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Diachronic analysis of variations induced on the flora and vegetation of river ecosystems by actions taken to reduce the risk of flooding. Case study of the River Chienti (central Adriatic, Italy)

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Abstract
We present here a diachronic comparison of the flora and vegetation of a stretch of River Chienti, in central Marche (Italy). We assess the impact of mechanical cleaning of the river on its ecological structure and biodiversity. The first survey was carried out in 1993, and then repeated in the same areas and with the same methodology in 2005, following heavy and repeated hydraulic maintenance of River Chienti. This process included excavation of gravel from the river bed and its accumulation on the river banks, with the objective to broaden and deepen the flow channel. In some places that were under strong anthropic influence and subjected to continuous erosion, this process was accompanied by work on the protection of the river banks using various materials, to reduce the risk of flooding. In connection with this, it should be noted that the mouth of River Chienti has been defined as an area at very high hydro-geological risk according to the Specific Basin Plan (*Piano Stralcio di Bacino*) for the Hydrogeological Assets of the Basins of Regional Importance (PAI), as approved by Resolution N° 116 of the Regional Council, of 21 January, 2004. This work has resulted in the disappearance of lateral branches of the river that had still or slow-flowing water, and mechanical removal of the vegetation of the river bed, and in some instances, also of the river banks. These actions have removed the wet flats at the sides of the main channel, which represented favourable habitats for the establishment of different types of helophytic and hydrophytic plant communities according to the main ecological gradients. These actions that were designed to secure the river banks have led to an upheaval in the vegetation of the alluvial terraces closest to the water course, with profound alterations to the structure of the communities that had developed in the area, resulting in some cases in their disappearance. The floristic comparison shows the loss of 95 (69.34%) entities in 2005 in comparison to those surveyed in 1993. The floristic entities that have been lost in the area are mainly those related to helophytic and marsh environments, such as *Zannichellia palustris*, *Nasturtium officinale* and *Glyceria notata*. On the other hand, particularly invasive exotic entities have appeared, such as *Robinia pseudoacacia*, *Amorpha fruticosa*, *Arundo donax*, *Cuscuta scandens* subsp *cesatiana*, *Paspalum distichum* and *Helianthus tuberosus*, along with species from the fields or from the surrounding marshy areas, such as *Helianthus annuus*, *Brassica nigra*, *Rumex crispus* and *Tripleurospermum inodorum*. Analysis of the vegetation has shown a decrease in the plant communities both of the river bed and the river banks, which have been reduced from 15 (in 1993) down to 10 (in 2005). The following associations have disappeared: *Zanichellietum palustris*, *Nasturtietum officinalis*, *Helosciadetum nodiflori*, *Bolboschoenetum maritimi*, *Glycerietum plicatae*, *Typhaetum latifoliae*, *Sparganietum erecti*, *Saponario-Artemisietum verlotorum*, *Ranunculetum repentis*, *Aro italici-Alnetum glutinosae* and *Salicetum incano-purpureae*. The vegetational types that have disappeared can be attributed to the classes *Potametea pectinati*, *Phragmito australis-Magnocaricetea elatae*, *Agrostietea stoloniferae*, *Alnetea glutinosae* and *Salicetea purpureae*. The class that has suffered the greatest number of losses is *Phragmito australis-Magnocaricetea elatae*. Many of the communities that are no longer found have high ecological value, such as *Zanichellietum palustris*, *Nasturtietum officinalis*, *Helosciadetum nodiflori*, *Bolboschoenetum maritimi* and *Glycerietum plicate*.

Key words: diachronic analysis, flora, River Chienti, river ecosystem, river maintenance, vegetation.

Introduction

The purpose of this report is to highlight the changes in the flora and vegetational components of a stretch of River Chienti (central Marche, Italy) over a period of 12 years. During this period, repeated maintenance was performed that has led to the transformation of the river bed and the river banks along the entire analysed section of the river. The study area covered the middle section and the end (i.e., the last 15 km) of River Chienti, near its mouth. A large area in the lower valley of River Chienti was affected by heavy pollution in the 1970s, by organic halogen compounds that are used by the footwear industry. The pollution affected the soil and subsoil, and contaminated the groundwater. The site has been under environmental remediation and restoration by the Marche Region.

In June 1993, systematic surveys were carried out for the entire stretch under analysis. Later, the same sites underwent similar vegetation surveys, in the period between July and September 2005.

The study area

Geographic and geomorphological characteristics

River Chienti is one of the main rivers in the Marche Region, and it falls within the hydrographic District of the Central Apennines (Decree N° 152, of 3 April, 2006). Its path at the point of confluence with River (Torrente) Fiastra (the right tributary) expands into a relatively broad bed, with alluvial deposits and various terracing levels. Near the mouth, River Chienti receives the waters from several smaller rivers, all of which are characterised by low flow rates. River Chienti en-

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ters the Adriatic Sea south of the town of Civitanova Marche (Fig. 1).

The last stretch of River Chienti flows over alluvial deposits that arrived during various stages, ranging from the late Pleistocene to the Holocene (Centamore & Deiana, 1986). All of these alluvial deposits are of gravel, sandy gravel, sandy clay and silty clay. The thickness of the terraced deposits varies widely, and these deposits are structured in gravelly or sandy-gravelly lenticular complexes, with lenses of clay-silt.

Hydrological characteristics

The basin of River Chienti covers 1,298 km^2, and is elongated in a WNW-ESE direction. It has an average altitude of about 510 m a.s.l., with an average slope of 0.9% (Dramis & Bisci, 1991). The water regime of River Chienti is heavily conditioned by the pluviometric situation, and the river is characteristic of a seasonal river. During periods of heavy and/or prolonged rain, the river flow can reach considerable levels (e.g., up to 200 m^3/s).

Materials and Methods

This diachronic analysis was performed through comparisons of the species and communities surveyed in 1993 with those surveyed in 2005. For the floristic analyses, the nomenclature used refers to '*Flora d'Italia*' (Pignatti, 1982), to '*Flora Europea*' (Tutin *et al*., 1968-1980) and to the 'Check List of Italian Flora' (Conti *et al*., 2005, 2007). The first survey of the species in the study area was carried out in 1993, and this was then adjusted in terms of the nomenclature to follow the basis of the 'Check List of Italian Flora', to provide the necessary correspondence with the second survey, which was carried out in 2005.

The list of the plant species that were defined is not the result of a specific floristic study, but is derived from the set of phytosociological relevés. This diachronic study of the flora was carried out through floristic comparisons of the species observed during these two different periods of investigation (Table 1).

The vegetation analysis was conducted according to the phytosociological method (Braun-Blanquet, 1928, 1964; Pirola, 1970; Guinochet, 1973; Tüxen, 1978; Biondi 2011). For the syntaxonomic classifications, reference was made to the national and international literature (Tüxen, 1978, 1979; Oberdorfer, 1979, 1983; Meriaux 1981a, 1981b; Scoppola, 1981; Rivas-Martínez, 1982; Mucina *et al*., 1993; Passarge, 1996; Rivas-Martínez *et al*., 1999, 2001, 2002; Venanzoni & Gigante, 2000; Blasi *et al*., 2001; Biondi *et al*., 2004; Sburlino *et al*., 2004), and especially to the '*Prodromo della Vegetazione d'Italia*' (Biondi *et al*., 2014). A number of relevés were performed for the extention of the vegetation along the stretch of the river under study.

Results

Floristic analysis

In 1993, 137 species were recorded, while 65 were recorded for 2005. Overall, the flora that was recorded for this stretch of river under study over 12 years comprised 164 species.

The most surprising observation is the number of

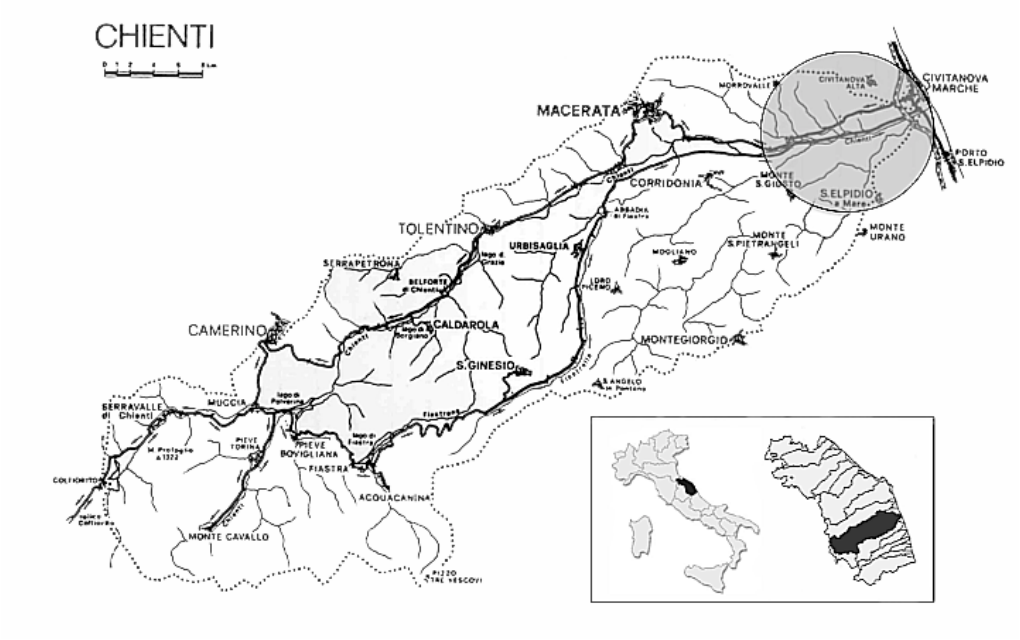


Fig. 1 - Hydrographic Basin of River Chienti, with the study area highlighted in grey.

Tab. 1 - Comparison floristic list 1993 -2005 years (in italic, species in 1993-2005; in boldface, species in 1993; in block letters, species in 2005)

Agrostis stolonifera L.
Alisma plantago-aquatica L.
Alnus glutinosa (L.) Gaertner
Amaranthus retroflexus L.
Anagallis arvensis L. subsp. arvensis
Anthemis arvensis L. subsp. arvensis
Amorpha fruticosa L.
Apium nodiflorum (L.) Lag. subsp. nodiflorum
Artemisia verlotiorum Lamotte
Artemisia vulgaris L.
Arundo donax L.
Arum italicum Mill.
Atriplex prostrata Boucher ex DC.
Barbarea vulgaris R.Br. subsp. vulgaris
Berula erecta (Huds.) Coville
Bidens frondosa L.
Bidens tripartita L. (s.l.)
Bolboschoenus maritimus (L.) Palla
Brassica nigra (L.) W.D.J. Koch
Brachypodium sylvaticum (Hudson) Beauv.
Bromus commutatus Schrad.
Cakile maritima Scop. subsp. maritima
Calystegia sepium (L.) R. Br. subsp. sepium
Cardamine impatiens L. subsp. impatiens
Carex depauperata Good. ex With.
Carex divulsa Stockes
Carex otrubae Podp.
Carex pendula Huds.
Chenopodium album L. subsp. album
Clematis vitalba L.
Clematis viticella L.
Convolvulus arvensis L.
Cuscuta scandens Brot. subsp cesatiana (Bertol.) Soó
Cota tinctoria (L.) J. Gay subsp. australis (R.Fer.) Oberprieler e Greuter
Cyclamen repandum Sm. subsp. repandum
Cyperus glomeratus L.
Cyperus longus L.
Cytisus villosus Pourr.
Dactylis glomerata L. subsp. glomerata
Daucus carota L. subsp. carota
Dianthus sylvestris Wulfen subsp. longicaulis (Ten.) Greuter & Burdet.
Diplotaxis tenuifolia (L.) DC.
Dipsacus fullonum L.
Echinochloa crus-galli (L.) Beauv.
Echium italicum L. subsp. italicum
Echium vulgare L. (s.l.)
Elymus repens (L.) Gould. subsp. repens
Epilobium hirsutum L.
Epilobium parviflorum Schreber
Equisetum arvense L.
Erigeron canadensis L.
Eryngium maritimum L.
Galatella linosyris (L.) Rchb. f. subsp. linosyris
Eupatorium cannabinum L. subsp. cannabinum
Euphorbia platyphyllos L. subsp. platyphyllos
Euphorbia segetalis L.
Foeniculum vulgare Mill. subsp. vulgare
Fraxinus angustifolia Vahl subsp. oxycarpa (Willd.) Franco et Rocha Afonzo
Galega officinalis L.
Galium mollugo L. subsp. erectum Syme
Galium mollugo L. subsp. mollugo
Galium palustre L. (s.l.)
Glyceria fluitans (L.) R. Br.
Glyceria notata Chevall.
Hedera helix L. subsp. helix
Helianthus annuus L.
Helianthus tuberosus L.
Helminthoteca echioides (L.) Holub
Herniaria hirsuta L. subsp. hirsuta
Holcus lanatus L. subsp. lanatus
Holoschoenus australis (L.) Rchb.
Humulus lupulus L.
Juncus articulatus L.
Juncus bufonius L.
Juncus inflexus L.
Kickxia spuria (L.) Dumort. subsp. spuria
Lactuca serriola L.
Limbarda crithmoides (L.) Dumort. subsp. crithmoides
Lolium multiflorum Lam.
Lolium remotum Schrank
Lonicera caprifolium L.
Lotus corniculatus L. subsp. corniculatus
Luzula forsteri (Sm.) DC.
Lycopus europaeus L. subsp. europaeus
Lythrum salicaria L.
Medicago lupulina L.
Melilotus albus Medik.
Medicago marina L.
Melilotus officinalis (L.) Pall.
Mentha aquatica L. subsp. aquatica
Mentha pulegium L.
Myosotis arvensis (L.) Hill subsp. arvensis
Nasturtium officinale R. Br. subsp. officinale
Odontites vulgaris Moench subsp. vulgaris
Papaver rhoeas L. subsp. rhoeas
Paspalum distichum L.
Persicaria hydropiper (L.) Delarbre
Persicaria lapathifolium (L.) Delarbre subsp. lapathifolia
Petrorhagia saxifraga (L.) Link subsp. saxifraga
Phragmites australis (Cav.) Trin. ex Steud. subsp. australis
Picris hieracioides L. subsp. hieracioides
Plantago coronopus L. subsp. coronopus
Plantago lanceolata L.
Plantago major
Poa trivialis L.
Polygonum aviculare L. (s.l.)
Polygonum bellardii All.
Polygonum maritimum L.
Polypogon monspeliensis (L.) Desf.
Polypogon viridis (Gouan) Breistr.
Populus nigra L.
Pulicaria dysenterica (L.) Bernh.
Ranunculus repens L.
Raphanus raphanistrum L. (s.l.)
Reseda alba L. subsp. alba
Reseda phyteuma L. subsp. phyteuma
Rostraria cristata (L.) Tzvelev subsp. cristata
Robinia pseudoacacia L.
Rubus caesius L.
Rubus ulmifolius Schott
Rumex conglomeratus Murray
Rumex obtusifolius L.
Rumex sanguineus L.
Rumex crispus L.
Salix alba L.
Salix purpurea L. (s.l.)
Salix triandra L. (s.l.)
Salsola kali L.
Sambucus nigra L.
Saponaria officinalis L.
Schoenoplectus tabernaemontani (C.C.Gmelin) Palla
Scirpoides holoschoenus (L.) Soják
Scrophularia auriculata L. subsp. auriculata
Scrophularia nodosa L.
Scrophularia peregrina L.
Senecio aquaticus Hill
Silene latifolia Poir. subsp. alba (Mill.) Greuter et Burdet
Sinapis alba L.
Sinapis arvensis L. subsp. arvensis
Solanum dulcamara L.
Solanum nigrum L.
Sonchus asper (L.) Hill (s.l.)
Sparganium erectum L. subsp. erectum
Stachys palustris L.
Stellaria aquatica (L.) Scop.
Stellaria nemorum L.
Symphyotrichum squamatum (Spreng.) G.L. Nelson
Thalictrum aquilegifolium L. subsp. aquilegifolium
Trifolium pratense L. subsp. pratense
Tripleurospermum inodorum (L.) Sch.Bip.
Tripolium pannonicum (Jacq) Dobrocz subsp. tripolium (L.)
Typha domingensis (Pers.) Steud
Typha latifolia L.
Urtica dioica L. (s.l.)
Verbascum sinuatum L.
Verbena officinalis L.
Veronica anagallis-aquatica L. subsp. anagallis-aquatica L.
Vinca major L. subsp. major L.
Xanthium orientaleL. subsp. italicum Moretti Greuter
Zannichellia palustris L. (s.l.)

species that were not found during the second survey, which reached as many as 95 taxa, including especially species associated with marshy and forestal areas. Indeed, some of the species that have disappeared are linked to conditions of still or weakly flowing water. These species are represented by *Alisma plantago-aquatica*, *Zanichellia palustris*, *Sparganium erectum*, *Apium nodiflorum*, and *Glyceria palustris*. Other species that were no longer found belong to forest coenoses of the slopes, such as *Fraxinus angustifolia*, *Salix purpurea*, *S. triandra*, and *Citysus villosus*, climbing species, such as *Humulus lupulus*, *Clematis viticella*, *Clematis vitalba*, and *Lonicera caprifolium*, and undergrowth herbaceous species, such as *Vinca major*, *Cyclamen repandum* and *Scrofularia nodosa*. The few species that colonised the small islands in the river during the summer–autumn were also missing, such as *Persicaria lapathifolium* and *Bidens frondosa*.

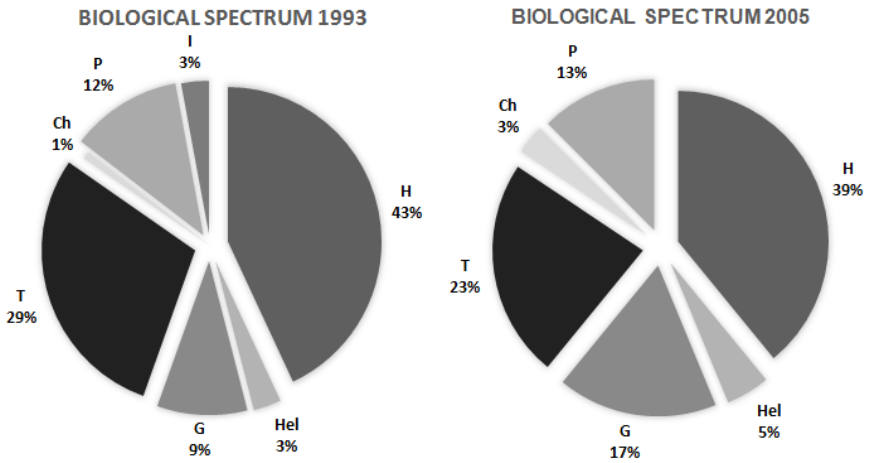
The comparisons of the biological spectra of the floristic lists from the two different periods (Table 2) allows the changes that have occurred to be highlighted. The most important finding is the complete disappearance in the 2005 vegetation relevés of the hydrophytes that were present in the 1993 relevés, albeit that these represented 1% of the total species. The geophytes increased from 9% to 18%. This is an increase that can be considered in relation to the remodelling of the river bed that favoured species with underground storage organs, due to the fragmentation of the vegetation and the lack of competition. Phanerophytes underwent a small increase, from 12% to 14%, although this increase is represented by invasive exotic species, favoured by the anthropic disturbance, such as *Robinia pseudoacacia*, *Arundo donax* and *Amorpha fruticosa*. The number of hemicryptophytes was significantly reduced (from 43% to 37%), and this change appears to be related to the simplification of the habitats (mainly herbaceous) of the river bed following this remodelling. The therophytes that are mainly attributable to the classes *Stellarietea mediae* (such as *Anagallis arvensis*, *Anthemis arvensis*, *Myosotis arvensis*), *Artemisitea vulgaris* (such as *Melilotus albus*, *Chenopodium album*) and *Bidentetea tripartitae* (such as *Persicaria lapatifolia*, *Bidens frondosa*), suffered a decline (from 29% to 23%). This decrease might be due to the artificial remodelling of the river bed that removed the lower terraces, where annual pioneer coenoses of the classes *Nano-Juncetea* and *Bidentetea tripartitae* developed that were often accompanied by a rich flora of the class *Stellarietea mediae*, and the intermediate terraces, which were mainly colonised by species belonging to the class *Artemisitea vulgaris* (in these open spaces that were left, different commensal species of fields or marshes develop in a mosaic).

Vegetational analyses

In the study area, a total of 39 phytosociological relevés have been performed. The characterisation of the

Tab. 2 - Compare biological spectra relating to investigations of 1993 and 2005 years.

	1993		2005	
P	16	12%	8	14%
Ch	1	1%	2	3%
H	59	43%	24	37%
G	13	9%	12	18%
T	40	29%	15	23%
Hel	4	3%	3	5%
I	4	3%	-	-



vegetation highlighted 17 associations and two groupings, related to eight different vegetational classes.

ZANICHELLIETUM PALUSTRIS Lang 1967 (Table 3)

This plant phytocoenosis belongs to the typology of monophytic aquatic vegetation. It consists of rooted hydrophytes that are completely submerged, and it is linked to low eutrophic water, with moderate flow, on silty or silty-muddy substrates. In the 1993 relevés, monospecific communities were found along the sides of the bends in the river close to the mouth. These communities had disappeared completely in the 2005 survey.

This widely diffuse coenosis can be found for several rivers of the Italian peninsula, such as River Taro (Biondi *et al*., 1997), River Esino (Baldoni & Biondi, 1993), River Musone (Biondi *et al*., 2002), River Metauro (Biondi *et al*., 2007) and River Tevere (Ceschin & Salerno, 2008; Lastrucci *et al*., 2012). According to these previous studies, *Zannichellia palustris* is considered a good indicator of eutrophic waters that are rich in organic matter and minerals.

POLYGONO LAPATIFOLII-XANTHIETUM ITALICI Pirola & Rossetti 1974 (Table 4)

This pioneer, therophytic, hygro-nitrophilous community develops on sandy-silty deposits or on deposits that have a coarser particle size, but with a wet clay matrix that is rich in nitrogen, and that are left by the river when it overflows. This community develops in the river bed during the dry season, and on the islets formed in the middle of the channels when the water withdraws in the autumn period and has minimal flow. This community is favoured by its great production of seeds and by the river dynamics that prevents its replacement with more stable plant communities that consist of herbaceous biennial or perennial species. For River Chienti, the physiognomy of the vegetation was characterised by the following species: *Xanthium orientale*, *Bidens tripartita*, *Persicaria lapathyfolia* and *Echinocloa crus galli*. These are in association with helophytes of shallow waters, and therophytes and hemicryptophytes of the classes *Artemisietea* (synanthropic plants that spread from the surrounding cultivated fields), *Molinio-Arrhenateretea* and *Phragmito australis-Magnocaricetea elatae*. This vegetation has already been described for various waterways in this Region, such as River Esino (Baldoni & Biondi, 1993). In addition, this coenosis has been described for River Reno (Pirola & Rossetti, 1974), River Stirone (Biondi *et al*., 1999), River Po (Assini, 1997), River Pescara (Pirone, 1981) and River Vomano (Pirone and Frattaroli, 1998). This community was more structured in the 1993 relevés, where *Persicaria lapathifolium* was always present (also at high coverage), although *P. lapathifolium* was no longer found in the subsequent relevés. In the floristic survey of 2005, exotic species appeared, such as *Helianthus annuus*, *Helianthus tuberosus*, *Brassica nigra* and *Cuscuta scandens*, which indicate disturbed and unstable environments.

PHRAGMITETUM AUSTRALIS Savič 1926 (Table 5)

The vegetation of the association *Phragmitetum australis* is often found as groupings of only a few species that are dominated by *Phragmites australis*, with very dense coverage. This occupies areas on the banks of rivers and swamps, in meso-eutrophic waters, on silty-clay substrate (Venanzoni & Gigante, 2000). The tangle of rhizomes of the dense *Phragmites australis* outgrowths retains a thick layer of debris mixed with silt, and in stagnant or slow-flowing water this favours further silting up through the accumulation of deposits (Baldoni & Biondi, 1993). The common reed can develop even in relatively dry soils with superficial groundwater. For River Chienti, the association *Phragmitetum australis* shows a sporadic distribution and occurs in small groups, where it colonises the side branches of the main river bed, on silty-clay substrate with stagnant water. In Umbria, on the other hand, this association is present in almost all wet places (Venanzoni & Gigante, 2000). More recently, however, for Lake Trasimeno, again in Umbria, there has been a sharp reduction in the reeds of *Phragmites australis*, similar to what was previously indicated for middle Europe (Gigante *et al*., 2013). The results that were obtained for the vegetation that colonises the shores of Lake Trasimeno indicate that the reeds that show the most severe symptoms of decline are those that are monospecific and are found in areas that are permanently flooded and rich in deposits of autogenous organic matter. On the other hand, those that are found in areas that are not under water show vigorous growth, are in good health, and have greater floristic wealth. In these cases, a different phytocoenosis tends to develop that the authors indicate as a variant with *Rubus ulmifolius* of the association *Phragmitetum australis* Savič 1926.

The floristic comparison between the coenoses of River Chienti that were discovered in 1993 with those of 2005 highlights the loss of typical species that have high ecological value, such as *Clematis viticella*, *Humulus lupulus* and *Persicaria lapathifolium*, and other species such as *Thalictrum aquilegifolium* and *Scrophularia peregrina*, which have been substituted by more common species coming from the surrounding marsh environments, such as *Atriplex prostrata*, *Rumex crispus* and *Agrostis stolonifera*.

NASTURTIETUM OFFICINALIS Seibert 1962 (Table 6)

This association is linked to fresh oligomesotrophic waters where *Nasturtium officinale* generally forms compact colonies on constantly submerged river

Tab. 3 - *Zanichellietum palustris* Lang 1967

		Relevé number	1
		Area (m^2)	5
		Coverage (%)	100
		Altitude (m a.s.l.)	-
		Charact. species of the association	
I rad	COSMOP.	Zannichellia palustris L. (s.l.)	5.5

Tab. 4 - *Polygono-Xanthietum italici* Pirola & Rossetti 1974

		Relevé number	1	2	3	4	5	6	Presences
		Area (m^2)	20	20	50	100	20	30	
		Coverage (%)	100	100	100	100	100	100	
		Altitude (m a.s.l.)	5	5	5	5	5	5	
		Char. and diff. species of the ass. and upper levels							
T scap	SUBCOSMOPOL.	Xanthium orientale L. subsp. italicum (Moretti) Greuter (X. i. Moretti)	1.2	1.2	1.1	+	4.4	4.4	6
T scap	EURASIAT.	Bidens tripartita L. (s.l.)	3.4	3.4	2.3	+	+	1.1	6
T ros	SUBCOSMOPOL.	Persicaria lapathifolia (L.) Delarbre subsp. lapathifolia	3.3	3.3	5.5	5.5	.	.	4
T scap	SUBCOSMOP.	Echinochloa crus-galli (L.) Beauv.	.	.	2.2	1.1	+	+.2	4
H scap	EUROSIB.(SUBCOSMOPOL.)	Veronica anagallis-aquatica L. subsp.anagallis -aquatica	.	+	.	+	.	.	2
H scap	MEDIT.	Apium nodiflorum (L.) Lag. subsp. nodiflorum	+	.	+	.	.	.	2
Tscap	EURIMEDIT.	Lolium multiflorum Lam.	.	.	.	+	.	.	1
		Other species							
H scap	E ASIAT.	Artemisia verlotiorum Lamotte	+	+	1.2	.	3.3	1.2	5
H scap	SE EUROP.-SW ASIAT.	Galega officinalis L.	.	+	+	+	.	1.2	4
H scap	EUROP.-CAUC.	Rumex obtusifolius L.	.	1.2	2.2	+	.	.	3
T scap	MEDIT.	Anthemis arvensis L. subsp. arvensis	+	+	1.1	.	.	.	3
H scap	EURASIAT.	Lycopus europaeus L. subsp. europaeus	.	1.2	.	.	+	+.2	3
G rhiz/Hel	EURASIAT.-N AMER.	Typha latifolia L.	.	+	1.2	.	.	+.2	3
T scap	EURASIAT.	Atriplex prostrata Boucher ex D.C.	+	2.3	1.2	.	.	.	3
H scap	EURASIAT.	Stellaria aquatica (L.) Scop.	.	+	1.1	.	.	.	2
G rhiz	S EUROP.-W ASIAT.	Convolvulus arvensis L.	.	.	.	.	2.2	1.1	2
T scap	NEOTROP.	Symphyotricum squamatum (Spreng.) G.L. Nesom	.	2.2	+	.	.	.	2
H scand	EURASIAT.	Calystegia sepium (L.) R. Br. subsp. sepium	.	.	.	.	1.2	+	2
H scap	EURASIAT.	Rumex crispus L.	.	.	.	.	1.1	1.1	2
T scap	MEDIT.	Polygonum bellardii All.	.	.	.	.	1.1	1.1	2
T par	SE EUROP.-W ASIAT.	Cuscuta scandens Brot. subsp cesatiana (Bertol.) Greuter	.	.	.	.	+	1.1	2
H scap	EURASIAT.	Lythrum salicaria L.	.	.	.	.	+	+.2	2
T scap	MEDIT. (SUBCOSMOPOL.)	Brassica nigra (L.) W.D.J. Koch	.	.	.	.	+	+	2
Pscap	EURASIAT.	Salix alba L.	+	.	.	+	.	.	2
H scap	CIRCUMBOR.	Scrophularia nodosa L.	.	+	+	.	.	.	2
H caesp	MEDIT.-W ASIAT	Polypogon viridis (Gouan) Breistr.	.	.	.	1.2	.	.	1
P scap	EURASIAT.	Populus nigra L.	+	.	.	.	.	.	1
T scap	MEDIT.(SUBCOSMOPOL.)	Sinapis arvensis L. subsp. arvensis	+	.	.	.	.	.	1
T rept	COSMOP.	Polygonum aviculare L. (s.l.)	+	.	.	.	.	.	1
Hbienn	MEDIT	Daucus carota L. subsp. carota	.	+	.	.	.	.	1
H scap	EURASIAT.	Eupatorium cannabinum L. subsp. cannabinum	.	+	.	.	.	.	1
H scap	EURASIAT.	Galium mollugo L. subsp. erectum Syme	.	.	+	.	.	.	1
T scap	MEDIT.	Helminthoteca echioides (L.) Holub	.	.	+	.	.	.	1
Tscap	N AMER.	Bidens frondosa L.	.	.	.	+	.	.	1
He	EURASIAT.	Cyperus glomeratus L.	.	.	.	+	.	.	1
G rhiz	EUROSIB.-N AMER.	Juncus articulatus L.	.	.	.	+	.	.	1
T scap	N AMER.(COSMOPOL.)	Amaranthus retroflexus L.	.	.	.	+	.	.	1
H scap	EURASIAT.-AFR.	Mentha aquatica L. subsp. aquatica	.	.	.	.	.	2.3	1
H scap	MEDIT.	Pulicaria dysenterica (L.) Bernh.	.	.	.	.	.	+.2	1
H scap	EUROSIB.-N AMER.	Stachys palustris L.	.	.	.	.	+	.	1
G bulb	N AMER.	Helianthus tuberosus L.	.	.	.	.	+	.	1
H scap	EURASIAT.	Artemisia vulgaris L.	.	.	.	.	+	.	1
T scap	EURIMEDIT.	Raphanus raphanistrum L. (s.l.)	.	.	.	.	+	.	1
H scap	S-EUROP.	Galatella linosyris (L.) Rchb. f. subsp. linosyris	.	.	.	.	.	+	1
T scap	N AMER.	Helianthus annuus L.	.	.	.	.	.	+	1
H ros	EURASIAT.	Plantago major L.	.	.	.	.	.	+	1
H ros	EURASIAT.	Plantago lanceolata L.	.	.	.	.	.	+	1
H scap	EURASIAT.	Epilobium hirsutum L.	.	.	.	.	.	+	1
G rhiz	PANTROP./SUBTROP.	Typha domingensis (Pers.) Steud	.	.	.	.	.	+	1
T scap	EUROP. (COSMOPOL.)	Tripleurospermum inodorum (L.) Sch. Bip.	.	.	.	.	.	+	1
T scap	COSMOPOL.	Chenopodium album L. subsp. album	.	.	.	+	.	.	1

banks that are often monophytic, or are accompanied by a few sporadic species, such as *Apium nodiflorum* and *Veronica anagallis-aquatica*, where the water is shallower and less rheophilic. This hydrophytic community has been reported for the Pescasseroli plain (Pedrotti *et al*., 1992), for River Tirino (Corbetta & Pirone, 1989), and for the Norcia Marshes (Pedrotti, 2008). In the Marche Region, this same community has been reported for the resurgences of Stoni, near Fiuminata (Taffetani & Pedrotti, 1982), along the middle course of River Esino (Baldoni & Biondi, 1993), and particularly in the Jesi Ripa Bianca Regional Reserve (Biondi *et al*., 2009). In this stretch of River Chienti under consideration, this community develops in a fragmentary pattern along the muddy banks of the main water course and the sides of the bends, and it also develops in more rheophilic waters, in chain contact with the vegetation that colonises the central small islets (of the class *Bidentetea tripartitae*). This coenosis was present in the study area in 1993, but unfortunately it was not found in 2005.

SPARGANIETUM ERECTI Roll. 1938 (Table 7)

This community was detected for River Chienti in 1993 in a slightly depressed lateral branch with almost stagnant waters and muddy substrate. This is a well-structured coenosis with good levels of coverage that consists of groupings dominated by *Sparganium erectum* with a floristic complex of species of great ecological value of the class *Phragmito australis-magnocaricetea elatae*, like *Mentha aquatica*, *Lycopus europaeus*, *Alisma plantago-aquatica*, *Glyceria notata* and *Berula erecta*. This coenosis was also missing in the relevés of 2005.

Dense populations have been described for various sections along River Tirino (Corbetta & Pirone, 1989) and for River Sordo in Norcia (Pedrotti, 2008). In the delta of River Po (Merloni & Piccoli, 2001), this coenosis forms a dense paucispecific population. For River Esino in Marche, there are small nuclei of this coenosis especially near the mouth (Baldoni & Biondi, 1993), while in Umbria it was reported for Lake Piediluco (Venanzoni & Gigante, 2000).

HELOSCIADETUM NODIFLORI Br.-Bl., Roussine & Nègre 1952 (Table 8)

Apium nodiflorum (= *Helosciadum nodiflorum*) in River Chienti forms dense stretches along the muddy banks, around the small temporary pools of various sizes with mostly clay substrate that are created in the river bed due to the deposition of the finer material in relation to the flow rate variation. This community is distributed discontinuously along the entire stretch of River Chienti examined, and as for other hydrophytic coenoses, it has a paucispecific structure. This vegetation was no longer seen in 2005, although it is relatively common along rivers in Italy, and has been reported for the plains of Montelago di Camerino (Pedrotti, 1967), along River Tirino (Corbetta & Pirone, 1989) and River Trigno (Canullo *et al*., 1988), as well for River Esino (Baldoni & Biondi, 1993) and in the Ripa Bianca Regional Reserve (Biondi *et al*., 2009), and the Conero Regional Park (Biondi, 1986; Biondi *et al*., 2012). The typical species that accompany *Apium nodiflorum* are generally shielded by it in the less rheophilic waters, and they are represented by *Veronica anagallis-aquatica*, *Alisma plantago-aquatica*, and sporadically, *Glyceria notata*.

BOLBOSCHOENETUM MARITIMI Van Langendonck 1931 (Table 9)

[= *Bolboschoenetum maritimi* Eggler 1933; *Halo-Scirpetum* Dahl & Hadac 1941]

This halotolerant subalophilic vegetation of *Bolboschoenus maritimus* (= *Scirpus maritimus*) frequently develops at the mouth of rivers in terrain with a resonable concentration of salt that is sporadically reached by the sea water during the most violent storms. Its presence was detected for River Chienti only during the survey in 1993, on the mainly sandy river bed near the mouth of the river. This appears as a phytocoenosis that is physiognomically characterised by *Bolboschoenus maritimus*, with a good level of coverage, in which there is the fragmentary presence of a few hygro-nitrophilous species of the association *Polygono-Xanthietum italici*, like *Atriplex prostrata*, *Xanthium orientale* subsp. *italicum* and *Lolium multiflorum*. This vegetation was also recorded near the mouth of River Musone, south of the Conero promontory in the locality of Scossicci (Biondi *et al*., 2002).

GLYCERIETUM PLICATE Kulcz. 1928 *em*. Oberd. 1954 (Table 10)

Due to this association, the vegetation for River Chienti is represented by paucispecific coenoses that form a very thick cover of *Glyceria notata* accompanied by *Veronica anagallis-aquatica*, with a smaller number of companion species and low coverage. The relevés were from two nearby areas in weakly rheophilic and shallow waters at the mouth of the river. This coenosis was also found only in the 1993 survey.

This association has been recorded for River Tirino (Corbetta & Pirone, 1989), the high reaches of River Trigno (Canullo *et al*., 1988) and River Esino (Baldoni & Biondi, 1993), where *Apium nodiflorum* instead accompanies *Glyceria notata*.

TYPHO ANGUSTIFOLIAE-SCHOENOPLECTETUM TABERNAEMONTANI Br.-Bl. & Bolos 1957 (Table 11)

This association is relatively widespread in the wetlands of central Italy near the fianl sections of the ri-

Tab. 5 - *Phragmitetum australis* Savič 1926

		Relevé number	1	2	3	4	Presences
		Area (m²)	20	10	20	20	
		Coverage (%)	100	100	100	100	
		Altitude (m a.s.l.)	-	-	-	6	
		Char. and diff. species of the ass. and upper levels					
Hel/G rhiz	COSMOPOL.	Phragmites australis (Cav.) Trin. ex Steud. subsp.australis	5.5	5.5	5.5	5.5	4
H scand	EURASIAT.	Calystegia sepium (L.) R. Br. subsp. sepium	2.3	2.3	2.3	.	3
H scap	EURASIAT.	Lycopus europaeus L. subsp. europaeus	+	+	.	.	2
H scap	EURASIAT.-AFR.	Mentha aquatica L. subsp. aquatica	1.1	.	.	.	1
G rhiz	MEDIT.	Cyperus longus L.	.	.	+	.	1
		Other species					
T scap	SUBCOSMOPOL.	Xanthium orientale L. subsp. italicum Moretti Greuter	1.1	+	.	+.2	3
T scap	EURASIAT.	Atriplex prostrata Boucher ex DC.	+	+	.	1.1	3
T scap	EURASIAT.	Bidens tripartita L. (s.l.)	1.2	.	.	+	2
NP/H scap	EUROSIB.	Solanum dulcamara L.	.	1.1	+	.	2
Tscap	EURIMEDIT.	Lolium multiflorum Lam.	+.2	+.2	.	.	2
H scap	EURASIAT.	Rumex conglomeratus Murray	+	.	+	.	2
T scap	STENOMEDIT.	Scrophularia peregrina L.	+	1.1	.	.	2
P lian	EURASIAT.-N AMER.	Humulus lupulus L.	.	+	+	.	2
NP	EURIMEDIT.	Rubus ulmifolius Schott	.	+	+	.	2
T ros	SUBCOSMOPOL.	Persicaria lapathifolium (L.) Delarbre subsp. lapathifolia	1.1	.	.	.	1
P scap	EURASIAT.	Salix alba L.	.	.	.	1.2	1
H rept	EURASIAT. -N AMER.	Agrostis stolonifera L.	.	.	.	1.2	1
H scap	EUROP.	Thalictrum aquilegiifolium L. subsp. aquilegiifolium	.	.	+.2	.	1
H bienn	EURASIAT.	Tripolium pannonicum (Jacq) Dobrocz subsp. tripolium (L.) Greuter	.	.	.	+.2	1
P lian	S EUROP.-S SIBER.	Clematis viticella L.	.	.	+.2	.	1
H scap	SE-EUROP.-SW ASIAT.	Galega officinalis L.	+	.	.	.	1
G rhiz	COSMOPOL.	Bolboschoenus maritimus (L.) Palla	+	.	.	.	1
T scap	MEDIT.-ATL.	Cakile maritima Scop. subsp. maritima	.	+	.	.	1
T scap	EURIMEDIT.	Raphanus raphanistrum L. (s.l.)	.	+	.	.	1
H scap	SUBCOSMOP.	Urtica dioica L. (s.l.)	.	+	.	.	1
H scap	EURASIAT.	Rumex crispus L.	.	.	.	+	1

Tab. 6 - *Nasturtietum officinalis* Seibert 1962

		Relevé number	1
		Area (m²)	20
		Coverage (%)	100
		Altitude (m a.s.l.)	-
		Char. and diff. species of the ass. and upper levels	
H scap	COSMOPOL.	Nasturtium officinale R.Br. subsp. officinale	5.5
H scap	EUROSIB.(SUBCOSMOPOL.)	Veronica anagallis-aquatica L. subsp. anagallis-aquatica	1
H scap	MEDIT.	Apium nodiflorum (L.) Lag. subsp. nodiflorum	+
H scap	EURASIAT.	Lythrum salicaria L.	+

Tab. 7 - *Sparganietum erecti* Roll. 1938

		Relevé number	1
		Area (m^2)	20
		Coverage (%)	100
		Altitude (m a.s.l.)	-
		Char. and diff. species of the ass. and upper levels	
I rad/Hel	EUROSIB.-N AMER:	Sparganium erectum L. subsp. erectum	4.5
I rad	COSMOPOL.	Alisma plantago-aquatica L.	2.2
H scap	EURASIAT.-AFR.	Mentha aquatica L. subsp. aquatica	1.2
Hel/G rhiz	EUROP.-N AMERICA	Berula erecta (Hds.) Coville	1.2
G rhiz	EURASIAT.	Glyceria notata Chevall.	1.2
H scap	EURASIAT.	Lycopus europaeus L. subsp. europaeus	+
Hel	EURASIAT.-N AMER.	Glyceria fluitans (L.) R. Br.	+
		Other species	
H scap	MEDIT.	Apium nodiflorum (L.) Lag. subsp. nodiflorum	+
H rept	EURASIAT.	Ranunculus repens L.	+
H bienn	SW EUROP.	Senecio aquaticus Hill	+

Tab. 8 - *Helosciadetum nodiflori* Br.-Bl. 1952

		Relevé number	1	2	Presences
		Area (m^2)	50	15	
		Coverage (%)	100	100	
		Altitude (m a.s.l.)	-	-	
		Char. and diff. species of the ass. and upper levels			
H scap	MEDIT.	Apium nodiflorum (L.) Lag. subsp. nodiflorum	4.5	4.5	2
H scap	EURASIAT.	Lythrum salicaria L.	1.1	1.1	2
H scap	EUROSIB.(SUBCOSMOPOL.)	Veronica anagallis-aquatica L. subsp. anagallis-acquatica	1.1	+	2
G rhiz	EURASIAT.	Glyceria notata Chevall.	+	+	2
I rad	COSMOPOL.	Alisma plantago-aquatica L.	+	.	1
		Other species			
G rhiz	MEDIT.	Cyperus longus L.	+	+.2	2
T scap	EURASIAT.	Bidens tripartita L. (s.l.)	+	+	2
H scap	SE-EUROP.-SW ASIAT.	Galega officinalis L.	+	+	2
H bienn	MEDIT.	Dipsacus fullonum L.	+	+	2
H scap	EUROP.-CAUC.	Rumex sanguineus L.	1.2	.	1
T scap	SUBCOSMOPOL.	Echinochloa crus-galli (L.) Beauv.	.	1.1	1
H scap	PALEOTEMP.	Lycopus europaeus L. subsp. europaeus	1.1	.	1
H scap	EURASIAT.	Epilobium hirsutum L.	1.1	.	1
T scap	SUBCOSMOPOL.	Xanthium orientale L. subsp. italicum (Moretti) Greuter	.	1.1	1
T scap	EURIMEDIT.	Lolium multiflorum Lam.	.	+.2	1
P caesp	EUROSIB.	Salix triandra L. (s.l.)	+	.	1
P scap	EURASIAT.	Salix alba L.	+	.	1
H Scand	EURASIAT.	Calystegia sepium (L.) R.Br. subsp. sepium	+	.	1

Tab. 9 - *Bolboschoenetum maritimi* Eggler 1933

		Relevé number	1
		Area (m^2)	10
		Coverage (%)	100
		Altitude (m a.s.l.)	-
		Char. and diff. species of the ass. and upper levels	
G rhiz	COSMOPOL.	Bolboschoenus maritimus (L.) Palla	4.5
		Other species	
T scap	EURIMEDIT.	Lolium multiflorum Lam.	1.2
T scap	SUBCOSMOPOL.	Xanthium orientale L. subsp. italicum (Moretti) Greuter	1.2
T ros	SUBCOSMOPOL.	Persicaria lapathifolia (L.) Delarbre subsp. lapathifolia	+
T scap	MEDIT.ATL.	Cakile maritima Scop. subsp. maritima	+
T scap	EURASIAT.	Atriplex prostrata Boucher ex DC.	+

Tab. 10 - *Glycerietum plicatae* Kulcz. 1928 *em*. Oberd. 1954

		Relevé number	1	2	Presences
		Area (m^2)	10	5	
		Coverage (%)	100	100	
		Altitude (m a.s.l.)	-	-	
		Char. and diff. species of the ass. and upper levels			
G rhiz	EURASIAT.	Glyceria notata Chevall.	4.5	4.5	2
H scap	EUROSIB.(SUBCOSMOPOL.)	Veronica anagallis-aquatica L. subsp. anagallis-aquatica	1.2	2.2	2
		Other species			
G rhiz	EUROSIB-N AMER.	Juncus articulatus L.	1.1	+	2
G rhiz	EURASIAT.	Schoenoplectus tabernaemontani (C.C.Gmelin) Palla	.	+	1
P scap	EURASIAT.	Salix alba L.	.	+	1
H scap	EUROP.-CAUC.	Rumex sanguineus L.	.	+	1

Tab. 11 - *Typho angustifoliae-Schoenoplectetum tabernemontani* Br.-Bl. & Bolós 1957

		Relevé number	1	2	3	Presences
		Area (m^2)	10	6	3	
		Coverage (%)	100	100	90	
		Altitude (m a.s.l.)	4	4	4	
		Char. and diff. species of the ass. and upper levels				
G rhiz	EURASIAT.	Schoenoplectus tabaernemontani (C.C.Gmelin) Palla	5.5	5.5	5.5	3
G rhiz	PANTROP./SUBTROP.	Typha domingensis (Pers.) Steud	.	+	+	2
G rhiz	COSMOPOL.	Bolboschoenus maritimus (L.) Palla	.	.	1.2	1
G rhiz/Hel	EURASIAT.-N AMER.	Typha latifolia L.	.	.	+	1
		Other species				
T ros	SUBCOSMOPOL.	Persicaria lapathifolium (L.) Delarbre subsp. lapathifolia	+	+	.	2
H scap	EURASIAT.	Rumex obtusifolius L. (s.l.)	+	+	.	2
G rhiz	NEOTROP. (SUBCOSMOPOL.)	Paspalum distichum L.	.	.	+	1

vers, and it develops on muddy soil that is constantly wet and subjected to large fluctuations in the water level. This was recorded for the relevés in 1993, and indeed remained present in the relevés of 2005. It has been indicated for several sites: in Emilia, along the course of River Stirone (Biondi *et al*. 1999, 2003), in Umbria (Venanzoni & Gigante, 2000), for River Tirino (Corbetta & Pirone, 1989), for River Esino (Baldoni & Biondi, 1993) and for Lake Trasimeno (Orsomando & Catorci, 1991). There is no agreement among the various studies about the correlation between the fertility of the substrate and the depth of the water. This species appears to have low ecological value as a biomarker, as it can develop under very diverse conditions. Its ecological role as a refuge for birds is important, however.

TYPHAETUM LATIFOLIAE Lang 1973 (Table 12)

This association is present for many rivers of central Italy, and it prefers eutrophic, and even stagnant, waters, with long periods of submersion. It has been reported for River Esino (Baldoni & Biondi, 1993) and for River Tirino in Abruzzo (Corbetta & Pirone, 1989). It also develops frequently in small communities along the edges of fields, as well as in ditches, where there is stagnant water. For River Chienti, this vegetation with *Thypha latifolia* forms a belt of vegetation for the bends in the river where the current stops temporarily or slows down. On the edges, there is strong penetration of *Lithrum salicaria*, and the coenosis is completed by the presence of *Apium nodiflorum* and *Veronica anagallis-aquatica*. The floristic content is relatively poor, and it is represented by species that belong to the class *Bidentetea tripartitae*. This association was found in 1993, but was not confirmed in 2005.

CYPERETUM LONGI Micevski 1957 (Table 13)

This coenosis is present in almost all of the regions of Italy. It has been reported for the Abruzzo Region for Lake Serranella (Pirone *et al*., 2003), for River Tirino (Corbetta & Pirone, 1989), for the lakes of Monticchio (Venanzoni *et al*., 2003) and for Lake Trasimeno (Venanzoni & Gigante, 2000). For River Chienti, it only appeared in the relevés in 2005, near the mouth of the river. *Cyperus longus* shows high coverage, together with *Typha latifolia*, for raised banks that are affected by short periods of flooding, and it is probably related to greater accumulation of silty materials.

CYPERUS GLOMERATUS community (Table 14)

This is an amphibious vegetation of stagnant waters or wet soils that are flooded in winter and free of water in the summer. *Cyperus glomeratus* is a naturalised allochthonous species of the river beds of the Marche Region (Gubellini & Pinzi, 2010), and it forms dense, but limited, structures on silty-sandy soils in areas with summer drainage. As for *Cyperus longus*, *Cyperus glomeratus* was only present in the relevés in 2005, under similar ecological conditions.

SALSOLO KALI-CAKILETUM MARITIMAE Costa & Mansanet 1981 (Table 15)

In the final section of rivers, the contact with the coastal sands allows the presence of a psammophylic flora of ephemeral annual vegetation. This community consists of *Cakile maritima*, *Salsola kali*, *Eryngium maritimum*, *Limbarda crithmoides*, *Polygonum maritimus* and *Xanthium orientale*, the differential species of the nitrophilous subassociation (Turrisi, 2005; Biondi *et al*., 1992) that develops on sandy soils that are rich in organic matter that is beached during storms or that arrives in the rivers. It is a xerophilous community that is under continuous alterations due to waves, and also to the river dynamics when near the mouth of the river. It was present in the dune belts that separate the river mouth from the sea in the relevés carried out in 2005, while in the 1993 study, it was not found for the sandy coastal environments of the mouth of the river.

SAPONARIO OFFICINALIS-ARTEMISIETUM VERLOTIORUM Baldoni & Biondi 1993 (Table 16)

This vegetation of tall herbs is typical of disturbed soils, and it develops on river islands and on the terraces that are only occasionally flooded. Its substrate can have different grain sizes, from sandy to pebbly silty if it is well drained and rich in nutrients carried by the river floods. The association was first described for River Esino (Baldoni & Biondi, 1993) and it was also recorded for River Arno in Tuscany (Lastrucci *et al*., 2010) and for River Pesa (Mereu *et al*., 2010). The community found for River Chienti in 1993 was indicated for terraces raised above the river bed and dominated by *Artemisia verlotiorum*, *Saponaria officinalis*, *Melilotus albus*, *M. officinalis* and *Galega officinalis*. The structure and ecological conditions of the area allows this phytocoenosis to be attributed to the association *Saponario-Artemisietum verlotiorum*. The floristic complex is rich in species but is very heterogenous, and is represented mainly by entities belonging to different classes of vegetation, not only of the river beds, but also from the surrounding environments.

ARUNDO DONAX community (Table 17).

This coenosis was only observed in the relevés in 2005, and it comprises exotic species, some of which are highly invasive, such as *Arundo donax* and *Amorpha fruticosa*. These occupy areas pertaining to shrubby willows, and so result in a considerable fall in biodiversity and naturality (Banfi & Galasso, 2010). Its polliniferous ability and drought resistance favours its spread also in the ruderal areas next to water courses. *Arundo donax* is a nitrophilous and anthropogenic spe-

Tab. 12 - *Typhaetum latifoliae* Lang 1973

		Relevé number	1
		Area (m^2)	20
		Coverage (%)	100
		Altitude (m a.s.l.)	-
		Char. and diff. species of the ass. and upper levels	
G rhiz/Hel	EURASIAT.-N AMERIC.	Typha latifolia L.	4.5
H scap	EURASIAT.	Lythrum salicaria L.	3.3
H scap	MEDIT.	Apium nodiflorum (L.) Lag. subsp. nodiflorum	1.1
H scap	EUROSIB.(SUBCOSMOPOL.)	Veronica anagallis-aquatica L. subsp. anagallis-aquatica	1.1
		Other species	
T scap	EURASIAT.	Bidens tripartita L. (s.l.)	2.3
T scap	PALEOTEMP.	Persicaria lapathifolia (L.) Delarbre subsp. lapathifolia	2.3
Pscap	EURASIAT	Salix alba L.	1.2

Tab. 13 - *Cyperetum longi* Micevski 1957

		Relevé number	1
		Area (m^2)	10
		Coverage (%)	80
		Altitude (m a.s.l.)	5
		Char. and diff. species of the ass. and upper levels	
G rhiz	MEDIT.	Cyperus longus L.	5.5
G rhiz/Hel	EURASIAT.-N AMER.	Typha latifolia L.	1.2
H scap	EURASIAT.	Lycopus europaeus L. subsp. europaeus	+.2
		Other species	
T scap	EURASIAT.	Persicaria hydropiper (L.) Delarbre	2.2
H rept	EURASIAT.	Ranunculus repens L.	1.2
T scap	EURASIAT.	Bidens tripartita L. (s.l.)	1.2
T scap	SUBCOSMOPOL.	Echinochloa crus-galli (L.) Beauv.	+.2
G rhiz	NEOTROP. (SUBCOSMOPOL.)	Paspalum distichum L.	+.2
T scap	SUBCOSMOPOL.	Xanthium orientale L. subsp. italicum (Moretti) Greuter	+
H scap	EUROSIB. (SUBCOSMOPOL.)	Veronica anagallis-aquatica L. subsp. anagallis-aquatica	+

Tab. 14 - *Cyperus glomeratus* community

		Relevé number	1	2	Presences
		Area (m^2)	4	6	
		Coverage (%)	80	90	
		Altitude (m a.s.l.)	5	5	
		Char. and diff. species of the ass. and upper levels			
H scap	EURASIAT.	Cyperus glomeratus L.	5.5	5.5	2
T scap	SUBCOSMOP.	Echinochloa crus-galli (L.) P. Beauv.	+.2	.	1
		Other species			
G rhiz	MEDIT.-W ASIAT.	Scirpoides holoschoenus (L.) Soják	1.2	1.2	2
G rhiz	NEOTROP. (SUBCOSMOPOL.)	Paspalum distichum L.	.	1.2	1
G rhiz	S EUROP.-W ASIAT.	Convolvulus arvensis L.	.	+	1

Tab. 15 - *Salsolo kali-Cakiletum maritimae* Costa & Mansanet 1981

		Relevé number	1
		Area (m^2)	30
		Coverage (%)	10
		Altitude (m a.s.l.)	3
		Char. and diff. species of the ass. and upper levels	
T scap	MEDIT.-ATL.	Cakile maritima Scop. subsp. maritima	1.1
T scap	EURASIAT.	Salsola kali L.	1.1
H rept	SUBCOSMOPOL.	Polygonum maritimum L.	+
Ch rept	MEDIT.	Medicago marina L.	+
		Diff. species of the subass. *xanthietosum italici*	
T scap	SUBCOSMOPOL.	Xanthium orientale L. subsp. italicum (Moretti) Greuter	1.1
		Other species	
T par	SE EUROP.-W ASIAT.	Cuscuta scandens Brot. subsp cesatiana (Bertol.) Soó	+
Ch suffr	MEDIT.ATL.	Limbarda crithmoides (L.) Dumort. subsp. crithmoides	+
	MEDIT.ATL.	Eryngium maritimum L.	+
G rhiz	NEOTROP. (SUBCOSMOPOL.)	Paspalum distichum L.	+

cies that originated from Asia, and as such it can develop under very different ecological conditions, and especially in disturbed environments, provided that there is enough edaphic humidity. The spread of *Arundo donax* was also favoured because of its use in the past to protect vegetable crops. This is a paucispecific community that is dominated by *Arundo donax* and that has been reported for River Aspromonte (Brullo *et al*., 2001) and for Sicily, in Lake Biviere di Gela basin (Brullo & Sciandrello, 2006). It has been included in the association *Calystegio silvaticae–Arundinetum donacis*. In Tuscany, for River Pesa (Meredith *et al*., 2011), for the rivers of central and northern Italy (Biondi *et al*., 2004), for River Esino (Baldoni & Biondi, 1993) and for River Metauro (Biondi *et al*., 2007), it has been described as *Arundini donacis–Convolvuletum sepium*, an association that develops on alluvial deposits with surface groundwater. In Marche, the coenosis with a dominance of *Arundo donax* has also been included in the association *Clematido vitalbae–Arundinetum donacis* for Conero Park (Biondi *et al*., 2012) and the forests of Gallignano (Biondi & Allegrezza, 2004).

RANUNCULETUM REPENTIS Knapp 1947 (Table 18)

This paucispecific herbaceous phytocoenosis is dominated by *Ranunculus repens* and develops as carpets of very dense vegetation where the few other species that can be found are represented by pioneer therophytes of the class *Bidentetea*. This develops in small depressions along the sides of the river bed on swampy clay substrate that is constantly wet and is rich in nutrients. For the final section of River Chienti, this coenosis is not very frequent, and it was found for a single site. For River Esino instead, it has been recorded for many places, albeit of limited size (Baldoni & Biondi, 1993). In Abruzzo, it has been reported for River (Torrente) Gogna (Pirone *et al*., 2003) and for Rivers Tordino and Vomano (Pirone, 2000) and River Tirino (Corbetta and Pirone, 1989).

ARO ITALICI-ALNETUM GLUTINOSAE Gafta & Pedrotti 1995 (Table 19)

This association has a dominance of *Alnus glutinosa*, with *Salix alba* and sporadically *Fraxinus angustifolia* and *Populus nigra*. This is a riparian forest, with a rich shrub layer that is constituted by *Salix purpurea*, *Cytisus villosus*, *Salix triandra* and *Sambucus nigra*, and climbing species like *Lonicera caprifolium*, *Hedera helix* and *Humulus lupulus*. It is a coenosis locally present for the rivers of Marche, such as River Esino (Baldoni & Biondi, 1993), and in Emilia Romagna for River Taro (Biondi *et al*., 1997). This vegetation is made up of as many as 42 species, it was recorded for River Chienti esclusively in 1993. Within this riparian forest, there are various components with different ecologies: hygrophilous species such as *Apium nodiflorum*, *Ranunculus repens*, *Mentha aquatica* and *Lycopus europaeus*; sciaphilous forest species, such as *Arum italicum*, *Solanum dulcamara* and *Stellaria nemorum*; and species linked to the presence of edaphic moisture, such as *Apium nodiflorum*, *Galium palustre*, *Equisetum arvense* and *Carex pendula*.

SALICETUM ALBAE Soó 1930 *em*. Moor 1958

Variant with *Alnus glutinosa* (Table 20)

For the more distant alluvial terraces that are reached by water only during the periods of the highest water levels, there are discontinuous bands of forest a few

Tab. 16 - *Saponario-Artemisietum verlotiorum* Baldoni & Biondi 1993

		Relevé number	1	2	3	4	5	6	Presences
		Area (m^2)	50	50	30	50	50	20	
		Coverage (%)	80	100	40	100	80	100	
		Altitude (m a.s.l.)	-	-	-	-	-	-	
		Char. and diff. species of the ass. and upper levels							
H scap	E ASIAT	Artemisia verlotiorum Lamotte	3.3	2.3	+	4.4	4.5	4.5	6
T scap	EURASIAT.	Melilotus albus MediK.	3.4	1.2	+	+	2.3	1.2	6
H scap	SE-EUROP.-SW ASIAT.	Galega officinalis L.	1.2	3.4	+	2.3	+	2.3	6
H bienn	EURASIAT.	Melilotus officinalis (L.) Pall.	1.2	+	.	+	1.1	+	5
H bienn	MEDIT.	Dipsacus fullonum L.	1.1	+	.	1.1	.	+.2	4
H scap	EURASIAT.	Picris hieracioides L. subsp. hieracioides	1.2	+	.	.	+	.	3
H scap	EUROP.- W ASIAT.	Saponaria officinalis L.	.	.	1.2	2.2	1.2	.	3
H scap	EURASIAT.	Artemisia vulgaris L.	+	+	.	.	.	.	2
H bienn	MEDIT.	Daucus carota L. subsp. carota	1.2	.	.	.	.	.	1
H bienn	EURASIAT.	Silene latifolia Poir. subsp.alba (Mill.) Greuter *et* Burdet	.	.	.	1.2	.	.	1
H Scand	EURASIAT.	Calystegia sepium (L.) R.Br. subsp. sepium	.	+	.	.	.	.	1
		Diff species of subass. *rumicetosum obtusifolii*							
H scap	EUROP.-CAUC.	Rumex obtusifolius L.	1.1	+	+	1.1	.	1.1	5
H scap	PALEOTEMP.	Verbena officinalis L.	+	+	1	.	1	.	4
		Other species							
H bienn	MEDIT.	Verbascum sinuatum L.	2.3	1.2	.	+	1.2	.	4
H scap	EURASIAT.	Barbarea vulgaris R.Br. subsp. vulgaris	1.2	+	+	.	+	.	4
T scap	N AMER. (COSMOPOL)	Erigeron canadensis L.	1.1	1.2	+	.	+	.	4
T scap	EURIMEDIT.	Lolium multiflorum Lam.	+	+	1.2	.	+	.	4
T scap	MEDIT.	Anthemis arvensis L. subsp. arvensis	+	+	.	.	1.1	+	4
T scap	EURASIAT.-W AFR	Medicago lupulina L.	+	.	+	.	+	+	4
T scap	MEDIT.	Helminthoteca echioides (L.) Holub	+	.	1.1	.	+	.	3
T scap	MEDIT.	Papaver rhoeas L.subsp. rhoeas	+	.	.	.	+	+	3
H bienn	MEDIT.-W ASIAT.	Echium italicum L. subsp. italicum	+	.	.	.	+	.	2
T rept	MEDIT.(COSMOPOL.)	Anagallis arvensis L. subsp. arvensis	+	.	4.5	.	.	.	2
H scap	EURASIAT.	Epilobium hirsutum L.	+	.	.	+	.	.	2
H scap	MEDIT.	Foeniculum vulgare Mill. subsp. vulgare	+	.	.	+	.	.	2
H scap	EURASIAT.	Galium mollugo L. subsp. erectum Syme	+	.	.	1.1	.	.	2
H scap	EURASIAT.	Stellaria aquatica (L.) Scop.	1.1	.	.	+	.	.	2
NP	EUROP.-W ASIAT.	Rubus caesius L.	+	.	.	.	.	+	2
H bienn		Echium vulgare L. (s.l.)	+	.	.	.	.	+	2
H caesp	S EUROP.	Petrorhagia saxifraga (L.) Link subsp. saxifraga	.	+	.	+	.	.	2
T scap	MEDIT.	Reseda alba L. subsp. alba	1.1	.	.	.	+	.	2
T scap	SUBCOSMOPOL.	Xanthium orientaleL. subsp. italicum Moretti Greuter	.	+	+	.	.	.	2
G rhiz	EURASIAT.	Elymus repens (L.) Gould. subsp. repens	.	.	.	+	.	.	1
H bienn	EUROP.-W ASIAT.	Cota tinctoria (L.) J. Gay subsp. australis (R.Fer.) Oberprieler e Greuter	+	.	.	.	.	.	1
T scap	NEOTROP.	Symphyotrichum squamatum (Spreng.) G.L. Nelson	.	.	+	.	.	.	1
T scap		Bidens tripartita L. (s.l.)	.	.	+	.	.	.	1
T scap	EUROP.	Bromus commutatus Schrad.	.	.	.	+	.	.	1
H caesp	EURASIAT.	Dactylis glomerata L. subsp. glomerata	+	.	.	.	.	.	1
H scap	MEDIT.	Diplotaxis tenuifolia (L.) DC.	.	.	.	.	+	.	1
T scap	SUBCOSMOP.	Echinochloa crus-galli (L.) Beauv.	.	.	+	.	.	.	1
T scap	MEDIT.W ASIAT.	Euphorbia segetalis L.	+	.	.	.	.	.	1
H bienn	EURASIAT.	Lactuca serriola L.	+	.	.	.	.	.	1
H scap	EURASIAT.	Lycopus europaeus L. subsp. europaeus	.	.	.	+	.	.	1
H scap	EURASIAT.	Lythrum salicaria L.	.	+	.	.	.	.	1
H scap	EURASIAT.-W AFR	Lotus corniculatus L. subsp. corniculatus	+	.	.	.	.	.	1
H scap	EURASIAT.-AFR.	Mentha aquatica L. subsp. aquatica	.	+	.	.	.	.	1
H ros	EURASIAT.	Plantago lanceolata L.	+.2	.	.	.	.	.	1
H ros	EUROSIB.	Plantago media L. subsp. media	.	+	.	.	.	.	1
H caesp	EURASIAT.N AMER.	Poa trivialis L.	+.2	.	.	.	.	.	1
T scap	MEDIT.-ASIAT.N AFR	Polypogon monspeliensis (L.) Desf.	.	.	+	.	.	.	1
H scap		Urtica dioica L. (s.l.)	.	.	.	1.1	.	.	1
H scap	W EUROP.-MEDIT	Scrophularia auriculata L. subsp. auricolata	+	.	.	.	.	.	1
T scap	STENOMEDIT.	Scrophularia peregrina L.	.	+	.	.	.	.	1
T scap	E-MEDIT.-MONT.	Sinapis alba L.	+	.	.	.	.	.	1
T scap	EURASIAT.	Solanum nigrum L.	.	.	+	.	.	.	1
T scap		Sonchus asper (L.) Hill (sl.)	.	.	+	.	.	.	1
T scap	MEDIT.(SUBCOSMOPOL.)	Sinapis arvensis L. subsp. arvensis	.	.	+	.	.	.	1
NP/Hscap	EUROSIB.	Solanum dulcamara L.	+	.	.	.	.	.	1
T scap	EURASIAT.	Atriplex prostrata Boucher ex D.C.	.	.	.	.	+	.	1
T scap	MEDIT.	Herniaria hirsuta L. subsp. hirsuta	.	.	.	.	+	.	1
H scap	EUROSIB.	Trifolium pratense L. subsp. pratense	.	.	.	.	+	.	1
G rhiz	S EUROP- W ASIAT.	Convolvulus arvensis L.	.	.	.	.	.	+	1
T scap	EURIMEDIT.	Lolium multiflorum Lam.	.	.	.	.	.	2.3	1

Tab. 17 - *Arundo donax* community

		Relevé number	1
		Area (m^2)	20
		Coverage (%)	100
		Altitude (m a.s.l.)	2,5
		Char. and diff. species of the ass. and upper levels	
G rhiz	ASIAT. SUBCOSMOP.	Arundo donax L.	4.5
H scap	E ASIAT.	Artemisia verlotiorum Lamotte	3.3
NP	MEDIT.	Rubus ulmifolius Schott	1.2
G rhiz	EURASIAT.	Elymus repens (L.) Gould subsp. repens	1.2
T scap	MEDIT.	Helminthoteca echioides (L.) Holub	1.1
		Other species	
P caesp	AVV.	Amorpha fruticosa L.	3.3
H bienn	EURASIAT.	Silene latifolia Poir. subsp. alba (Mill.) Greuter et Burdet	1.1
H bienn	MEDIT.	Daucus carota L. subsp. carota	1.1
H caesp	EURASIAT.	Dactylis glomerata L. subsp. glomerata	+.2
T scap	EURASIAT.	Odontites vulgaris Moench subsp. vulgaris	+

Tab. 18 - *Ranunculetum repentis* Knapp 1947

		Relevé number	1	2	Presences
		Area (m^2)	10	10	
		Coverage (%)	100	100	
		Altitude (m a.s.l.)	-	-	
		Char. and diff. species of the ass. and upper levels			
H rept	EURASIAT.	Ranunculus repens L.	5.5	5.5	2
T ros	PALEOTEMP.	Persicaria lapathifolia (L) Delarbre subsp. lapatifolia	+	+	2
H scap	EUROP.-CAUC.	Rumex obtusifolius L.	1	+	2
H ros	EURASIAT.	Plantago major L.	.	+	1
		Other species			
T scap	EURASIAT.	Atriplex prostrata Boucher ex D.C.	+	.	1
T scap	EURASIAT.	Bidens tripartita (s.l.)	+	.	1
H scap	EUROSIB.(SUBCOSMOPOL.)	Veronica anagallis-aquatica L. subsp. anagallis-aquatica	+	.	1
H scap	EURASIAT.	Lythrum salicaria L.	.	+	1
G rhiz	S EUROP.-W ASIAT.	Convolvulus arvensis L.	.	+	1

metres wide that are dominated by *Salix alba*, with *Populus nigra* and *Alnus glutinosa*. This type of hygrophilous wood is distributed throughout Italy, and it develops in the middle and lower stretches of rivers (Pedrotti & Gafta, 1996). It is subjected to strong reduction of its coverage due to continued removal of the relevant river areas for agricultural or industrial purposes. In the surveys of 1993, the shrub layer was represented by *Salix purpurea*, accompanied by *Clematis vitalba*, *Humulus lupulus* and *Rubus caesius*. In the surveys in 2005, the loss of the climbing species *Clematis vitalba* and *Humulus lupulus* can be noted in particular, along with the absence of *Salix purpurea*, and the arrival of species from different environments, like *Hedera helix*, *Galium mollugo*, *Sambucus nigra*, *Stachys palustris*, *Rubus caesius* and the exotic *Robinia pseudoacacia*.

SALICETUM INCANO-PURPUREAE Sillinger 1993 (Table 21)

This association of shrubby pioneer willows develops in contact with water or on the lower parts of river banks. It can tolerate repeated, albeit brief, periods of flooding by the flood waters. Due to the ease of its vegetative propagation, these willows can quickly re-colonise the river bank. According to Baldoni and Biondi (1993), this is the first stage of colonisation of the banks by woody species. This association for River Chienti is characterised by *Salix triandra* and *S. alba* that accompany the dominant species (*Salix purpurea*), along with several hemicryptophytes of the class *Molinio-Arrhenatheretea*, and it was detected only in 1993.

Tab. 19 - *Aro italici-Alnetum glutinosae* Gafta & Pedrotti1995

		Relevé number	1
		Area (m^2)	200
		Coverage (%)	100
		Altitude (m a.s.l.)	-
		Char. and diff. species of the ass.	
P scap	PALEOTEMP.	Alnus glutinosa (L.) Gaertn.	3.3
G rhiz	MEDIT.	Arum italicum Mill.	1.2
P scap	S EUROP.-SW ASIAT..	Fraxinus angustifolia Vahl subsp. oxycarpa (Willd.) Franco et Rocha Afonzo	+
		Char. and diff. species of the upper levels	
NP	EUROP.-W ASIAT.	Rubus caesius L.	4.4
Hel	EURASIAT.	Carex pendula Huds.	2.2
H caesp	EURASIAT.	Brachypodium sylvaticum (Hudson) Beauv.	1.2
NP/Hscap	EUROSIB.	Solanum dulcamara L.	1.2
P lian	EURASIAT.-N AMER.	Humulus lupulus L.	+.2
P scap	EURASIAT.	Populus nigra L.	+
		Other species	
H rept	EURASIAT.	Ranunculus repens L.	3.3
H scap		Urtica dioica L. (s.l.)	2.2
H scap	EURASIAT.	Lycopus europaeus L. subsp. europaeus	2.2
P scap		Salix purpurea (s.l.)	1.2
P caesp	EUROP	Sambucus nigra L.	1.2
G rhiz	EURASIAT. N-AM	Equisetum arvense L.	1.2
H scap	EUROP.-CAUC.	Stellaria nemorum L.	1.2
H scap	E ASIAT	Artemisia verlotiorum Lamotte	1.2
H scand	EURASIAT.	Calystegia sepium (L.) R.Br. subsp. sepium	1.2
H scap	MEDIT.	Mentha pulegium L.	1.2
H scap	MEDIT.	Apium nodiflorum (L.) Lag. subsp. nodiflorum	1.2
H scap	EUROP.- W ASIAT.	Saponaria officinalis L.	+.2
H scap	W EUROP.-MEDIT	Scrophularia auriculata L. subsp. auricolata	+.2
H scap	EUROP.-CAUC.	Galium palustre L.	+.2
H caesp	S EUROP.	Luzula forsteri (Sm.) DC.	+
T scap	MEDIT.	Reseda phyteuma L. subsp. phyteuma	+
T caesp	COSMOPOL.	Juncus bufonius L.	+
P lian	EUROP.-SW ASIAT.	Hedera helix L. subsp. helix	+
H scap	EURASIAT.	Eupatorium cannabinum L. subsp. cannabinum	+
H scap	EURASIAT.	Epilobium hirsutum L.	+
H scap	EUROP.	Epilobium parviflorum Schreber	+
H scap	EUROP.-CAUC.	Rumex sanguineus L.	+
H scap	EURASIAT.-AFR.	Mentha aquatica L. subsp. aquatica	+
H caesp	EURASIAT.	Juncus inflexus L.	+
G rhiz	EURIMEDIT.	Holoschoenus australis (L.) Rchb.	+
T scap	MEDIT.	Kickxia spuria (L.) Dumort. subsp. spuria	+
T scap	EUROP.	Myosotis arvensis (L.) Hill subsp. arvensis	+
H scap	S EUROP.	Galium mollugo L. subsp. mollugo	+
P lian	SE EUROP.	Lonicera caprifolium L.	+
P caesp	MEDIT.	Cytisus villosus Pourr.	+
G bulb	MEDIT.	Cyclamen repandum Sm. subsp. repandum	+
P caesp	EUROSIB.	Salix triandra (s.l.)	+

Conclusions

The EU Directives require that by 2015 the achievement of good water quality will be reached (Directive 2000/60 or WFD). This should be accompanied by completion and publication of the management plans of the flood risk in each hydrographic district, which is better known as the Floods Directive (Directive 2007/60). Indeed, the PAI (Hydrogeological Assets of the Basins of Regional Importance, which provided provisional plans for hydrogeological basins) has already been withdrawn, as it was almost always inadequate for prevention and risk planning. The revisions should cover, among other things, the types of defence systems to be implemented. This is from one point of view not wholly hydraulic, and not only limited to the stretch of river where the problem occurs, as has been done to date for most of the rivers. This needs to be according to a systemic approach, which includes the biotic components of the whole hydrographic basin, as

Tab. 20 - *Rubo ulmifolii-Salicetum albae* Allegrezza, Biondi & Felici 2006

		Relevé number	1	2	Presences
		Area (m^2)	50	30	
		Coverage (%)	100	75	
		Altitude (m a.s.l.)	8	8	
		Char. and diff. species of the ass. and alliance			
P scap	EURASIAT.	Salix alba L.	5.5	4.5	2
Hel	EURASIAT.	Carex pendula Huds.	+	2.3	2
P lian	EUROP.-CAUC.	Clematis vitalba L.	1.1	.	1
P lian	EURASIAT.-N AMER.	Humulus lupulus L.	1.1	.	1
NP	MEDIT.	Rubus ulmifolius Schott	.	+.2	1
P lian	EUROP.-SW ASIAT.	Hedera helix L. subsp. helix	.	2.2	1
		Char. and diff. species of the upper levels			
P caesp		Salix purpurea L. (s.l.)	1.1	.	1
P caesp	EUROP.	Sambucus nigra L.	.	+.2	1
NP/ H scap	EUROSIB.	Solanum dulcamara L.	.	1.1	1
		Alnus glutinosa variant			
P scap	EUROSIB.	Alnus glutinosa (L.) Gaertner	+	1.1	2
		Other species			
H scap		Urtica dioica L. (s.l.)	2.3	3.3	2
H scap	E ASIAT.	Artemisia verlotiorum Lamotte	1.2	1.2	2
H scand	EURASIAT.	Calystegia sepium (L.) R.Br. subsp. sepium	+	+.2	2
H rept	EURASIAT.	Ranunculus repens L.	+	+.2	2
H scap	STENO-MEDIT.	Dianthus sylvestris Wulfen subsp. longicaulis (Ten.) Greuter &	+	.	1
H scap	EURASIAT.	Galium mollugo L. subsp. erectum Syme	.	1.2	1
P scap	N AMER	Robinia pseudoacacia L.	.	2.2	1
Hel/G rhiz	COSMOP.	Phragmites australis (Cav.) Trin.ex Steud. subsp. australis	.	1.2	1
T scap	EURASIAT.	Bidens tripartita L. (s.l.)	.	1.1	1
H scap	EURASIAT.	Lythrum salicaria L.	.	+	1
H scap	EUROSIB. -N AMER.	Stachys palustris L.	.	+.2	1
G rhiz	ASIAT (SUBCOSMOP).	Arundo donax L.	.	+.2	1
NP	EUROP.-W ASIAT.	Rubus caesius L.	.	+	1
H scap	W EUROP.-MEDIT	Scrophularia auriculata L. subsp. auricolata	.	+	1
H scap	EURASIAT.	Stellaria aquatica (L.) Scop.	.	+	1
T scap	EUROP.	Lolium remotum Schrank	.	+	1

Tab. 21 - *Salicetum incano-purpureae* Sillinger 1993

		Relevé number	1
		Area (m^2)	50
		Coverage (%)	100
		Altitude (m a.s.l.)	-
		Char. and diff. species of the ass. and upper levels	
P caesp		Salix purpurea L. (s.l.)	4.5
P caesp		Salix triandra L. (s.l.)	1.2
P scap	EURASIAT.	Salix alba L.	1.2
		Other species	
H scap	EUROSIB.-N AMER.	Stachys palustris L.	4.5
H rept	EURASIAT.	Ranunculus repens L.	2.2
H scap		Urtica dioica L. (s.l.)	2.2
H scap	EURASIAT.	Lycopus europaeus L. subsp. europaeus	2.2
H scap	EURASIAT.	Epilobium hirsutum L.	1.2
H scap	MEDIT.	Apium nodiflorum (L.) Lag. subsp. nodiflorum	1.2
H Scand	EURASIAT.	Calystegia sepium (L.) R.Br. subsp. sepium	1.1
H scap	EURASIAT.	Lythrum salicaria L.	+
P caesp	EUROP.	Holcus lanatus L. subsp. lanatus	+
H scap	EURASIAT.-AFR.	Mentha aquatica L. subsp. aquatica	+
H scap	E ASIAT	Artemisia verlotorum Lamotte	+
H scap	W EUROP.-MEDIT	Scrophularia auriculata L. subsp. auricolata	+
T caesp	COSMOPOL.	Juncus bufonius L.	+
H caesp	S EUROP.	Luzula forsteri (Sm.) DC.	+
T caesp	MEDIT. (SUBCOSMOPOL.)	Rostraria cristata (L.) Tzvelev subsp. cristata	+

required by the two Directives. The WFD Directive is innovative, in that it determines the health status of the water bodies not only through the quality of the water, but also through an examination of the ecological status. This covers a whole range of biological elements, including the composition and abundance of the aquatic macrophytes. Alterations in the water quality due to pollution of various kinds, as also for changes in the hydrological regime, the trivialisation of the river beds as a consequence of systems aimed at eliminating bends, irregularity of the river bed, and river-bank vegetation (which have always been regarded as obstacles to the free flow of water), entail the loss of many habitats and ecological niches present across the three dimensions of the river (longitudinal, transverse, vertical). This can result in considerable reduction in biodiversity and loss of the important ecological functions that rivers performs under natural conditions. The aquatic and riparian vegetation has an active role in the processes of self-purification, especially when they comprise diversified communities that are distributed according to sections based on the variations in the main ecological gradients, and are well structured.

The phytosociological method in the study of river vegetation involves overcoming problems related to the variability and rapidity of changes in the ecological conditions of the river bed that are determined by the flooding (Biondi *et al*., 2004). The importance of this method is also recognized by the WFD, as also by the Habitats Directive, which make use of the phytosociological method for the allocation of the percentages of coverage of the macrophytes and for the identification of the habitats. In a river that has been heavily altered, the first visible sign is a quantitative reduction in the vegetation of the river bed and river banks. This is accompanied by the development of ephemeral paucispecific communities that consist of taxa that are tolerant of the rapid growth that substitutes stable and persistent communities that are well-adapted to the river environment, and by the entry of exotic species that are favoured by the lack of competition. This biological monitoring provides an assessment of the overall quality of the environment.

The role of the spontaneous vegetation is crucial for the reduction of the risk, just by virtue of its function as a buffer for the hydrological changes produced by weather conditions. It has been known for some time now that there is a close correlation between the vegetation coverage and the intensity of floods at the level of the river basin. The strategies proposed for the defence against the risk, or at least for the containment of any damage, must be activated with actions that are aimed at limiting the impact on river ecosystems as much as possible. The safeguarding of the specific biodiversity that occurs through the protection of the environment has a place of primary importance in the European environmental policies. Directive 92/43 EEC (Habitats Directive) and its annexes, as well as Directive 79/409/EEC (Birds Directive), enshrine the need to safeguard the individual biotic components through the protection of the natural and seminatural habitats through the setting up of Special Zones for Protection, for the protection of wild birds and their habitats, and of Special Zones for Conservation, for the maintenance or restoration of the natural and seminatural habitats or species. The application of these two Directives concerning the objectives of nature conservation in the different Italian regions has taken place through the Natura 2000 network.

Along the different sections of River Chienti, there are natural habitats of importance to the European Community, some of which are more frequent, while others appear sporadically and/or transiently, as they can be subjected to spatial and temporal modifications in relation to the particular dynamics of the environmental factors. For the conservation of these habitats, which are important not only for their biodiversity, but also to ensure that the functions of the river are performed correctly, it is fundamental to guarantee the maintenance of the appropriate conditions. The habitats that are present are: 3240 (Alpine rivers with riparian ligneous vegetation with *Salix eleagnos*); 3250 (Permanently flowing Mediterranean rivers with *Glacium flavum*); 3260 (Lowland/ plain and mountain rivers with vegetation of *Ranunculion fluitantis* and *Callitrico-Batrachion*); 3270 (Rivers with muddy banks with vegetation of *Chenopodion rubri* p.p. and *Bidention* p.p.); 92A0 (Gallery forests of *Salix alba* and *Populus alba*); and the priority habitat 91E0* (Alluvial forests of *Alnus glutinosa* and *Fraxinus excelsior*).

This diachronic analysis of the flora and vegetation that was carried along the middle-to-terminal sections of River Chienti has highlighted the changes that have occurred over 12 years through the comparison of the data collected in 1993 with those of 2005, defined for the same sites. The floristic analysis (Table 3) shows a drastic reduction in the 137 species that were found in the initial relevés, 95 of which were not found again in 2005 (corresponding to 69.34%). This decrease in the number of plant species, which in itself testifies to the extent of the significant loss of biodiversity, is also accompanied by a significant increase of 23 exotic species found in the surveys of 2005. Among these, for their significance as invasive species, there are: *Robinia pseudoacacia*, *Amorpha fruticosa*, *Arundo donax*, *Paspalum distichum* and *Cuscuta scandens* subsp. *cesatiana*. The other species that appeared in 2005 come instead from the surrounding cultivation, such as: *Helianthus annuus*, *Helianthus tuberosus*, *Brassica nigra*, *Rumex crispus* and *Tripleurospermum inodorum*.

Along with this floristic impoverishment, there are corresponding alterations in the structure and compo-

sition of the phytocoenoses that depend on the hydrophytic, helophytic and riparian vegetation. The analysis of the vegetation shows a reduction in the vegetal communities of both the river bed and the river banks, which were reduced from 15 (in 1993) to 10 (in 2005). The following associations were missing in 2005: *Zanichellietum palustris*, *Nasturtietum officinalis*, *Helosciadetum nodiflori*, *Bolboschoenetum maritimi, Glycerietum plicatae*, *Typhaetum latifoliae*, *Sparganietum erecti*, *Saponario-Artemisietum verlotorum*, *Ranunculetum repentis*, *Aro italici-Alnetum glutinosae* and *Salicetum incano-purpureae*. The vegetational types that have disappeared represent the classes *Potametea pectinati*, *Phragmito australis-Magnocaricetea elatae*, *Agrostietea stoloniferae*, *Alnetea glutinosae* and *Salicetea purpureae*. The class with the largest number of losses was *Phragmito australis-Magnocaricetea elatae*, while the phytocoenoses that appeared only in the 2005 relevés are represented by the groupings with *Arundo donax* and with *Cyperus glomeratus*, of the associations *Cyperetum longi* and *Cakiletum maritimae*.

Fig. 2 - Situation of the study area of River Chienti in 1993.

Fig. 3 - Situation of the study area of River Chienti in 2005.

Fig. 4 - Example for the fragmentation and degradation of the habitats of the vegetation of the river bed you can see the mosaic of species (are easily recognizable the genus *Thypha*, *Salix*, *Phragmites*, *Xanthium*, etc.) belonging to plant communities with very different ecology chaotically mixed.

It is possible to hypothesise that the changes that have affected the stretch of the river under investigation can be linked to the cleaning and mechanical reshaping processes that were carried out along the entire middle-to-terminal section of River Chienti that starting in 2001 (Fig. 2 and Fig. 3). In addition to the mechanical destruction of the vegetation of the river bed, these workings also led to the remodelling of the substrate, and the fragmentation and degradation of the habitats (Fig. 4). The straightening of the river course eliminates the lateral branches and the bends that the river course follows in periods with scarce water, and where the water moves with low energy.

The loss of the riparian forest vegetation might be related to the workings on the river that in some places also affected the river banks. However, it cannot be ruled out that the serious pollution of organohalogen compounds in the stretch of river under study might have had effects on the flora and vegetation.

Therefore, it can be said that in the river stretch that is the object of the present study, the anthropic processes of the routine and extraordinary maintenance have produced a simplification of the territory that is pertinent to the river environment. It is specifically the irregularity of the river bed that arises as a result of the natural morphological evolution of the river that creates such diverse habitats, which are an essential prerequisite for the maintenance of the biodiversity. Natural phenomena, such as major floods, can cause alterations to the communities. However, in the absence of anthropogenic disturbance, the biocoenoses are subjected to natural dynamism, which benefits from

the particular resilience of such aquatic habitats, as long as there is no alteration to their substrate and morphology. In the river segment under study, and across the time interval under consideration (12 years), this was not the case. This diachronic analysis of the flora and vegetation was designed to be used to monitor the effectiveness of the management actions, and it demonstrates the need for an approach that pays due attention to the habitats and the natural structure of the river. This shows the need for methods and plans that enable sustainable management of the environmental resources, to recover and maintain the specific and biocoenotic biodiversity. Only from the knowledge of the characteristics of the ecosystems and the vegetational types can we derive models for their correct environmental management. Accurate and continuous monitoring allows us to understand whether the forms of management that have been implemented are adequate for the maintenance and restoration of biodiversity.

In conclusion, this study of the vegetation has allowed an accurate analysis of the qualitative environmental characteristics of the rural landscape, which constitutes a large part of the hydrographic basin under study. It has also allowed an accurate analysis of the qualitative environmental characteristics that accurately describe the different habitats related to the ecology of the river. Investigation and monitoring studies that examine and quantify the environmental characteristics are essential, and not only for the river course, but also for the entire hydrographic basin and its ability to collect and convey water to the main river courses. These studies have allow us to understand the different units of the river landscape that represent models that are highly predictive, and that are necessary for the management of the water courses and the protection of their biodiversity (Biondi *et al*., 2007; Biondi & Morbidoni, 2010). It would therefore be desirable to apply a multidisciplinary approach that is based on the knowledge of the habitats and vegetation of the entire river course and its reference basin for the support of management and maintenance decisions.

Syntaxonomic scheme

POTAMETEA PECTINATI Klika in Klika & Novák 1941
POTAMETALIA PECTINATI Koch 1926
Zannichellion pedicellatae Schaminée, Lanjouw & Schipper 1990 *em*. Pott 1992
Zanichellietum palustris Lang 1967

BIDENTETEA TRIPARTITAE Tüxen, Lohmeyer & Preising ex Von Rochow 1951
BIDENTETALIA TRIPARTITAE Br.-Bl. & Tüxen ex Klika in Klika & Hadač 1944
Bidention tripartitae Nordhagen 1940
Polygono lapathifolii-Xanthietum italici Pirola & Rossetti 1974

PHRAGMITO AUSTRALIS-MAGNOCARICETEA ELATAE Klika in Klika & Novák 1941
PHRAGMITETALIA AUSTRALIS Koch 1926
Phragmition communis Koch 1926
Phragmitetum australis Savič 1926
NASTURTIO OFFICINALIS-GLYCERIETALIA FLUITANTIS Pignatti 1953
Apion nodiflori Segal in Westhoff & Den Held 1969
Nasturtietum officinalis Seibert 1962
Glycerio fluitantis-Sparganion neglecti Br.-Bl. & Sissingh in Boer 1942
Sparganietum erecti Roll. 1938
Helosciadetum nodiflori Br.-Bl. 1952
Bolboschoenetum maritimi Eggler 1933
Glycerietum plicate Kulcz. 1928 *em*. Oberd. 1954
MAGNOCARICETALIA ELATAE Pignatti 1953
Magnocaricion elatae Koch 1926
Typho angustifoliae-Schoenoplectetum tabernaemontani Br.-Bl. & Bolós 1957
Typhaetum latifoliae Lang 1973
Cyperetum longi Micevski 1957
Cyperus glomeratus community

CAKILETEA MARITIMAE Tüxen & Preising ex Br.-Bl. & Tüxen 1952

EUPHORBIETALIA PEPLIS Tüxen 1950
Euphorbion peplis Tüxen 1950
Salsolo Kali-Cakiletum maritimae Costa e Mansanet 1981

ARTEMISIETEA VULGARIS Lohmeyer, Preising & Tüxen ex Von Rochow 1951
ARCTIO LAPPAE-ARTEMISIETALIA VULGARIS Dengler 2002
Arction lappae Tüxen 1937
Saponario-Artemisietum verlotorum Baldoni e Biondi 1993
Arundo donax community

AGROSTIETEA STOLONIFERAE Oberdorfer 1983
POTENTILLO ANSERINAE-POLYGONETALIA AVICULARIS Tüxen 1947
Mentho longifoliae-Juncion inflexi Müller & Görs ex De Foucault 2008
Ranunculetum repentis Knapp 1947

ALNETEA GLUTINOSAE Br.-Bl. & Tüxen ex Westhoff, Dijk & Passchier 1946
SALICETALIA AURITAE Doing ex Westhoff in Westhoff & Den Held 1969
Salicion cinereae Müller & Görs 1958
Aro italici-Alnetum glutinosae Gafta & Pedrotti1995

SALICETEA PURPUREAE Moor 1958
SALICETALIA PURPUREAE Moor 1958
Salicion albae Soó 1930
Rubo ulmifolii-Salicetum albae Allegrezza, Biondi & Felici 2006
Salicetum incano-purpureae Sillinger 1993

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References

Allegrezza M., Biondi E. & Felici S., 2006. A phytosociological analysis of the vegetation of the central Adriatic sector of the Italian peninsula. Hacquetia 5/2: 135-175.

Assini S., 1997. La vegetazione di greto del Po in relazione al substrato. Arch. Geob. 3(1): 41-50

Banfi E. & Galasso G. (eds.), 2010. La flora esotica lombarda. Museo di Storia Naturale di Milano, Milano.

Baldoni M. & Biondi E., 1993. La vegetazione del medio e basso corso del fiume Esino (Marche-Italia centrale). Stud. Bot. 11: 209-257.

Biondi E., 1986. La vegetazione del Monte Conero (con carta della vegetazione alla scala 1:10.000). Regione Marche, pp: 1-95. Ancona.

Biondi E., 2011. Phytosociology today: Methodological and conceptual evolution. Plant Biosystems 145, Supplement, September 2011: 19–29.

Biondi E. & Allegrezza M., 2004. L'ambiente della Selva di Gallignano.Secondo volume de " I Quaderni Della Selva.

Biondi E. & Baldoni M., 1993 (1994). La vegetazione del fiume Marecchia (Italia Centrale). Lavori della Società Italiana di Biogeografia N.S. vol. 17: 51-87.

Biondi E., Blasi C., Allegrezza M., Anzellotti I., Azzella M.M., Carli E., Casavecchia S., Copiz R., Del Vico E., Facioni L., Galdenzi D., Gasparri R., Lasen C., Pesaresi S., Poldini L., Sburlino G., Taffetani F., Vagge I., Zitti S. & Zivkovic L., 2014. Plant communities of Italy: The Vegetation Prodrome. Plant Biosystem 148 (4): 728-814. Biondi E., Brugiapaglia E., Allegrezza M. & Ballelli S., 1992. La vegetazione del litorale marchigiano (Adriatico centro-settentrionale). Coll. Phytosoc. XIX: 429-460.

Biondi E., Casavecchia S. & Radetic Z., 2002. La vegetazione dei «guazzi» e il paesaggio vegetale della pianura alluvionale del tratto terminale del Fiume Musone (Italia Centrale).Fitosociologia 39 (1): 45-70.

Biondi E., Casavecchia S., Paradisi L. & Pesaresi S., 2007. La vegetazione del medio e basso corso del Metauro. In: Poggiani L.; Dionisi V.; Gubellini L. (eds.): Boschi di fiume - Ambiente, flora e fauna dei boschi ripariali del Metauro: 25-41.

Biondi E., Catorci A., Pandolfi M., Casavecchia S., Pesaresi A., Galassi S., Pinzi M., S., Vitanzi, Angelini E., Bianchelli M., Cesaretti S., Foglia M., Gatti R.,

Morelli F., Paradisi L., Ventrone F. & Zabaglia C., 2007. Il Progetto di "Rete Ecologica della Regione Marche" (REM): per il monitoraggio e la gestione dei siti Natura 2000 e l'organizzazione in rete delle aree di maggiore naturalità. Fitosociologia 44 (2) Suppl. 1: 89-93.

Biondi E., Gubellini L., Pinzi M. & Casavecchia S., 2012. The vascular flora of Conero Regional Nature Park (Marche, Central Italy). Fl. Medit. 22: 67-167 doi: 10.7320/flmedit22.067.

Biondi E., Vagge I., Baldoni M. & Taffetani F., 1997. La vegetazione del Parco Fluviale regionale del Taro (Emilia Romagna). Fitosociologia 34: 69-110.

Biondi E., Vagge I., Baldoni M. & Taffetani F., 1999. La vegetazione del Parco Fluviale Regionale dello Stirone. Fitosociologia 36 (1): 67-96.

Biondi E., Vagge I., Baldoni M. & Taffetani F., 2004. Biodiversità fitocenotica paesaggistica dei fiumi dell'italia centro settentrionale: aspetti fitosociologici e sinfitosociologici. Studi Trent. Sci. Nat. Acta. Biol. 80: 13-21.

Biondi E. & Morbidoni M., 2010. Biodiversità nelle Marche. I Quaderni della Selva, III: 1-165. Errebi Grafiche Ripesi, Falconara Marittima (AN).

Biondi E., Zivkovic L., Esposito L. & Pesaresi S., 2009. Vegetation, plant landscape and analysis of a fluvial ecosystem in central Italy. Acta Botanica Gallica 156 (4): 571-587.

Blasi C., Di Pietro R., Fortini P. & Presti G., 2001. Aggiornamento alla lista dei syntaxa segnalati per la regione lazio. Fitosociologia 38 (2) suppl. 1: 121-136.

Braun-Blanquet J., 1928. Pflanzensoziologie. Springer, Berlin.

Braun-Blanquet J. 1964. Pflanzensoziologie – Grundzüge der Vegetationskunde, 3rd ed. Springer, Wien.

Brullo S., Giusto Del Galdo G. P., Siracusa G. & Spampinato G., 2001. Considerazioni fitogeografiche sulla vegetazione psammofila dei litorali italiani. Biogeographia 22: 93-137.

Brullo S. & Sciandrello S., 2006. La vegetazione del bacino lacustre "Biviere di Gela" (Sicilia meridionale). Fitosociologia 43 (2): 21-40.

Canullo R., Pedrotti F. & Venanzoni R., 1988. I prati umidi ed inondati dell'alto Trigno (Molise, Italia). Doc. Phytosoc. 11: 583-606.

Centamore E. & Deiana G., 1986. Studi Geologici Camerti. La Geologia delle Marche numero speciale in occasione del 73. Congresso della società geologica italiana. Roma.

Ceschin S. & Salerno G., 2008. La vegetazione del basso corso del Fiume Tevere e dei suoi affluenti (Lazio, Italia). Fitosociologia 45 (1): 39-74.

Corbetta F. & Pirone G., 1989. La vegetazione del fiume Tirino (Abruzzo). Arch. Bot. Ital. 65 (3/4): 121-153.

Conti F., Abbate G., Alessandrini A. & Blasi C. (Eds.), 2005. An annotated checklist of the italian vascular flora. Palombi Editori, Roma

Conti F., Alessandrini A., Bacchetta G., Banfi E., Barberis G., Bartolucci F., Bernardo L., Bonacquisti S., Bouvet D., Bovio M., Brusa G., Del Guacchio E., Foggi B., Frattini S., Galasso G., Gallo L., Gangale C., Gottschlich G., Grünanger P., Gubellini L., Iiriti G., Lucarini D., Marchetti D., Moraldo B., Peruzzi L., Poldini L., Prosser F., Raffaelli M., Santangelo A., Scassellati E., Scortegagna S., Selvi F., Soldano A., Tinti D., Ubaldi D., Uzunov D. & Vidali M., 2007. Integrazioni alla Checklist della flora vascolare italiana. Natura Vicentina 10: 5-74.

Dramis F. & Bisci C., 1986. Aspetti geomorfologici del territorio marchigiano. Studi Geologici Camerti, vol. Speciale " La geologia delle Marche". Italia.

Gigante D., Landucci F. & Venanzoni R., 2013. The reed die-back syndrome and its implications for floristic and vegetationaltraits of Phragmitetum australis. Plant Sociology 50 (1): 3-16.

Gubellini L. & Pinzi M., 2010. Flora vascolare alloctona e invasiva delle regioni d'Italia Marche. In: Celesti-Grapow L., Pretto F., Carli E. & Blasi C. (Eds.), Flora vascolare alloctona e invasiva delle regioni d'Italia. Casa Editrice Università La Sapienza, Roma: 89-94.

Guinochet M., 1973. Phytosociologie. Masson, Paris, 227 p.

Lastrucci L., Landucci F., Gonnelli V., Barocco R., Foggi B & Vananzoni R., 1012. The vegetation of the upper and middle River Tiber (Central Italy). Plant Sociology 49 (2): 29-48.

Lastrucci L., Paci F. & Raffaelli M., 2010. The wetland vegetation of the Natural Reserves and neighbouring stretches of the Arno riverin the Arezzo province (Tuscany, Central Italy). Fitosociologia 47 (1): 31-61.

Merloni N. & Piccoli F., 2001. La vegetazione del complesso Punte Alberete e Valle Mandriole (Parco Regionale del Delta del Po - Italia). Braun-Blanquetia 29: 1-17.

Mereu L., Lastrucci L. & Viciani D., 2011. Contributo alla conoscenza della vegetazione del fiume Pesa (Toscana, Italia Centrale). Stud. Bot. 29: 105-143.

Meriaux J.L., 1981a. La classe des Phragmitetea dans le nord-ouest de la France. Coll. Phytosoc. 10: 139-146.

Meriaux J.L., 1981b. La classe des Potametea dans le nord-ouest de la France. Coll. Phytosoc. 10: 115-129.

Mucina L., 1993. Nomenklatorische und syntaxonomische definitionen, konzepte und methoden. In Mucina L., Grabherr G. & Ellmauer T. (Eds.). Die Pflanzengesellschaften Österreichs, 1, Anthropogene Vegetation: 19-28. G. Fischer, Jena

Oberdorfer, E. 1979. Suddeutsche Pflanzengesel-

lschaften. 3.,2. Aufl. S.: 15-47. Stuttgart, New York.
Oberdorfer E., 1983. Pflanzensoziologische Exkursions Flora.Ulmer, Stuttgart.
Orsomando E. & Catorci A., 1991. Carta della vegetazione del comprensorio Trasimeno. Ed. Grafica L'Etruria, Cortona (Ar)
Passarge H., 1996. Pfanzengesellschaften Nordostdeutschlands. I. Hydro- und Therophytosa. J. Cramer, Berlin – Stuttgart.
Pedrotti F. 1967. Carta fitosociologica (1:3.000) della vegetazione dei piani di Montelago (Camerino). Not. Fitosoc. 4: 1-8.
Pedrotti F., 2008. La vegetazione delle Marcite di Norcia. Braun-Blanquetia: 3-21.
Pedrotti F. & Gafta D., 1996. Ecologia delle foreste ripariali e paludose dell'italia. L'uomo e l'ambiente 23: 1-165.
Pedrotti F., Gafta D., Manzi A. & Canullo R., 1992. Le associazioni vegetali della Piana di Pescasseroli (ParcoNazionale d'Abruzzo). Doc. Phytosoc. 14: 123-147.
Pedrotti F. & Taffetani F., 1982. La végétation des sources de Pontile et Fiuminata. Guide Itinérarie. Excursion internationale de Phytosociologie en Italie centrale (2-11 juillet 1982): 237-241.
Pignatti S., 1982. Flora d'Italia. 3 voll., Edagricole, Bologna.
Pirola A., 1970. Elementi di fitosociologia. Coop. libr. Univ., Bologna.
Pirola A. & Rossetti A., 1974. Polygono-Xanthietum italici ass. Nova, vegetazione di greto delcorso medio del Reno (Bologna). Not. Fitosoc. 8: 15-27.
Pirone G., 1981. Osservazioni preliminari sulla vegetazione legnosa ripariale del fiume Pescara (Abruzzo). Not. Fitosoc. 17: 45-54.
Pirone G., 2000. La vegetazione ripariale nei versanti nord-oriantali del Gran Sasso d'Italia e dei Monti della Laga (Abruzzo, Italia). Fitosociologia 37 (2): 65-86.
Pirone G., Ciaschetti G., Frattaroli A.R & Corbetta F., 2003. La vegetazione della Riserva Naturale Regionale "Lago di Serranella" (Abruzzo – Italia.Fitosociologia 40 (2): 55-71.
Pirone G. & Frattaroli A.R., 1998. Compendio sulle conoscenze della vegetazione delle zone umide dulciacquicole in Abruzzo. Atti Sem. Le Nuove Sorgenti (Pescasseroli 29-30/3/1996). Collana Studi per la Conservazione della Natura del Parco Nazionale d'Abruzzo, Pro Natura Abruzzo - Parco Nazionale d'Abruzzo 27: 37-Roma
Rivas-Martínez S., 1982. Vegetatio matritensis, I. Datos sobre la vegetacion flotante dulceacuicola de la clase Lemnetea minoris. Lazaroa 4: 149-154.
Rivas-Martínez S., Sánchez-Mata D. & Costa M., 1999. North American boreal and western temperate forest vegetation Syntaxonomical synopsis of the potential natural plant communities of North America, II). Itinera Geobotanica 12: 5-316.
Rivas-Martínez S., Fernandez-Gonzalez F., Loidi F., Lousa M. & Penas A., 2001. Syntaxonomical Checklist of Vascular Plant Communities of Spain and Portugal to association level. Itinera Geobotanica 14: 5-341.
Rivas-Martínez S., Díaz T.E., Fernández-González F., Izco J., Loidi J., Lousã M. & Penas A., 2002. Vascular plant communitiea of Spain and Portugal. Addenda to the syntaxonomical checklist of 2001. Itinera Geobotanica 15: 5-922.
Sburlino G., Tomasella M., Oriolo G. & Poldini L., 2004. La vegetazione acquatica e palustre dell'italia nord-orientale. Fitosociologia 41 (1): 27-42.
Scoppola A., 1981. Synthèse des Lemnetea minoris en Europe. Coll. Phytosoc 10: 513-520.
Turrisi R.E., 2005. Inquadramento fitosociologico dei popolamenti di Ipomoea imperati (Convolvulaceae) della Sicilia . Quad. Bot. Amb. Appl. 16: 87-92.
Tutin T.G., Heywood V.H., Burge R.H.A., Valentine D.H., Walters S.M., Webb D.A., (Eds.), 1968 - 1980. Flora europaea. 1- 5. Cambridge University Press.
Tüxen R., 1978. Assoziationscomplexe (Sigmetum). Ber. Intern. Symposium., 1977, in Rinteln.
Tüxen R., 1979. Pflanzengesellschaften nordwestdeutschlands. 2 aufl. J. Cramer, vaduz.
Venanzoni R., Apruzzese A., Gigante D., Suanno G., Vale F., 2003. Contributo alla conoscenza della vegetazione acquatica e igrofitica dei Laghi di Monticchio. Inf. Bot. Ital. 35(1): 69-80.
Venanzoni R. & Gigante D., 2000. Contributo alla conoscenza della vegetazione degli ambienti umidi dell'Umbria (Italia). Fitosociologia 37 (2): 13-64.

Appendix: Relevès dates and localities

Tab. 3: rel. 1, near the mouth, 18.06.1993.
Tab. 4: rels. 1 - 4, near the mouth, right side, 18.06.1993; rel. 5, dry river bed between branch and main course, near the mouth, 26.07.2005; rel. 6, silty river bed, near the mouth on the right side 26.07.2005.
Tab. 5: rels. 1, 2 , 3, near the mouth, 18.06.1993; rel. 4, near the mouth on the right side, 26.07.2005.
Tab. 6: rel. 1, near the mouth, 18.06.1993.
Tab. 7: rel. 1, near the bridge, between Montecosaro and Casette d'Ete, 18.06.1993.
Tab. 8: rels. 1-2, rel. n 1 -2, near the mouth, 18.06.1993.
Tab. 9: rel. 1, near the mouth, 18.06.1993.
Tab. 10: rels. 1- 2, near the mouth, 18.06.1993.
Tab. 11: rel. 1, near the mouth, downstream from the bridge on the railway, 18.06.1993; rel. 2, in a lateral canal, near the mouth, 18.06.1993; rel. 3, dry river bed, near the mouth, downstream from the bridge on the railway, 26.07.2005.
Tab. 12: rel. 1, near the mouth, 18.06.1993.

Tab. 13: rel. 1, right bank, silty margin, terrace raised above the water level, 26.07.2005.
Tab. 14: rels. 1 - 2 , right bank, silty margin, 26.07.2005.
Tab. 15: rel. 1, vegetation on the dune belt that separates the mouth from the sea, 26.07.2005.
Tab. 16: rels. 1,2,3,6, river terraces, near the mouth 18.06.1993; rel. 4, junction for Montecosaro 18.06.1993; rel.5, Casette d'Ete, 18.06.1993.
Tab. 17: rel. 1, left bank, terrace raised above the water level, 07.09.2005.
Tab. 18: rel. 1, near the mouth, 18.06.1993.
Tab. 19: rel. 1, left bank, near old quarry, bridge of Monte San Giusto, 31.08.1993.
Tab. 20: rel. 1, about 1 kilometer from the mouth between the first and the second bridge, right bank, 18.06.1993; rel. 2, about 1 kilometer from the mouth between the first and the second bridge, right bank, 26.07.2005.
Tab. 21: rel. 1, Casette d'Ete, junction for Montecosaro, 18.06.1993.