

Synecology of *Cutandia maritima* (L.) Barbey, a rare psammophytic species along the Montenegrin Coast (East Adriatic Coast)

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Key words: *Cutandia maritima*, Velika plaža in Ulcinj, sand dunes, vegetation.

Ključne besede: *Cutandia maritima*, Velika plaža pri Ulcinju, peščene sipine, vegetacija.

Abstract

Cutandia maritima is a circum-Mediterranean species that inhabits sandy dunes along the coast line. It is fairly frequent on the western Adriatic coast but fairly rare and possibly even non-native in the east. In Croatia, it was discovered in 1990 in Crnika Bay on the island of Rab, which was considered until 2005 to be the only site on the eastern Adriatic coast from the Gulf of Trieste in the north to Corfu in the south. In 2009, the species was briefly reported for Velika plaža (Long Beach) in Ulcinj (Montenegro) but without details about the habitat type and synecology. The aim of this paper is thus to provide a deeper insight into the ecology and synecology of *C. maritima* in the eastern Adriatic part of the distribution area. On Velika plaža in Ulcinj, the species was found along the whole sea-inland gradient of sand dunes, in various types of vegetation: [1210] – annual vegetation of drift lines, [2110] – embryonic shifting dunes, [2120] – shifting dunes with *Ammophila arenaria* (white dunes), [2220] – dunes with *Euphorbia terracina*, [2130*] – fixed coastal dunes with herbaceous vegetation (grey dunes), and also [2190] – humid dune slacks.

Izvleček

Cutandia maritima je vrsta, ki uspeva na peščenih sipinah ob morskih obalah ob celotnem Mediteranu. Ob zahodnih obalah je precej pogosta, medtem ko je na vzhodu redka ali celo tujerodna. Na Hrvaškem so jo odkrili leta 1990 v zalivu Crnika na otoku Rabu in to je bilo do leta 2005 edino nahajališče na vzhodni Jadranski obali med Tržaškim zalivom na severu in otokom Krfo na jugu. O najdbi vrste na Veliki plaži pri Ulcinju so na kratko poročali leta 2009, a brez podrobnosti o njenem rastišču in sinekologiji. V članku podajamo natančnejši vpogled v ekologijo in sinekologijo vrste *C. maritima* ob vzhodni Jadranski obali. Na Veliki plaži vrsta uspeva na peščenih sipinah na celotnem gradientu od morja v notranjost in v različnih vegetacijskih tipih: [1210] – Združbe enoletnic na obalnem drobirju, [2110] – Embrionalne premične sipine, [2120] – Premične sipine vzdolž obrežij z vrsto *Ammophila arenaria* (bele dine), [2220] – Sipine z vrsto *Euphorbia terracina*, [2130*] – Utrjene obalne sipine z zeliščno vegetacijo (sive dine), in [2190] – Vlažne uleknine na sipinah.

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Introduction

Although *Cutandia maritima* (L.) Barbey is considered to be a common species on sandy dunes along the Mediterranean coast (van der Maarel & van der Maarel-Versluys 1996), its record in Montenegro (Velika plaža in Ulcinj) dates from 2005 (N. Jogan, unpublished); it was published in 2009 (Glasnović et al. 2009). It appears frequently on the western Adriatic coast (reported for all countries east of Italy (Pignatti 1982), while along the eastern coast it is fairly rare (Trinajstić 1994) and may even have been recently introduced (Horvat 1939). It is considered to be a focal species of 2230 EU habitat – *Malcolmietalia* dune grasslands (Stanisci et al. 2014) and occurs in various plant communities of the *Ammophiletea*, *Cisto-Micromerietea* and *Helminthemetea* classes (Goday & Martínez 1958, Bolos 1996, Costa et al. 2000, Šykora et al. 2003, Zimmitti et al. 2015 etc.). It is a characteristic species of sabulicolous therophytic plant communities, which Rivas-Martínez et al. (2002) described as the *Cutandietalia maritimae* order within the class *Tuberarietaria guttatae* (syn. *Helianthemetea guttati*). This order comprises ephemeral vegetation growing on coastal sands and dunes with salt spray, as a therophytic vegetation type among the perennial vegetation of *Ammophiletea*, and it is distributed over the whole Mediterranean (Díez-Garretas et al. 2003). *C. maritima* is recorded in ca. 30 ephemeral plant communities that inhabit coastal sands and sand dunes with salt spray, among perennial vegetation of *Ammophiletea*, *Crucianelletea* and sometimes also *Quercetia ilicis* (Díez-Garretas et al. 2003, Minissale & Sciandrello 2015). It appears as a dominant species in 7 associations and sub-associations: *Vulpielo tenuis-Cutandietum maritimae* (Rivas-Martínez et al. 2002), *Cutandio maritimae-Parapholidetum marginatae* (Bartolo et al. 1988), *Sileno sericeae-Cutandietum maritimae* (Géhu & Biondi 1994), *Sileno nicaensis-Cutandietum maritimae* (Géhu & Biondi 1994), *Matthiolo tricuspadatae-Cutandietum maritimae* (Géhu et al. 1987), *Sileno succulentae-Cutandietum maritimae* (Géhu & Géhu-Franck 1986), *Sileno ononidetum variegatae* subass. *Cutandietosum maritimae* (Minissale & Sciandrello 2015), mainly distributed in the western part of the Mediterranean.

Sabulicolous therophytic plant communities in the Mediterranean are also classified into the order *Malcolmietalia*. Both orders are mainly dominated by annual plants with a short lifecycle growing on non-nitrified deep sandy soils. The optimum of *Malcolmietalia* communities is siliceous sands or paleodunes in the western Mediterranean, where they are a subseral stage of *Quercus suber* forests or *Juniperus navicularis* and *J. broussonetii* open woodlands. They are assumed to be indicators of conti-

mentality, whereas those of *Cutandietalia* are indicators of less expressed climatic conditions. Good correspondence is also shown along the altitudinal gradient and distance from the sea (Minissale & Sciandrello 2015). In the eastern Mediterranean, *C. maritima* is characteristic of the central fore-dune ridge (Doing 1985).

In other parts of the Mediterranean, the species *C. maritima* occurs rarely in *Cakiletea* plant communities (frequency class lower than II), while it is more frequent (frequency class IV) in plant communities of *Ammophiletea* and has the status of differential species (e.g. *Limonio graeci-Triplachnetum nitentis centaureetosum aegialophilae* Mayer 1995) (Brullo & Furnari 1970, Brullo et al. 1974, Perdigó & Papió 1985, Šykora et al. 2003 etc.). It is also a companion species of chamaephytic and hemicryptophytic *Crucianelletea maritimae* plant communities (e.g. *Centaureo-Oninidetum ramosissimae*) usually confined to dunes further inland with little movement (Zimmitti et al. 2015), as well as *Malcolmietalia* Rivas Goday 1958 communities (e.g. *Violo henriquesii-Silenetum littoreae* Izco & Guitian 1988; Costa et al. 2000).

In previous studies of sand dune vegetation of Velika plaža in Ulcinj, only communities of *Cakiletea maritimae* and *Ammophiletea* were mentioned (Trinajstić 1989, Mijović 1994, Mijović et al. 2006, 2012, Šilc et al. 2015), while sabulicolous therophytic communities were not taken into account. The aim of this paper is to provide a deeper insight into the ecology and synecology of the species *C. maritima* in Montenegro and to initiate more detailed investigation of annual sand dune vegetation on Velika plaža.

Materials and methods

Study area

Velika plaža in Ulcinj (Velika plaža, Montenegro) is considered to be the longest beach on the eastern Adriatic coast (ca. 12km), with still well preserved sand dune vegetation. Since 1968, the beach has been recognized as a monument of nature (Official Gazette of the Social Republic of Montenegro, SRG 30/68). According to the Spatial Plan of Special Purpose for the Coastal Zone, one spatial unit on the east side of Velika plaža is recognized as a new protected nature reserve, with forests, marshes and meadows. The area is protected from trampling or grazing with a wooden fence (JPMD 2015, Šilc et al. 2017). However, the rest of the beach, which represents more than 75 % of natural coast and 97 % of whole sand dune system, is heavily impacted by tourism, illegal dumping, sand exploitation and urbanization (Petrović

& Karaman 2009). Eleven NATURA 2000 habitats are reported for the beach and its hinterland (Petrović et al. 2012) and the site is included in the list of IPA areas (Petrović & Karaman 2009).

Data collection and analysis

During 2015, the floristic composition and zonation of plant communities on Velika plaža in Ulcinj were studied. Twenty transects were set perpendicular to the coast, at a distance from each other of cca. 500 m. Contiguous quadrats (2 × 2 m) were laid out in the form of a belt transect (Kent 2012), starting from the area with the first colonizing plants towards the end of the sand dune system up to forest vegetation. In each quadrat, the cover of plant species was visually estimated by the Braun-Blanquet (1964) scale. Plants were determined following Pignatti (1982) and Tutin et al. (1964–80). All gathered relevés were entered into the TURBOVEG (Hennekens & Schaminée 2001) database.

Multivariate analysis (Ward method and Euclidean distance) of the plots was performed in PC-ORD (McCune & Grace 2002) to recognize plant communities on sand dunes. Clusters were identified by their diagnostic species, using the JUICE program (Tichý 2002). Three species with the highest fidelity were selected for each cluster. Relevés with *C. maritima* were selected, presented in a single table (Table 1) and classified into different clusters.

Detrended Correspondence Analysis (DCA) ordination was used to visualize the floristic similarity of plots. Species cover values (mean percentage values) were square-root transformed. DCA was done in CANOCO 5 program (ter Braak & Šmilauer 2012).

The nomenclature of taxa is according to Tutin et al. (1964–80).

Results

Within the part of the study concerning the floristic composition and zonation of plant communities on Velika plaža in Ulcinj, 20 transects were set perpendicularly from the sea towards inland and 876 relèves were done. In further analysis, they were classified into 9 clusters corresponding to 9 plant communities (*Cakilo-Xanthietum italici*, *Cynodon dactylon* comm., *Euphorbio paraliae-Agrophyretum junceiformis*, *Medicagini marinae-Ammophiletum australis*, *Onobrychis caput-galli* comm., *Cladietum marisci*, *Eriantho-Schoenetum nigricantis*, *Juncetum maritimo-acuti*, *Holoschoenetum romani*) or to 7 NATURA 2000 habitats (Figure 1). The species *C. maritima* was

recorded in 4 transects and 33 quadrats (Table 1), distributed in a bandwidth from ca. 80 m from the sea to 150 m inland. Its cover value is lower (r, + and 1) in mobile parts of dunes and higher (1) in more stabilized parts of dunes covered with *Onobrychis caput-galli* comm. and *Holoschoenetum romani* (Figure 1).

During the floristic survey along Velika plaža in Ulcinj, *C. maritima* was fairly frequently recorded along almost the whole gradient of sand dune vegetation, although never in great abundance. It starts to appear either in the zone of annual vegetation of drift lines (EU habitat 1210) or in the transitional zone among annual vegetation of drift line sand embryonic shifting dunes (EU habitat 2110), which is characterised by intensive impact of wind and salt spray and fairly low vegetation cover. It also penetrates deeper into the vegetation of shifting dunes with *Ammophila arenaria* (white dunes, EU habitat 2120), dunes with *Euphorbia terracina* (EU habitat 2220), fixed coastal dunes with herbaceous vegetation (grey dunes, EU habitat 2130*) and humid dune slacks (EU habitat 2190).

Discussion

The first record of *C. maritima* in Montenegro dates back to 2005 (N. Jogan unpublished) and it was later published in Glasović et al. (2009) since it had not been mentioned in previous (Trinajstić 1989, Mijović 1994, Mijović et al. 2006) and recent (Mijović et al. 2012) vegetation studies of the dune vegetation of Velika plaža. In neighbouring Croatia, the species was also discovered fairly late, in 1990 in Crnika Bay on the island of Rab, so up to 2005 it was considered to be the only site on the eastern Adriatic coast from the Gulf of Trieste in the north to Corfu in the south. Its late record was probably explained by misidentification and confusion with robust individuals of *Scleropoa rigida* (Trinajstić 1997), although a well conducted study of psammophytic vegetation of Rab island from the 1930s (Horvat 1939) explicitly rejected the presence of the mentioned species, despite the fact that it could be expected in that type of vegetation. In the case of Montenegro, it is important to note that the species has not been found in Albanian coastal dunes, which are a natural prolongation of Velika plaža (Fanelli et al. 2015). It is thus possible that the species has colonized Velika plaža recently, as a result of touristic impact. On the other hand, scattered localities may be the result of quite old introduction, or even natural occurrence, which cannot be completely excluded, especially since the whole lowland Montenegro has been much less explored than the mountainous inland.

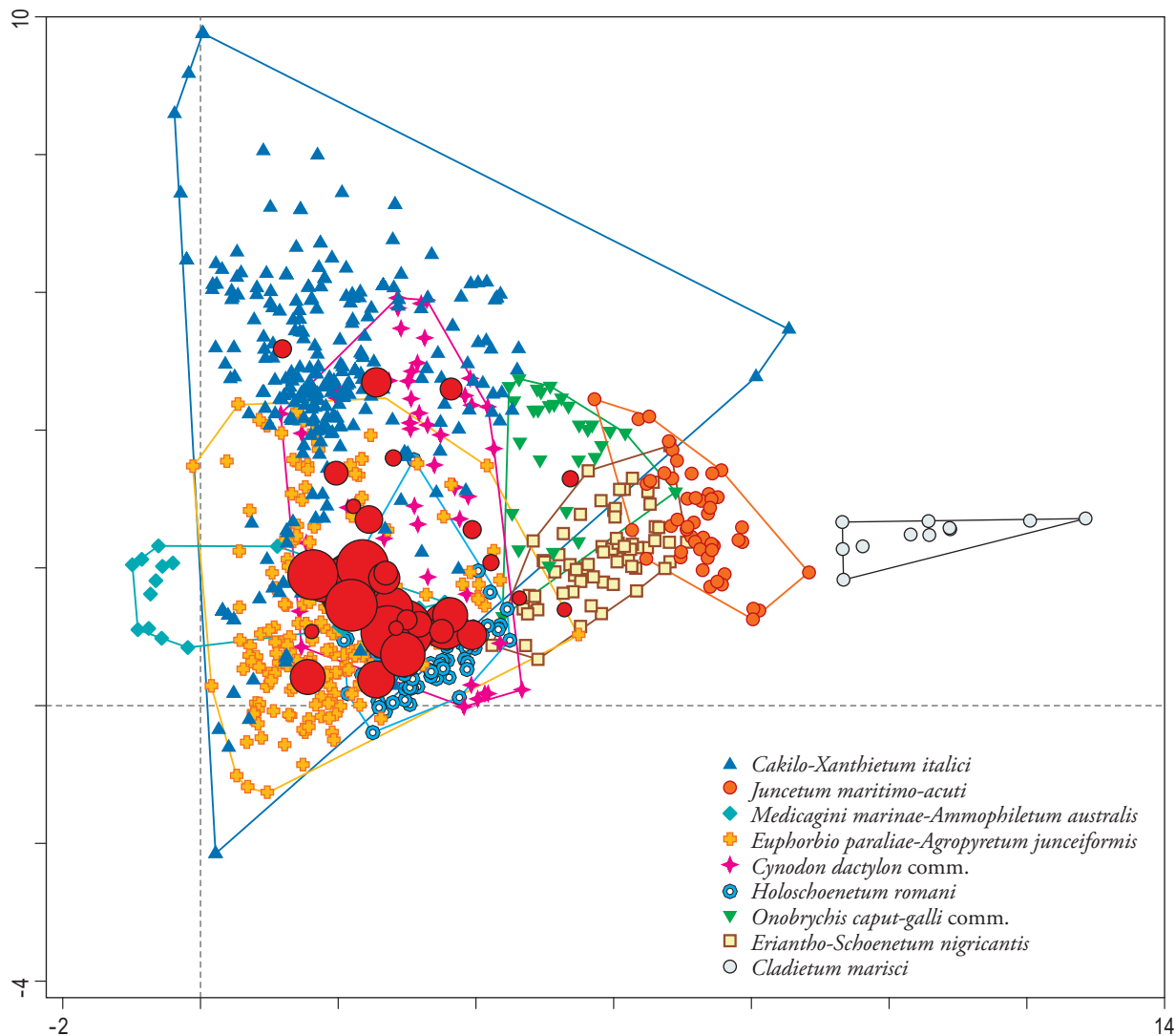


Figure 1: Detrended Correspondence Analysis (DCA) ordination of relevés from 20 transects classified into 9 plant communities (clusters). Size of red circles indicates cover value of *Cutandia maritima*.

Slika 1: DCA ordinacija popisov iz 20 transektov klasificiranih v 9 rastlinkih združb (klastrov). Velikost rdečih krogov nakazuje pokrovnost vrste *Cutandia maritima*.

C. maritima is known to be capable of tolerating exposure to intense sea winds and continual movement of sand grains of embryonic dunes facing seawards (Minisale & Sciandrello 2015). This explains its high frequency within the habitat types: annual vegetation of drift lines (*Cakilo-Xanthietum italici* (Beg. 1941) Pign. 1953) and embryonic dunes (*Echinophoro spinosae-Elymetum farcti* Géhu 1988) (Figure 1). It can thus be considered to be one the first pioneer species or colonizer of dunes.

Although the species was recorded in only 4 transects located in the western part of the beach, it is sparsely distributed over almost the entire beach. It should be noted that the 2 m wide transects were set systematically

at a distance of 500 m, so some occurrences may have been overlooked. Furthermore, the cover of *C. maritima* never exceeded the value 1.

As shown in Table 1, *C. maritima* frequently occurs in the studied area in annual grasslands with *Vulpia fasciculata*, *Lagurus ovatus* and *Onobrychis caput-galli*. This vegetation type has not been studied in detail on Velika plaža in Ulcinj. To date, only plant communities of *Cakiletea* and *Ammophiletea* have been reported for the dune area. *C. maritima* vegetation with the mentioned species can certainly not be classified into *Ammophilletea*. In the researched transects and numerical classification, we could not separate communities of *Malcolmietalia*

and *Crucinelletalia* orders. More detailed investigations are needed to complete knowledge about the synecology of this species, as well as sabulicolous therophytic plant communities on Velika plaža in Ulcinj.

Conclusion

In previous studies of the sand dune vegetation of Velika plaža in Ulcinj, only communities of *Cakiletea maritima* and *Ammophiletea* have so far been recognized, while sabulicolous therophytic communities have certainly not been taken into account. After the record of *C. maritima* on Velika plaža in Ulcinj, and some ecological and synecological notes on the species, communities of *Cutandieta-lia maritimi* might obviously also be present in Montenegro. However, more detailed phytocoenological research is needed.

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Table 1: *Cutandia maritima* in the vegetation of Velika plaža (Montenegro).

Tabela 1: Vrsta *Cutandia maritima* v rastlinskih združbah na Veliki plaži (Črna Gora).

Table number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33		
Cover herb layer (%)	1	1	2	6	12	35	45	1	3	25	25	35	35	45	50	40	15	60	65	85	95	80	75	70	75	75	70	70	70	70	60	50	40		
Distance from the sea (m)	100	102	110	104	106	108	110	104	106	134	136	138	108	110	112	114	82	112	114	116	118	120	122	124	126	128	130	132	134	136	138	146	148		
Habitat type	1210															2110	2130*																		
<i>Cutandia maritima</i>	r	r	r	+	1	1	1	+	+	+	+	+	+	+	+	1	1	1	1	1	1	1	+	1	1	1	+	+	+	+	+	+	+		
<i>Cakiletea maritimae</i>																																			
<i>Xanthium italicum</i>	.	.	.	+	1	1	.	+	.	2	1	1	.	.	.	.	1	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Salsola kali</i>	.	.	r	.	.	.	.	.	r	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Ammophiletea</i>																																			
<i>Cyperus capitatus</i>	.	.	.	.	.	.	.	.	.	+	1	1	.	+	1	+	2	2	2	3	3	2	2	2	1	1	2	2	2	1	1	.	.	
<i>Echinophora spinosa</i>	.	.	.	+	2	2	2	.	+	+	r	r	+	+	1	1	+	+	1	1	+	2	1	1	.	.	.	.	.	.	.	.	.
<i>Euphorbia terracina</i>	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	+	2	2	2	2	2	2	2	1	2	2	1	2	2	3		
<i>Alkanna tinctoria</i>	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	1	+	.	1	+	+	+	+	1	+	2	2	.	+		
<i>Medicago marina</i>	.	.	.	.	.	.	.	+	1	.	.	.	+	+	.	.	.	.	.	.	1	1	.	2	+	.	.	1	1	1	.	.		
<i>Pancreatum maritimum</i>	.	.	.	.	.	.	+	.	+	r	.	.	.	.	.	.	.	.	.	.	.	.	1	1	2	+	.	.	r	+	.	.		
<i>Eryngium maritimum</i>	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	1	+	.	.	r	1	+	.	+	r	.		
<i>Elymus farctus</i>	.	.	1	.	2	2	.	.	.	.	.	.	.	.	.	.	.	+	2	2	1	.	1	.	.	.	.	.	.	.	.	.	.
<i>Scolymus hispanicus</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	r	+	+	+	.	+	+	.	.	.	.	.	.
<i>Lagurus ovatus</i>	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	2	1	1	
<i>Pseudorlaya pumila</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Sedo-Scleranthetea</i>																																			
<i>Hypochoeris radicata</i>	.	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	1	+	+	+	1	1	1	1	2	2	2	2	1	1	1	1	
<i>Arenaria serpyllifolia</i> agg.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2	2	2	2	2	2	2	1	1	1	1	
<i>Tunica saxifraga</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	1	1	1	1	1	1	+	1	
<i>Trifolium campestre</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.
<i>Helianthemetea guttati</i>																																			
<i>Vulpia fasciculata</i>	.	r	.	.	1	.	2	1	1	1	1	2	1	1	1	+	.	2	2	2	2	2	2	3	2	2	2	2	2	2	2	2	2		
<i>Catapodium rigidum</i>	.	r	.	.	.	.	.	+	+	.	.	+	+	+	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	+	1	
<i>Artemisietea vulgaris</i>																																			
<i>Bromus diandrus</i>	.	.	.	.	.	.	+	.	.	1	1	+	.	.	.	.	.	1	.	1	1	+	+	.	1	.	.	+	1	1	1	1		
<i>Verbascum sinuatum</i>	.	.	.	.	.	.	.	.	.	+	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.
<i>Dasyphyrum villosum</i>	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Juncetea maritimi</i>																																			
<i>Imperata cylindrica</i>	.	.	.	.	.	.	.	.	.	2	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.	
<i>Holoschoenus romanus</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	2	.	.	.	.	.
<i>Parapholis incurva</i>	+	.	.	.	.	.	.	r	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Others																																			
<i>Medicago littoralis</i>	.	+	1	1	1	1	1	+	1	1	.	.	3	3	3	3	1	1	1	1	1	.	.	.	.	.	.	.	1	1	1	+	1	1
<i>Onobrychis caput-galli</i>	.	.	.	.	.	1	2	r	.	.	.	1	.	.	+	+	.	2	2	2	2	2	2	2	3	1	2	2	2	2	2	2	2	
<i>Crepis foetida</i>	.	.	.	1	1	1	.	.	.	1	1	1	.	r	.	r	1	1	1	1	1	.	.	1	1	1	1	+	.	1	+	.	1		
<i>Cerastium</i> sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	1	1	1	1	+	.	+	.	.	
<i>Chondrilla juncea</i>	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.	.	.	r	.	.	.	.	.	.	.	.	r	r	.	.	.	.	.
<i>Cynodon dactylon</i>	.	.	.	.	.	1	.	.	.	.	.	.	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1
<i>Conyza albida</i>	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.
<i>Phleum arenarium</i>	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Oenothera</i> spp.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Pinus</i> sp.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
<i>Rubus ulmifolius</i>	1	.	.	