo verae-Atriplicetum halimi, a nanophanerophytic-chamaephytic and halophyte cliff community on nitrified soils, built up by *Suaeda vera* and *Atriplex halimus*.

Crithmo maritimi-Limonietum virgati, an aerosaline association of the conglomerate cliff that is endemic of the southern Abruzzo, with *Crithmum maritimum* and *Limonium virgatum*. On accumulations of gravel, a particular aspect can be seen that is characterised by the presence of *Inula crithmoides*.

Crithmo maritimi-Adiantetum capillus-veneris, an association of the loose sandstone cliffs, with dripping water.

Myrto-Pistacietum lentisci, a Mediterranean shrub community, with a dominance of *Myrtus communis* and *Pistacia lentiscus*.

Schoeno nigricantis-Plantaginetum crassifoliae, an association of the brackish retrodunal depressions that is physiognomically characterised by *Schoenus nigricans*, *Plantago crassifolia* and *Juncus littoralis*.

Plantagini crassifoliae-Caricetum extensae, a thermophilic subsaline grassland that has developed in the retrodunal areas that have fresh soil for long periods of the year. In Abruzzo this has a dominance of *Carex extensa* and *Juncus littoralis*.

Carex extensa community, thermophilic subsaline grassland, which represents an impoverished phase of *Plantagini-Caricetum*.

Cyperus kalli community, a pioneer phytocoenosis of embryonic dunes that sometimes represents an aspect of *Agropyron prairie*.

Imperato cylindricae-Schoenetum nigricantis and *Imperata cylindrica* community, a retrodunal community, on humid sandy substrate at times with silt, physiognomically dominated by *Imperata cylindrica*, a thermo-cosmopolitan species that is very rare in Abruzzo.

Juncus maritimi-Cladietum marisci, an association with a dominance of *Cladium mariscus*, which develops in flooded retrodunal areas.

Caricetum divisae, a vegetation of few species reported for small depressions, on weakly saline soils that are flooded in winter.

Aro italici-Ulmetum minoris, a hygrophilous wood with a dominance of common elm (*Ulmus minor* subsp. *minor*), sometimes with white poplar (*Populus alba*) and southern ash (*Fraxinus angustifolia* subsp. *oxycarpa*).

Laurus nobilis-Alnetum glutinosae, alder wood with a Mediterranean character, and a vicariant of the association *Aro italici-Alnetum glutinosae* of the Temperate climates.

Ulmus minor and *Laurus nobilis* community, mesohygrophilic wood of common elm (*Ulmus minor* subsp. *minor*) and laurel (*Laurus nobilis*), which is found along the watersheds on soil that is constantly moist.

Tab. 1 - Comparison of bibliographic data and the current situation.

Martinsicuro (center)	Past (*)	Current
<i>Salsolo kali-Cakiletum maritimae</i>	x	x
<i>Echinophoro spinosae-Elymetum farcti</i>	x	x
<i>Sileno coloratae-Ononidetum variegatae</i>	x	x
<i>Sileno coloratae-Vulpium membranaceae</i>		x
<i>xanthio italici-Cenchretum incerti</i>		x
Cutandia maritima community		x
<i>Parapholiso incurvae-Spergularietum marginatae</i>	x	
<i>Catapodio marini-Parapholisetum incurvae</i>	x	x
Cyperus fuscus community	x	
Polygonum maritimum community		x
<i>Paspalo-Polypogonum viridis</i>	x	
Carex extensa community		x
<i>Scirpetum compacto-littoralis</i>	x	
Elytrigia atherica community		x
Ulmus minor community		x

(*) Pirone, 1997

Martinsicuro (Villa Rosa)	Past (*)	Current
<i>Salsolo kali-Cakiletum maritimae</i>	x	
<i>Echinophoro spinosae-Elymetum farcti</i>	x	
<i>Sileno coloratae-Vulpium membranaceae</i>	x	
<i>Sileno coloratae-Ononidetum variegatae</i>	x	
<i>Ambrosio coronopifoliae-Lophochloetum pubescentis</i>	x	
Elytrigia atherica community		x
Parapholiso incurva community		x
Carex extensa community	x	
<i>Scirpetum compacto-littoralis</i>	x	
Elytrigia atherica community	x	
<i>Phragmitetum australis</i>	x	
<i>Cyperetum longi</i>	x	

(*) Pirone, 1997

Giulianova, Tortoreto, Alba Adriatica	Past (*)	Current
<i>Sileno coloratae-Ononidetum variegatae</i>	(x)	x
<i>Sileno coloratae-Vulpium membranaceae</i>	(x)	x
Cutandia maritima community	(x)	x
<i>Salsolo kali-Cakiletum maritimae</i>	(x)	x

Tordino, Salinello and Vibrata rivers mouths

	Past (*)	Current
Elytrigia atherica community	x	x
<i>Phragmitetum australis</i>	x	x

(*) Pirone, 1997, 2005

Roseto (Villa Mazzarosa)	Past (*)	Current
<i>Salsolo kali-Cakiletum maritimae</i>	x	
<i>Sileno coloratae-Ononidetum variegatae</i>	x	
<i>Sileno coloratae-Vulpium membranaceae</i>	x	x
<i>xanthio italici-Cenchretum incerti</i>		x
<i>Echinophoro spinosae-Elymetum farcti</i>		x
Elytrigia atherica community	x	
Atriplex prostrata community	x	
Scirpoides holoschoenus community		x
Spartina versicolor community		x
<i>Phragmitetum australis</i>		x
Ulmus minor community		x

(*) Pirone, 1997, 2005

Promenade of Roseto	Past (*)	Current
<i>Sileno coloratae-Vulpium membranaceae</i>		x
<i>Sileno coloratae-Ononidetum variegatae</i>	x	x
Cutandia maritima community	x	x
Ambrosia coronopifolia community		x
<i>Parapholiso incurvae-Spergularietum marginatae</i>	x	
Elytrigia atherica community		x

(*) Pirone, 2005

Vomano river mouth	Past (*)	Current
Atriplex prostrata community	x	
<i>Suaedetum maritimae</i>	x	
<i>Suaedo maritimae-Salicornietum patulae</i>	x	
<i>Parapholiso incurvae-Spergularietum marginatae</i>	x	
<i>Scirpetum compacto-littoralis</i>	x	
Phragmites australis halophilous community	x	x
Elytrigia atherica community	x	

(*) Pirone, 1995, 1997, 2005

Between Pineto and Scerne	Past (*)	Current
<i>Salsolo kali-Cakiletum maritimae</i>	x	
<i>Echinophoro spinosae-Elymetum farcti</i>	x	
<i>Echinophoro spinosae-Ammophiletum arundinaceae</i>	x	
<i>Ambrosio coronopifoliae-Lophochloetum pubescentis</i>	x	
<i>Plantagini crassifoliae-Caricetum extensae junctetosum litoralis</i>	x	
Carex extensa community		x
Elytrigia atherica community		x
Phragmites australis community		x
<i>Caricetum otrubae</i>		x (fragm.)
Glaucium flavum gravel community		x
Schoenoplectus tabernaemontani community		x
<i>Scirpetum compacto-littoralis</i>		x

(*) Pirone, 1995, 1997; Pirone et al., 2001

Pineto (Torre Cerrano)	Past (*)	Current
<i>Salsolo kali-Cakiletum maritimae</i>	x	x
<i>Echinophoro spinosae-Elymetum farcti</i>	x	x
<i>Echinophoro spinosae-Ammophiletum arundinaceae</i>	x	x
<i>Sileno coloratae-Ononidetum variegatae</i>	x	x
<i>Sileno coloratae-Vulpium membranaceae</i>	x	x
<i>Ambrosio coronopifoliae-Lophochloetum pubescentis</i>	x	x
<i>Sporobolium arenarii</i>	x	x
Romulea rollii community	x	x

(*) Pirone, 1995, 1997; Pirone et al., 2001; Pirone, 2006 (unpublished)

North of the Piomba river mouth	Past (*)	Current
<i>Salsolo kali-Cakiletum maritimae</i>		x
<i>Sileno coloratae-Vulpium membranaceae</i>		x (fragm.)
Cutandia maritima community		x
<i>Echinophoro spinosae-Elymetum farcti</i>		x
Elytrigia atherica community		x
<i>Phragmitetum australis</i>		x
Carex otrubae community		x

Piomba river mouth

	Past (*)	Current
<i>Suaedo maritimae-Salicornietum patulae</i>	x	
<i>Sarcocornietum deflexae</i>	x	
<i>Limonio serotini-Artemisietum caeruleuscentis</i>	x	
Elytrigia atherica community	x	

(*) Pirone, 1988

Between Saline and Piomba	Past (*)	Current
<i>Parapholiso incurvae-Spergularietum marginatae</i>	x	
<i>Suaedetum maritimae</i>	x	
Atriplex prostrata community	x	
Elytrigia atherica community	x	x
<i>Phragmitetum australis</i>		x
<i>Juncetum acuti</i>		x
Carex otrubae community		x

Saline river mouth

	Past (*)	Current
<i>Suaedo maritimae-Salicornietum patulae</i>	x	
Spartina versicolor community	x	
<i>Scirpetum compacto-littoralis</i>	x	
<i>Limonio serotini-Artemisietum caeruleuscentis</i>	x	
Elytrigia atherica community	x	
<i>Phragmitetum australis</i>		x

(*) Pirone, 1988

Montesilvano coastline	Past (*)	Current
<i>Salsolo kali-Cakiletum maritimae</i>	x	x (fragm.)
<i>Echinophoro spinosae-Elymetum farcti</i>	x	
<i>Echinophoro spinosae-Ammophiletum arundinaceae</i>	x	
<i>Sileno coloratae-Vulpium membranaceae</i>	x	x (fragm.)
<i>Schoeno nigricantis-Erianthetum ravennae</i>	x	
<i>Scirpetum compacto-littoralis</i>	x	

(*) Pirone, 1983

Pescara coastline	Past (*)	Current
<i>Salsolo kali-Cakiletum maritimae</i>	x	x
<i>Sporobolium arenarii</i>	x	
<i>Echinophoro spinosae-Elymetum farcti</i>	x	x (°)
<i>Echinophoro spinosae-Ammophiletum arundinaceae</i>	x	
<i>Sileno coloratae-Vulpium membranaceae</i>	x	x
Polygonum maritimum community		x (°)
<i>Schoeno nigricantis-Erianthetum ravennae</i>	x	x
<i>Allietum chamaemoly</i>	x	x (fragm.)
<i>Cistus creticus</i> ssp. <i>creticus</i> and <i>C. salviifolius</i> community	x	x
<i>Pinus halepensis</i> and <i>Laurus nobilis</i> community	x	x
<i>Aro italicum-Ulmetum minoris</i>	x	x

(*) Tammaro & Pirone, 1979, 1981; Pirone, 1983, 1997; Pirone et al., 2003
(°) Newly formed

Francavilla coastline	Past (*)	Current
<i>Salsolo kali-Cakiletum maritimae</i>	x	
<i>Echinophoro spinosae-Elymetum farcti</i>	x	
<i>Elytrigia atherica</i> community	x	
<i>Sileno coloratae-Vulpium membranaceae</i>		x

(*) Géhu et al., 1984; Pirone, 1997

Ortona, between the train station of Tollo and the Arielli river mouth	Past (*)	Current
<i>Salsolo kali-Cakiletum maritimae</i>	x	x
<i>Echinophoro spinosae-Elymetum farcti</i>	x	x
<i>Sporobolium arenarii</i>	(x)	
<i>Euphorbia terracina</i> community	x	x
<i>Sileno coloratae-Vulpium membranaceae</i>	x	x
<i>Sileno coloratae-Ononidetum variegatae</i>	x	x
<i>Ambrosio coronopifoliae-Lophochloetum pubescentis</i>	x	x
<i>Cutandia maritima</i> community		x
<i>Spartina versicolor</i> community	x	x
<i>Phragmitetum australis</i>	x	x
<i>Scirpetum compacto-littoralis</i>	x	x
<i>Carex otrubae</i> community		x
<i>Alnus glutinosa</i> community		x

(*) Géhu et al., 1984; unpublished data

Ortona coastline	Past (*)	Current
<i>Salsolo kali-Cakiletum maritimae</i>	x	
<i>Echinophoro spinosae-Elymetum farcti</i>	x	
<i>Suaedo maritimae-Salicornietum patulae</i>	x	
<i>Parapholis incurvae-Spergularietum marginatae</i>	x	x
<i>Crithmum maritimum</i> community	x	x
<i>Suaedo verae-Atriplicetum halimi</i>	x	x

(*) Géhu et al., 1984; Pirone, 1995; unpublished data

Rocca S. Giovanni (Punta Cavalluccio)	Past (*)	Current
<i>Crithmo maritimi-Limonietum virgati</i>	x	x
<i>Elytrigia atherica</i> community	x	

Fossacesia Marina	Past (*)	Current
<i>Crithmo maritimi-Limonietum virgati</i>	x	
<i>Sileno coloratae-Vulpium membranaceae</i>	(x)	x
<i>Parapholis incurvae-Spergularietum marginatae</i>	(x)	x
<i>Elytrigia atherica</i> community	(x)	x
<i>Hainardia cilindrica</i> and <i>Spergularia media</i> community	(x)	x

Torino di Sangro Marina	Past (*)	Current
<i>Allietum chamaemoly</i>	x	x
<i>Anthemis maritima</i> and <i>Stachys maritima</i> community	x	
<i>Crithmum maritimum</i> and <i>Anthemis maritima</i> community		x

Oseinto river mouth	Past (*)	Current
<i>Echinophoro spinosae-Elymetum farcti</i>	x	x
<i>Echinophoro spinosae-Ammophiletum arundinaceae</i>	x	x (fragm.)
<i>Sileno coloratae-Vulpium membranaceae</i>		x
<i>Ambrosio coronopifoliae-Lophochloetum pubescentis</i>		x
<i>Anthemis maritima</i> and <i>Lotus creticus</i> community		x
<i>Phragmitetum australis</i> (halophilous)	x	

(*) Pirone, 1995, 1997; Pirone et al., 2001

Promenade of Casalbordino	Past (*)	Current
<i>Echinophoro spinosae-Elymetum farcti</i>		x
<i>Echinophoro spinosae-Ammophiletum arundinaceae</i>		x
<i>Sileno coloratae-Vulpium membranaceae</i>	x	x
<i>Anthemis maritima</i> and <i>Lotus creticus</i> community		x

Sinello river mouth	Past (*)	Current
<i>Scirpetum compacto-littoralis</i>		x
<i>Suaeda maritima</i> community		x
<i>Parapholis incurvae-Spergularietum marginatae</i>		x

(*) Pirone, 1995

Punta Aderci	Past (*)	Current
<i>Crithmo maritimi-Adiantetum capillus-veneris</i>	x	x
<i>Atriplex halimus</i> community	x	x
<i>Scirpetum compacto-littoralis</i>	x	
<i>Myrto-Pistacietum lentisci</i>	x	x
<i>Raphano maritimi-Glaucietum flavi</i>		x

(*) Pirone, 1995; Pirone et al., 2001

Punta Penna	Past (*)	Current
<i>Echinophoro spinosae-Elymetum farcti</i>	x	x
<i>Echinophoro spinosae-Ammophiletum arundinaceae</i>	x	x
<i>Sileno coloratae-Vulpium membranaceae</i>	x	x
<i>Ambrosio coronopifoliae-Lophochloetum pubescentis</i>	x	x
<i>Juncetum acuti</i>	x	
<i>Crithmo maritimi-Limonietum virgati</i>	x	x
<i>Cutandia maritima</i> community		x

Beacon of Vasto	Past (*)	Current
<i>Juncetum acuti</i>	x	
<i>Schoeno nigricantis-Plantagetum crassifoliae</i>	x	
<i>Holoschoenetum romani</i>	x	
<i>Plantagini crassifoliae-Caricetum extensae</i>	x	
<i>Elytrigia atherica</i> community	x	
<i>Parapholis incurvae-Spergularietum marginatae</i>	x	
<i>Catapodium marini-Parapholisetum incurvae</i>	x	
<i>Atriplex halimus</i> community	x	

(*) Pirone, 1985, 1995, 1997; Pirone et al., 2001

Vasto Marina	Past (*)	Current
<i>Salsolo kali-Cakiletum maritimae</i>	x	x
<i>Sporobolietum arenarii</i>	x	x
<i>Echinophoro spinosae-Elymetum farcti</i>	x	x
<i>Echinophoro spinosae-Ammophiletum arundinaceae</i>	x	x
Cyperus kalli community	x	x
<i>Sileno coloratae-Vulpietum membranaceae</i>	x	x
<i>Sileno coloratae-Ononidetum variegatae</i>	x	x
<i>Ambrosio coronopifoliae-Lophochloetum pubescentis</i>	x	x
<i>Schoeno nigricantis-Erianthetum ravennae</i>	x	x
Imperata cilindrica community	x	x
Spartina versicolor community	x	x
<i>Schoeno nigricantis-Plantaginetum crassifoliae</i>	x	x
<i>Holoschoenetum romani</i>	x	x
<i>Plantagini crassifoliae-Caricetum extensae</i>	x	x
<i>Elytrigia atherica</i> community	x	x
<i>Scirpetum compacto-littoralis</i>	x	
<i>Phragmitetum australis</i> (halophilous)	x	x

(*) Géhu et al., 1984; Pirone, 1985, 1995; 1997; Stanisci & Conti, 1990; Pirone et al., 2001

S. Salvo coastline	Past (*)	Current
<i>Salsolo kali-Cakiletum maritimae</i>	x	x
Cutandia maritima community	x	x
<i>Echinophoro spinosae-Elymetum farcti</i>		x
<i>Echinophoro spinosae-Ammophiletum arundinaceae</i>		x
<i>Sileno coloratae-Vulpietum membranaceae</i>	x	x
<i>Sileno coloratae-Ononidetum variegatae</i>	x	x
<i>Anthemis maritima</i> and <i>Lotus creticus</i> community		x
<i>Schoeno nigricantis-Plantaginetum crassifoliae</i>	x	x
<i>Imperato cylindricae-Schoenetum nigricantis</i>	x	x
<i>Schoeno nigricantis-Erianthetum ravennae</i>	x	x
<i>Phragmitetum australis</i> (halophilous)	x	x
<i>Cladietum marisci</i>	x	x
<i>Scirpetum compacto-littoralis</i>	x	x
Spartina versicolor community	x	x
<i>Schoenoplectus tabernaemontani</i> community	x	
<i>Caricetum divisae</i>		x
<i>Chara globularis</i> and <i>Chara intermedia</i> community	(x)	x

(*) unpublished data (2000-2001)

It is a Mediterranean vicariant of *Symphyto bulbosum-Ulmetum minoris*, of the Temperate climates.

On a positive note, it can be highlighted that the investigation also revealed the presence of coastal segments that at one time had low vegetation value, in which phytocoenoses that are typical of coastal habitats are now re-established. These include:

The coast between the mouths of Rivers Saline and Piomba, with the emergence of a vast grassland of *Elytrigia atherica* and a nucleus of *Juncus acutus*;

North mouth of the seasonal River Piomba; the most significant plant communities now present are *Echinophoro spinosae-Elymetum farcti*, the grassland of *Elytrigia atherica*, and grouping of *Carex otrubae*;

The coast of Pescara, close to the port canal, the newly formed beach is colonised by species such as the psammophytes *Elymus farctus* and *Polygonum maritimum*. In an area with a slight depression, some in-

dividuals of the very rare *Limonium virgatum* are also present;

The coast between Tollo railway station and the mouth of River Arielli, where a retrodunal forest nucleus of *Alnus glutinosa* has developed;

The Casalbordino coast, with the formation of new dune ridges colonised by *Echinophoro spinosae-Elymetum farcti*;

The San Salvo coast, where also here there are new dune ridges with edges of *Echinophoro spinosae-Elymetum farcti* and of *Echinophoro spinosae-Ammophiletum arundinaceae*. In the retrodunal area of San Salvo, numerous halophilic and halo-hydrophilous communities have also been detected.

Conclusion

From these comparisons between previous data and the most recent data related to the presence of the typical vegetation, it is possible to infer the state of conservation of the coastal ecosystems, as the plant communities of the dunes provide excellent bio-indicators of the level of human disturbance (as well as natural disturbance) of these ecological systems, and the sedimentological, geomorphological, hydrological and biological changes they have undergone.

The picture that emerges for Abruzzo from this comparison is not, unfortunately, comforting. Although there has been positive dynamic reconstruction of the dune phytocoenoses in the rare cases mentioned above, this is offset by a loss of floristic and phytocoenotic biodiversity that affects large sections of the coast. The recent census of the vascular flora of the coastal dune environments of central Italy (Izzi et al., 2007) showed the presence along the Abruzzo coast of about 160 vascular species; this is counterbalanced by the high number of alien and synanthropic species, of which many have assumed an invasive character.

The remodelling, infrastructure and urban developments suffered by the mouths of rivers and their surroundings and the destruction of the original geomorphology, as in the case of Rivers Vomano, Saline, Piomba and Sangro, have resulted in the extinction of halophilic plant associations that were very rare not only in the Abruzzo region, and also throughout the central-southern Adriatic coast. This same fate has affected the psammophytic associations of the strip of beach closest to the shoreline, which in many segments is systematically 'ploughed' mechanically at the start of each summer, which eliminates all forms of plant life.

Despite everything, the last stretches of the Abruzzo coast that have not yet become mere geographical expressions provide a priceless heritage of biodiversity that must be bequeathed to future generations, as a 're-

servoir' at the disposal of the processes of biological evolution and for the ecosystem services, and as witness to the extraordinary natural history of our country.

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