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The case of the Itata estuary (Bio-Bio Region-Chile) plant formations: anthropogenic interference or natural disturbance-induced diversity enrichment?

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Abstract. The current study examined the relationship between native and introduced plant species, as indicators of the state of anthropogenic influence on plant formations in the area of the Itata estuary (Bío-Bío Region, Chile). A total of 186 vegetation samples were collected in different plant communities in the wetlands and adjacent areas of the Itata River during 2011 and 2012. The communities of four terrestrial plant formations were sampled within dunes, prairies, shrub lands and food crops, and within two aquatic habitats (freshwater and salt marsh). The total flora comprised of 222 species, these were dominated by introduced taxa with thirty-three species considered invasive for Chile. The high percentage contribution of these alien weeds to the total community could be interpreted as signs of a strong degree of anthropogenic interference in the natural plant formations. However, some habitats such as salt marshes are subjected to periodic natural disturbances (e.g. tsunamis), lacking human interference. Consequently, in some habitats, alien species, which are more resilient, represent the primary plant formations.
Keywords: Coastal wetlands; salt marsh; disturbances; plant formations; flora; neophytes.

El caso de las formaciones vegetales en la desembocadura del río Itata (Región del Bío-Bío, Chile): ¿antropización o enriquecimiento de la diversidad inducida por perturbaciones naturales?

Resumen. En este estudio se analizó la relación entre la cantidad de especies nativas e introducidas como indicadoras del estado de antropización de las formaciones vegetales de un humedal costero sometido a perturbaciones naturales, en la zona central de Chile. Los datos fueron tomados de 186 censos de vegetaciólevantados en las comunidades vegetales diferenciables en el humedal y zonas adyacentes de la desembocadura del río Itata (Región de Bío-Bío) durante los años 2011 y 2012. Se muestrearon las comunidades de 4 formaciones vegetales terrestres (dunas, praderas, matorrales y cultivos) y 2 acuáticas (una de agua dulce y otra de agua salobre, marisma). Posteriormente se analizaron los espectros biológicos y corológicos de cada una de ellas. La flora total, incluyendo la de los censos y aquella observada fuera de las parcelas, se compone de 222 especies entre las cuales predominan taxones introducidos. En todas las formaciones vegetales estudiadas dominan malezas sobre las plantas nativas, de las cuales 33 son consideradas invasoras en el país. La abundancia de malezas alóctonas indica un alto grado de antropización de las todas formaciones investigadas. Pero la intervención humana falta en la formación de marismas que en cambio, están sometidas a perturbaciones naturales periódicas (terremotos, tsunamis, inundaciones, aluviones, marejadas), concluyendo que éstas serían formaciones originales primarias, aun cuando están dominadas por especies introducidas, que presentan una alta capacidad de resiliencia.
Palabras clave: Humedales costeros; marismas; perturbaciones; formaciones vegetales; flora, neófitos.

Introduction

One of the great utopian desires of human beings is to return to the past. The common notion is that in the past everything was better because the environment was in a pristine state, undisturbed, and landscape destruction and contamination were not an issue. This heavenly-like perception was already well displayed in Don Quixote's speech thanking the goatherds (Cervantes, 2004). However, parallel with the evolution of hominids, a continuous modification and alteration of the natural, pristine environment took place in order to facilitate human life, and with these changes began the process of anthropogenic landscape transformation (Lovelock, 2000; Frey & Loesch, 2010). This process, speeded up by the technical revolution, has led to large-scale environmental destructions, causing a general imbalance in the biogeochemical cycles that led to the extinction of species, often harming dominant species the most (Kauffman & Harries, 1996; Barnoski & *al.*, 2012; Pott, 2013). One could also speculate that before Homo sapiens, the extinction of dinosaurs was self-inflicted, as this mass extinction might have been caused by their massive impact on the environment. As Margalef (1996)

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stated, perhaps so many complacent meteorites are not necessary to produce extinction.

Nevertheless, assuming a pristine state of the earth, or at least a state without human interference, is central to assess levels of ecological landscape degradation. This assumption has important consequences for the conservation of species, their habitats and their ecological interactions in order to understand the magnitude of damage environmental alterations may cause.Thus, particularly a dominant species' ecology such as its activity affects biodiversity, which in turn is central to maintain ecosystem stability (Streit, 2007; Schulze & *al*., 2002; MacDougall & *al*. 2013).

Rather pristine landscapes in sparsely populated locations enable the study of plant communities, which represent the zero point of an anthropogenic induced degradation process and others, which represent different degrees of alteration. This facilitates the assessment of degradation processes, its stages of secondary succession and, consequently, the understanding what might have caused these state changes (Ramírez & *al*., 1994; Ramírez & *al*., 2016; San Martín & *al.,* 2014; Alarcón, 2014).

The original, pristine communities without human intervention are considered primary and their stands represent the reference point in respect to landscape degradation. In Chile, these primary communities were mainly forests between the Aconcagua River (Valparaíso Region) and the Magellan Strait (Reiche, 2013). The anthropogenic processes, which are the 'slash and burn' strategies, give rise to the development of secondary communities. In the case of forests, these secondary communities correspond to shrub communities (secondary thickets), from which the original forest could be regenerated, in the absence of other disturbances such as cattle grazing. Generally, it is known that cattle grazing induce the development of a secondary prairie community (Alarcón, 2014). If the latter is overgrazed and further degraded, it will be populated by invasive shrub species, forming a tertiary shrub community. This tertiary community does not allow a potential regeneration of the original forests. The main changes of the flora and vegetation in this degradation process are outlined in Figure 1. However, ironically stated, human interference can also diversify the landscape by giving rise to secondary and tertiary communities that in turn increase floristic biodiversity, because of the introduction of alien weeds (Murphy & Romanuk, 2004; Richardson & *al*., 2000; Sandoval & *al*., 2016).

The present study is a floristic survey of the plant formations of a coastal wetland in South Central Chile affected by frequent natural disturbances. Our study was based on the assumption that in such disturbed habitats, the presence of alien species would not necessarily be a consequence of human interference (Figure 1) changing the perception that alien species reflect secondary and tertiary conditions. Our aim was to identify, characterise the flora, including alien species, inhabiting six plant formations within different habitats in the area of the Itata estuary (Bío-Bío Region, Chile). We also evaluated the life forms within those plant formations and assessed the scale of human interference using different indexes of landscape degradation.

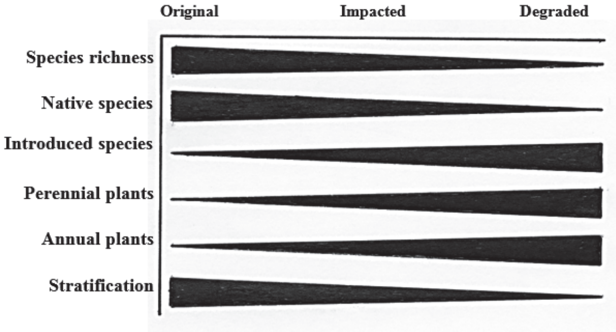


Figure 1. Changes in species richness and vegetation structure (increase or decrease) due to landscape degradation in South Central Chile (after Ramírez *et al*., 1992a).

Material & Methods

Study sites

The study sites comprised the plant formations inhabiting dunes, a salt marsh, prairies, shrub lands, freshwater and food crops within the estuary of the Itata River (Ñuble province, Bío-Bío Region, Chile) (Figure 2). A sand bar at the estuary´s mouth reduces the surface flow of the river (except during periods of high water), where the estuary expands into a large lagoon which gives rise to a salt marsh. The estuary consists of a narrow water channel between dunes, flanked by the sector of Boca Itata (36°22'28"S-72°50'50" W) to the North and Las Vegas del Itata (36°24'0"S-72°50'57"W) to the South (Figure 2).

The climate of this region is oceanic temperate with Mediterranean influence. The climatic diagram of Punta Tumbes (36°37'59"S-73°06'57"W), 12 km north of the city of Talcahuano, shows a marked seasonality with long winters characterised by high precipitation and short but dry summers (Hajek & Di Castri, 1975) (Figure 2). The annual average monthly temperature reaches 12.3°C with an average maximum and minimum of 15.6°C and 9°C, respectively. The climate in this region can be considered humid Meso-Mediterranean with an annual precipitation reaching 829 mm (Amigo & Ramírez, 1998).Depending on the topography, the original forest vegetation along the coastal zone of the Bío-Bío Region was formed in depressions characterised by water-logged soil of swamp forests of the Temo-Pitra association (*Temo-Myrceugenietum exsuccae*) and at elevated locations by partially sclerophyllous forests dominated by roble (*Nothofagus obliqua*) of the *Nothofago-Perseetum boldetosum* association (Oberdorfer, 1960). However, both communities were destroyed and have been replaced by "junquillo" wet grassland association (*Juncetum procerii*) biotopes and sclerophyllous shrubs, such as "boldo" (*Peumus boldus*) and "yelmo" (*Griselinia racemosa*), respectively (Ramírez & *al*., 2014).

Moreover, the boundary hedges of the roads in that zone are presently covered by invasive blackberry bushes (*Rubo-cestretum parquii*) (Amigo & *al*., 2007). The surrounding land of the estuary hosts large plantations of *Pinus radiata* and *Eucaliptus globulus*.

The sand dunes were covered with vegetation on both sides of the estuary. The salt marsh was characterised by brackish swamps exhibiting extreme conditions under the tidal influence. On the other hand, the prairies, which were located inland, were anthropogenic formations used for cattle grazing. The shrub lands consisted of secondary plant communities, which originated from anthropogenic destruction of the primitive sclerophyllous forest vegetation and the introduction of blackberry shrubs as hedges on roadsides. The aquatic vegetation in freshwater habitats comprised the free water zone of saltwaters and the boggy zones near riverbanks. The food crops were mainly cereals and potatoes.

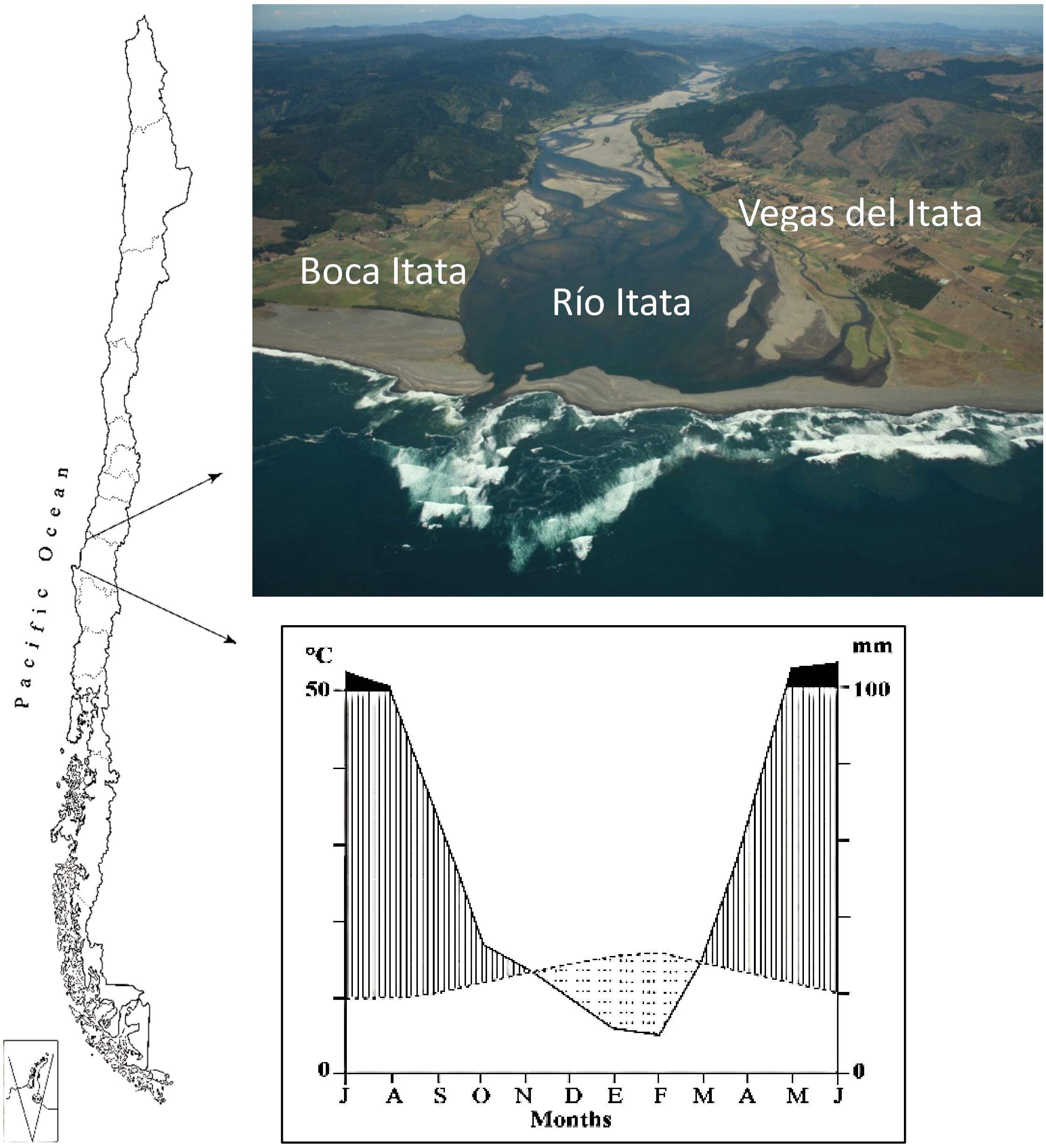


Figure 2. The Itata River estuary (Bío-Bío Region, Chile) located in the Central South of Chile. Inset: Ombrothermic diagram of Punta Tumbes (modified from Hajek & Di Castri, 1975); *x*-axis displays months from July to June; left y-axis represents temperature (°C) and right y-axis precipitation (mm). Continuous and broken lines shows monthly precipitation (mm) and temperature (°C). Dotted and lined areas shows dry (arid period, P<2T) and wet months. Black areas indicate months with precipitation over 100 mm.

Sampling

The present study represents an assessment of the terrestrial and aquatic vegetation of the northern and southern reaches of the Itata river mouth, applying the phytosociological methodology of Southern Europe (Braun-Blanquet, 1979; Dengler & *al*., 2008).

A total of 186 sample units of vegetation were surveyed from all distinguishable plant communities at the southern estuary reach (Las Vegas del Itata) as well as from the dunes present on both sides of the estuary.The study comprises six plant formations with 30 communities (plant associations) (Table 1).The latter will be analysed in a forthcoming publication. The differentiation of plant formations was based on the biological spectra and environmental conditions depicted in Table 1 following Schmithüsen (1968).

Table1. Number of plant associations and number of vegetation samples raised for each plant formation studied in the work place.

Plant formation	Plant associations	Samples
Aquatic	8	21
Dunes	6	63
Salt marhes	6	54
Shrubs	2	19
Prairie	5	29
Crops	3	0
Total (6)	30	186

In the spring and summer, 2011 and 2012, surveys were carried out on 25 m^2 (5x5m) plots arranged within the six plant formations (see Table 1). For each sample unit of vegetation, the list of plant species present in the plot was first noted, followed by a subsequent abundance estimation of each species in the plots, represented as total percentage cover (Dierschke, 1994). For plants with less than 1% cover, we used a "+" symbol to denote the presence of several individuals of a species, and the "r" symbol to indicate the presence of a single individual of a species (Knapp, 1984). These symbols were later changed to a unit of one to facilitate further calculations.

Unknown plant species were collected, dried and preserved in a herbarium to aid later identification, using the taxonomic literature (Ramírez & *al*., 1989; Matthei, 1995; Ramírez & Álvarez, 2017; Ramírez & San Martín, 2006).These preserved specimens were deposited in the VALD Herbarium of the Universidad Austral de Chile (Valdivia-Chile).The nomenclature was updated following the Plant List website (http://www.theplantlist.org) while their native or introduced status followed the assessment of Zuloaga & *al*. (2008). The classification into large groups considered the dicotyledons, including the basal Angiosperms and the Magnoliidae. Life forms were assigned using the key of Mueller-Dombois & Ellenberg (1974). The proportion of life forms including phanerophytes (woody plants), chamaephytes (subshrubs), hemicryptophytes (perennial plants) and therophytes (annual and biannual plants) were used to depict biological spectra following the approach of Raunkiaer (1937). The classification into invasive species was based on Fuentes & *al.* (2014). The stages of anthropogenic modifications followed those defined in González (2000), Schroeder (1998), Frey & Loesch (2010) and Steinhardt & *al*. (1999).

Results

Classification of the introduced and native flora

A total of 222 plant species were identified from the northern and southern reaches of the Itata estuary (Appendix 1). Among those species, only 44.15% were native plants while the remainder (55.85%) was composed of alien species (Table 2, Figure 3). The angiosperms widely dominated with 219 species (98.65%) the plant formations, while the dicotyledonous (in a wider sense) were more abundant (148 species, 66.66%) than monocotyledonous species (71 species, 31.98%). The gymnosperms were represented by a single, introduced species used for forest plantations, *Pinus radiata* D. Don ('Pino insigne') and two ferns: *Adiantum chilense* Kaulf. ('Culantrillo') and *Azolla filiculoides* Lam. ('Flor del pato') (Table 2, Appendix 1). *A. chilense* inhabits the understory of forests and shrub lands, while *A. filiculoides* is a floating aquatic plant.

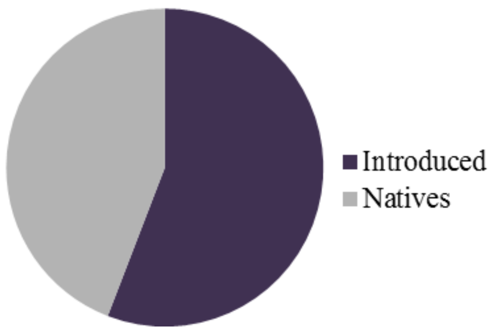


Figure 3. Percentage contribution of introduced and native plant species in the area of the Itata estuary (Bío-Bío Region, Chile).

The 222 plant species are distributed in 165 genera and 65 families. The species-richest genus is *Juncus* with seven species, followed by the genera Ranunculus and *Trifolium*, each with four species, and ten genera (*Acacia*, *Carex*, *Cyperus*, *Hordeum*, *Lolium*, *Lythrum*, *Plantago*, *Polygonum*, *Rumex* and *Salix*) each with three species. However, most genera (153) were represented with either two or one species. When considering species richness among families, the Poaceae (grasses), Fabaceae (legumes), Asteraceae (composites) and Cyperaceae dominated with 38, 19, 18 and 13 species, respectively. Nevertheless, if the number of species of the Cichorioideae (5 species), a subfamily of the composites is added to the Asteraceae, the latter becomes the second species-richest family with 23 species. Furthermore, the families of Scrophulariaceae were represented with eight, both the Juncaceae, and the Polygonaceae with seven, the Apiaceae (Umbelliferae) with six, and both the Chenopodiaceae and Cichoriaceae with five species. More than three-quarters (84.61%) of all families were represented with fewer than five species (Appendix 1).

Table 2. Origin, classification and biological spectrum of the flora at the study area.

Phytogeographic origin	Species	Percentage
Introduced	124	55,86
Natives	98	44,14
Total	222	100
Classification groups		
Dycotiledons	148	66,67
Monocotiledons	71	31,98
Gymnosperms	1	0,45
Ferns	2	0,90
Total	222	100
Life forms		
Phanerophytes	33	14,86
Chamaephytes	23	10,36
Hemicryptophytes	86	38,74
Cryptophytes	23	10,36
Therophytes	57	25,68
Total	222	100

Biological spectrum

The biological spectrum was dominated by hemi-cryptophytes (perennial plants) with 86 species (38.74%) and therophytes (annual and biannual plants) with 57 (25.68%) species (Table 2). Thus, both herbaceous life forms include 143 species (64.42%), while all other plant life forms including the phanerophytes (woody plants), chamaephytes (sub-bushes and erect grasses) and cryptophytes have fewer species (see Table 2).

The biological spectrum found at the estuary of the Itata River does not represent any typical phyto-climate but demonstrated altered vegetation at the study sites. In particular, the high percentages of annual plants (therophytes) and perennial (hemicryptophytes) groups that incorporated only neophytes indicate a high degree of anthropogenic modification of the flora.

Plant formations

The species-richest plant formations were found in the dunes (98 species, 44.14%) and in the prairies (97 species, 43.69%), respectively. Slightly fewer plant species were identified in the aquatic habitats (74 species, 33.33%), the shrub lands (68 species, 30.63%) and the salt marsh (52 species, 23.42%). As expected, food crops were the species-poorest habitat (14 species, 6.31%), comprising cultivated plants and weeds (Table 3).

Comparing the commonness of plant species among the different habitats, revealed that 115 species occurred in one, 55 in two, 35 in three and 12 in four plant formations (Table 3). Four non-native weed species (*Lupinus arboreus*, *Plantago lanceolata*, *Anthemis cotula* and *Calystegia sepium*) occurred in all but one plant formation, indicating a strong anthropogenic influence. In contrast, only one species, *Galega officinalis*, occurred in all of them (Table 3).

Introduced and native species within plant formations

All plant formations were dominated (> 50%) by introduced species (Figure 4). This high percentage implies a perturbed plant community altering plant formations. Only within the studied shrubs and freshwaters, native species reached 50% of the whole plant communities. Only food crops, as expected, were dominated by introduced species (Figure 4).

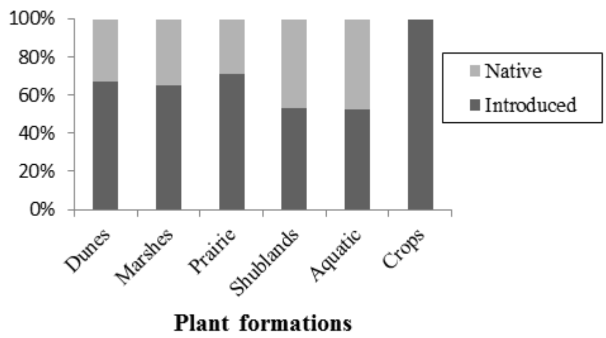


Figure 4. Origin spectrum of the flora of each plant formation determined in the work place.

Plant life forms within plant formations

Among plant life forms, the phanerophytes (woody plants) were most abundant in the plant formations of the shrub lands (27 species, Table 4, Figure 5). Particularly in dunes and in freshwater habitats, this group dominated over other life forms. Near freshwaters, they were represented by introduced species such as *Salix babylonica*, *S. viminalis* and *Alnus glutinosa* and the native *Salix humboldtiana*. In all other plant formations, the woody plants played a minor role while being absent in the food crops. In the dunes, the contribution in species number (15) by the chamaephytes (sub-shrubs) to the plant formation was higher than in all other studied habitats (Table 4, Figure 5). The hemicryptophytes (perennial weeds) dominated in the plant formations of four habitats (dunes, salt marsh, prairies and freshwater) with the highest number of species (46) in the prairies. The highest number of cryptophytes species (17) was found in freshwater habitats including swamps. Geophytes, a subgroup of the cryptophytes, reached the highest number of species (6) in the prairies. In contrast, this group was only represented by one species (*Alium vineale*) in the food crops and was missing in the salt marsh.

Table 3. Presence of the species in the plant formations ordered by frequency (Freq.). ‘1’ indicates presence of the species.

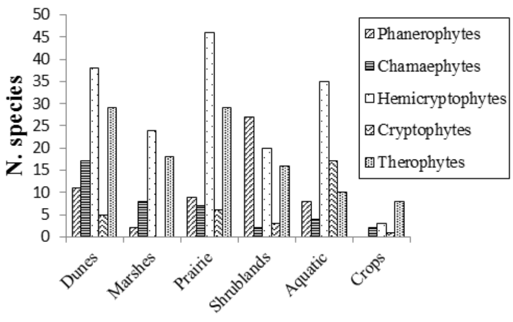
Species	Plant formations						
	Dune	Marshes	Prairie	Shrubs	Aquatic	Crops	Freq.
Galega officinalis	1	1	1	1	1	1	6
Lupinus arboreus	1	1	1	1	1	.	5
Plantago lanceolata	1	1	1	1	1	.	5
Anthemis cotula	1	1	1	.	1	1	5
Calystegia sepium	1	.	1	1	1	1	5
Agrostis capillaris	1	1	1	1	.	.	4
Cotula coronopifolia	1	1	1	.	1	.	4
Leontodon saxatilis	1	1	1	1	.	.	4
Raphanus raphanistrum	1	1	1	1	.	.	4
Rumex acetosellla	1	1	1	1	.	.	4
Rumex conglomeratus	1	1	1	.	1	.	4
Scirpus americanus	1	1	1	.	1	.	4
Xanthium spinosum	1	1	1	.	1	.	4
Barbarea verna	1	1	1	.	1	.	4
Convolvulus arvensis	1	.	1	1	.	1	4
Digitaria sanguinalis	1	1	1	.	.	1	4
Polygonum persicaria	1	1	1	.	.	1	4
Cichorium intybus	1	.	1	.	1	.	3
Eleocharis pachycarpa	.	1	1	.	1	.	3
Lotus corniculatus	1	1	1	.	.	.	3
Muehlenbeckia hastulata	1	.	1	1	.	.	3
Polypogon australis	.	1	1	.	1	.	3
Triglochin concinna	.	1	1	.	1	.	3
Acacia caven	1	.	1	1	.	.	3
Acacia dealbata	1	.	.	1	1	.	3
Agrostis stolonifera	1	.	1	.	1	.	3
Alnus glutinosa	1	.	1	.	1	.	3
Alstroemeria hookeriana	1	.	1	1	.	.	3
Anthemis arvensis	1	1	1	.	.	.	3
Atriplex chilenssis	1	1	1	.	.	.	3
Atriplex patula	.	1	1	.	.	1	3
Carex fuscula	1	.	1	.	1	.	3
Chenopodium album	1	.	1	.	1	.	3
Chenopodium ambrosioides	1	1	1	.	.	.	3
Holcus lanatus	1	1	1	.	.	.	3
Juncus balticus	1	1	1	.	.	.	3
Juncus microcephalus	1	.	1	.	1	.	3
Juncus planifolius	1	.	1	.	1	.	3
Lythrum hyssopifolia	.	1	1	.	1	.	3
Medicago hispida	1	1	1	.	.	.	3
Paspalum dilatatum	1	.	1	.	1	.	3
Plantago truncata	1	1	1	.	.	.	3
Rumex sanguineus	1	1	1	.	.	.	3
Salix babylonica	.	.	1	1	1	.	3
Salix humboldtiana	.	.	1	1	1	.	3
Salix viminalis	1	.	.	1	1	.	3
Selliera radicans	1	1	1	.	.	.	3
Spergularia rubra	1	1	1	.	.	.	3
Stemodia durantifolia	.	1	1	.	1	.	3
Conium maculatum	.	.	1	1	.	1	3
Euphorbia portulacoides	1	.	.	.	1	1	3
Saponaria officinalis	1	1	1	.	.	.	3
Distichlis spicata	1	1	.	.	.	.	2
Hordeum chilensis	1	1	.	.	.	.	2
Carduus pycnocephalus	1	.	.	1	.	.	2

Species	Plant formations						
	Dune	Marshes	Prairie	Shrubs	Aquatic	Crops	Freq.
Hypochaeris radicata	1	.	1	.	.	.	2
Alstroemeria ligtu	1	.	1	.	.	.	2
Ambrosia chamissonis	1	1	.	.	.	.	2
Anagallis arvensis	1	.	1	.	.	.	2
Arrhenatherum elatius	.	.	1	1	.	.	2
Aster squamatus	.	1	1	.	.	.	2
Baccharis racemosa	1	.	.	1	.	.	2
Bellardia trixago	1	.	1	.	.	.	2
Bromus catharticus	.	.	1	1	.	.	2
Carex pumila	1	1	.	.	.	.	2
Cirsium vulgare	.	.	1	1	.	.	2
Cynodon dactylon	1	.	1	.	.	.	2
Cyperus rotundus	.	.	1	.	1	.	2
Daucus carota	.	.	1	1	.	.	2
Festuca rubra	1	.	1	.	.	.	2
Foeniculum vulgare	1	.	.	1	.	.	2
Glandularia corymbosa	.	.	1	.	1	.	2
Juncus pallescens	.	.	1	.	1	.	2
Lagurus ovatus	1	1	.	.	.	.	2
Lathyrus sativus	.	.	.	1	.	1	2
Lolium temulentum	1	1	.	.	.	.	2
Lythrum maritimum	.	1	.	.	1	.	2
Lythrum portula	.	1	.	.	1	.	2
Margyricarpus pinnatus	1	.	1	.	.	.	2
Melilotus albus	.	.	1	1	.	.	2
Mentha pulegium	.	.	1	.	1	.	2
Myoporus laetus	1	.	1	.	.	.	2
Peumus boldus	.	.	1	1	.	.	2
Phyla nodiflora	1	.	1	.	.	.	2
Plantago hispidula	.	1	1	.	.	.	2
Polygonum hydropiperoides	.	.	1	.	1	.	2
Polygonum sanguinaria	1	1	.	.	.	.	2
Populus nigra	.	.	1	.	1	.	2
Rubus ulmifolius	1	.	.	1	.	.	2
Salsola kali	1	1	.	.	.	.	2
Schoenoplectus californicus	.	.	1	.	1	.	2
Sisymbrium officinale	1	.	1	.	.	.	2
Solanum nigrum	.	.	.	1	.	1	2
Sporobulus indicus	1	.	1	.	.	.	2
Stenotaphrum secundatum	.	1	1	.	.	.	2
Vulpia bromoides	1	.	1	.	.	.	2
Xanthium cavanillessii	1	.	1	.	.	.	2
Anthoxanthum utriculatum	.	.	1	1	.	.	2
Crepis capillaris	1	.	.	.	.	1	2
Cyperus eragrostis	.	.	1	.	1	.	2
Hordeum murinum	1	1	.	.	.	.	2
Juncus bufonius	1	.	.	.	1	.	2
Oldenlandia salzmannii	.	.	1	.	1	.	2
Ranunculus muricatus	.	.	1	.	1	.	2
Tetragonia maritima	1	1	.	.	.	.	2
Trifolium angustifolium	1	.	.	1	.	.	2
Cyperus rigens	.	.	.	.	1	.	1
Ludwigia peploides	.	.	.	.	1	.	1
Callitriche terrestris	.	.	.	.	1	.	1
Panicum urvilleanum	1	.	.	.	.	.	1
Parentucellia viscosa	1	.	.	.	.	.	1

Species	Plant formations						
	Dune	Marshes	Prairie	Shrubs	Aquatic	Crops	Freq.
Typha dominguensis	.	.	.	.	1	.	1
Acacia melanoxylon	1	.	.	.	.	.	1
Acaena ovalifolia	.	.	1	.	.	.	1
Acmispon subpinnatus	1	.	.	.	.	.	1
Adesmia filifolia	1	.	.	.	.	.	1
Adesmia viscida	1	.	.	.	.	.	1
Adiantum chilense	.	.	.	1	.	.	1
Aira caryophyllea	1	.	.	.	.	.	1
Alisma lanceolatum	.	.	.	.	1	.	1
Allium vineale	.	.	.	.	.	1	1
Ammophila arenaria	1	.	.	.	.	.	1
Arctotheca calendula	1	.	.	.	.	.	1
Aristotelia chilensis	.	.	.	1	.	.	1
Azara integrifolia	.	.	.	1	.	.	1
Azolla filiculoides	.	.	.	.	1	.	1
Bidens aurea	.	.	.	.	1	.	1
Brassica rapa	.	.	.	1	.	.	1
Briza maxima	.	.	1	.	.	.	1
Briza minima	.	.	1	.	.	.	1
Bromus hordeaceus	1	.	.	.	.	.	1
Calceolaria integrifolia	.	.	.	1	.	.	1
Calystegia soldanella	1	.	.	.	.	.	1
Carex riparia	.	.	.	.	1	.	1
Carpobrotus chilensis	1	.	.	.	.	.	1
Cestrum parqui	.	.	.	1	.	.	1
Chusquea cumingii	.	.	.	1	.	.	1
Cissus striata	.	.	.	1	.	.	1
Coniza bonariensis	.	.	.	1	.	.	1
Cuscuta suaveolens	1	.	.	.	.	.	1
Cynosurus echinatus	1	.	.	.	.	.	1
Datura stramonium	.	.	.	.	.	1	1
Echium plantagineum	.	.	1	.	.	.	1
Eryngium paniculatum	.	.	.	1	.	.	1
Escallonia pulverulenta	.	.	.	1	.	.	1
Eucalyptus nitens	.	.	.	1	.	.	1
Francoa appendiculata	.	.	.	1	.	.	1
Fuchsia magellanica	.	.	.	1	.	.	1
Gamochaeta americana	1	.	.	.	.	.	1
Griselinia racemosa	.	.	.	1	.	.	1
Hordeum jubatum	.	.	1	.	.	.	1
Hydrocotyle bonariensis	.	.	.	.	1	.	1
Hypericum perforatum	.	.	.	1	.	.	1
Isolepis cernuus	.	.	.	.	1	.	1
Isolepis inundatus	.	.	.	.	1	.	1
Jovellana violacea	.	.	.	1	.	.	1
Juncus imbricatus	.	.	1	.	.	.	1
Juncus procerus	.	.	.	.	1	.	1
Lactuca serriola	.	.	1	.	.	.	1
Lemna valdiviana	.	.	.	.	1	.	1
Libertia chilensis	.	.	.	1	.	.	1
Lilaeopsis macloviana	.	.	.	.	1	.	1
Limosella australis	.	.	.	.	1	.	1
Lithraea caustica	.	.	.	1	.	.	1
Lobelia tupa	.	.	.	1	.	.	1
Lolium multiflorum	.	.	.	1	.	.	1
Lolium perenne	.	.	1	.	.	.	1

Species	Plant formations						
	Dune	Marshes	Prairie	Shrubs	Aquatic	Crops	Freq.
Lotus uliginosus	.	.	.	.	1	.	1
Lupinus microcarpus	1	.	.	.	.	.	1
Medicago polymorpha	.	.	.	1	.	.	1
Melilotus indicus	.	.	1	.	.	.	1
Mentha aquatica	.	.	.	.	1	.	1
Mimulus briggessii	.	.	.	.	1	.	1
Myosotis arvensis	.	.	.	1	.	.	1
Myriophyllum aquaticum	.	.	.	.	1	.	1
Myriophyllum quitense	.	.	.	.	1	.	1
Nolana paradoxa	1	.	.	.	.	.	1
Notanthera heterophylla	.	.	.	1	.	.	1
Nothoscordum bivalve	.	.	1	.	.	.	1
Noticastrum sericeum	1	.	.	.	.	.	1
Oenothera stricta	.	.	.	1	.	.	1
Otholobium glandulosum	.	.	.	1	.	.	1
Oxalis corniculata	.	.	1	.	.	.	1
Oxalis perdicaria	1	.	.	.	.	.	1
Parapholis incurva	.	1	.	.	.	.	1
Parapholis strigosa	.	1	.	.	.	.	1
Paspalum distichum	1	.	.	.	.	.	1
Phragmites australis	.	.	.	.	1	.	1
Phyla canescens	1	.	.	.	.	.	1
Pinus radiata	.	.	.	1	.	.	1
Piptochaetium montevidense	.	.	1	.	.	.	1
Poa lanuginosa	1	.	.	.	.	.	1
Polypogon monspeliensis	.	.	.	.	1	.	1
Potamogeton berteroanus	.	.	.	.	1	.	1
Stuckenia pectinata	.	.	.	.	1	.	1
Potamogeton pusillus	.	.	.	.	1	.	1
Proustia pyrifolia	.	.	.	1	.	.	1
Puccinellia glaucescens	.	1	.	.	.	.	1
Ranunculus bonariensis	.	.	.	.	1	.	1
Ranunculus chilensis	.	.	.	.	1	.	1
Ranunculus minutiflorus	.	.	.	.	1	.	1
Rhodophiala chilensis	.	.	.	1	.	.	1
Rosa rubiginosa	.	.	.	1	.	.	1
Sambucus nigra	.	.	.	.	1	.	1
Sarcocornia fruticosa	.	1	.	.	.	.	1
Scirpus olneyii	1	.	.	.	.	.	1
Scrophularia auriculata	.	.	.	.	1	.	1
Senecio chilensis	.	.	.	1	.	.	1
Sicyos bryoniifolius	.	.	.	1	.	.	1
Sonchus oleraceus	.	.	.	.	1	.	1
Srachys grandidentata	.	.	.	1	.	.	1
Teline mospessulana	.	.	.	1	.	.	1
Tetragonia espinosae	1	.	.	.	.	.	1
Trifolium dubium	.	.	1	.	.	.	1
Trifolium pratense	.	.	1	.	.	.	1
Trifolium repens	.	.	1	.	.	.	1
Tweedia birostrata	1	.	.	.	.	.	1
Ugni molinae	.	.	.	1	.	.	1
Uncinia phleoides	.	.	.	1	.	.	1
Verbascum thapsus	.	.	.	1	.	.	1
Verbena corymbosa	.	.	.	.	1	.	1
Veronica anagallis-aquatica	.	.	.	.	1	.	1
Total species:	98	52	97	68	74	14	403

Figure 5. Comparison of the biological spectrum (by number of species) in the plant formations determined in the study area.



The annual and biannual life forms (therophytes) were common in all studied habitats, reaching their highest species number in dunes and prairies (29 species each; Table 4). In addition, they were only represented with one species in the crops and were absent in the salt marsh. Finally, therophytes (annual and biannual plants) are abundant in all formations, but especially in dunes and prairies each with 29 species (Table 4, Figure 5).

Comparing the percentage contribution of each life form within each plant formation demonstrated that the chamaephytes were evenly represented across the dune, salt marsh and food crop habitats (Table 5). Similarly well represented were the hemicryptophytes in the plant formations of the salt marsh, prairies and freshwater (Table 5). In contrast, phanerophytes and therophytes dominated the plant formations in the shrub lands and food crops, respectively (Table 5). The cryptophytes, on the other hand, were only well represented in the freshwater habitats, while the therophytes reached a high percentage contribution among all plant life forms in the dunes and dominated in the food crops.

Table 4. Biological spectra according to the number of species by life form of study area plant formations.

Life forms	Plant formations					
	Dunes	Marsh	Prairie	Shrubs	Aquatic	Crops
Phanerophytes	11	2	9	27	8	0
Chamaephytes	15	8	7	2	4	2
Hemicryptophytes	38	24	46	20	35	3
Cryptophyes	3	0	6	3	17	1
Therophytes	29	18	29	16	10	8
Total	96	52	97	68	74	14

Table 5. Biological spectra according to the species by life form in the study area plant formations.

Life forms	Dunes	Marshs	Prairies	Shrubs	Aquatic	Crops
Phanerophytes	11,45	3,85	9,28	39,71	10,81	0
Chamaephytes	17,35	15,38	7,22	2,94	5,41	14,29
Hemicryptophytes	39,58	46,15	47,42	29,41	47,3	21,43
Cryptophytes	5,1	0	6,19	4,41	22,97	7,14
Therophytes	30,21	34,62	29,9	23,53	13,51	57,14
Total	100	100	100	100	100	100

Invasive plants

Thirty-three species of the 124 introduced ones could be considered invasive (Tables 6 and 7). These constitute species that invade natural and anthropogenic altered ecosystems, changing the floristic structure of the existing plant communities.

The biological spectrum of this group is dominated by the therophytes with 48% (16 species) followed by the phanerophytes and hemicryptophytes (8 species each), while cryptophytes are only represented by one invasive aquatic species, *Veronica anagallis-aquatica*.

Table 6. Invasive plant species determined in the work place. It indicates Scientific name, classification, life forms and presence in Chile. Abbreviations: Gr: Classification group (D: Dicotyledon, M: Monocotyledon, G: Gymnosperm, H: Fern); LF: Life form (F: Fanerophyte, C: Chamaephyte, H: Hemicryptophyte, Cr:= Cryptophyte, T: Terophyte).

Scientific name	Gr	LF	Place of invasion in Chile
Acacia dealbata	D	F	Valparaíso to Valdivia
Acacia melanoxylon	D	F	Valparaíso to Chiloé
Agrostis capillaris	M	H	Coquimbo to Magallanes
Alnus glutinosa	D	F	Bío-Bío to Valdivia
Bromus hordeaceus	M	T	Coquimbo to Magallanes
Carduus pycnocephalus	D	T	Valparaíso to Puerto Montt
Cirsium vulgare	D	T	Coquimbo to Magallanes
Conium maculatum	D	T	Coquimbo toAysén
Convolvulus arvensis	D	H	In continental chile
Crepis capillaris	D	T	Atacama to Magallanes
Cynosurus echinatus	M	T	Valparaíso to Magallanes
Datura stramonium	D	T	Arica to Temuco
Daucus carota	D	T	Valparaíso to Chiloé
Echium plantagineum	D	H	Rancagua to Temuco
Galega officinalis	D	H	Valparaíso to Osorno
Holcus lanatus	M	H	Coquimbo to Magallanes
Hordeum murinum	M	T	Atacama to Magallanes
Lagurus ovatus	M	T	Coquimbo to Magallanes
Leontodon saxatilis	D	H	Valparaíso to Aysén.
Lotus corniculatus	D	T	Santiago to Chiloé
Lupinus arboreus	D	F	Coquimbo to Aysén
Medicago polymorpha	D	T	Arica to Puerto Montt
Pinus radiata	G	F	Coquimbo to Valdivia
Polygonum persicaria	D	T	Chile continental
Rosa rubiginosa	D	F	Valparaíso to Aysén.
Rubus ulmifolius	D	F	Valparaíso to Temuco
Rumex acetosellla	D	H	In continental Chile
Sisymbrium officinale	D	T	In continental Chile
Teline mospessulana	D	F	Valparaíso to Osorno
Trifolium repens	D	H	Chile continental
Verbascum thapsus	D	T	Valparaíso to Aysén.
Veronica anagallis-aquatica	D	Cr	In continental Chile
Vulpia bromoides	M	T	Coquimbo to Magallanes

Table 7. Biological spectrum of the invasive species. Number of species and percentage are indicated.

Life forms	Species	Percentage
Phanerophytes	8	24,24
Chamaephytes	0	0,00
Hemicryptophytes	8	24,24
Cryptophytes	1	3,03
Therophytes	16	48,48
Total	33	100,00

Discussion

The high species richness, in total 222 plant species, within the studied sites of the Itata estuary was expected, particularly when considering the vegetation diversity of six plant formations and 30 plant associations (see Table 1). However, this high floristic diversity was mostly due to the presence of angiosperms, which in turn comprised a high number of neophytes. The latter evidences a high degree of anthropogenic alterations of the environment. This result contrasts with a rather balanced biological spectrum (among life forms between 10.36 and 38.74%). In the Itata estuary, both the scare remnants of the original forest flora and numerous invasive plants are characterised by phanerophytes. Among the species of the biological spectrum, sub-shrubs (chamaephytes) thrive in extreme environmental conditions (Raunkiaer, 1937: Cain, 1950). Among the habitats they inhabit in the area of the estuary are the dunes that are a nutrient poor, wind-swept, and, therefore, an unstable environment with little water retention. The other habitat colonised by sub-shrubs is the salt marsh, with a substrate of silt and organic matter, exposed to tidal water level changes. The weed representatives of therophytes and hemicryptophytes reflect a high anthropogenic intervention into ecosystems, among which alien species changed the source spectrum of the native flora. In particular, therophytes show a higher prevalence for compacted soils, while hemicryptophytes prefer 'loose' soils with higher porosity (Ellies & Ramírez, 1994). More generally, the presence of invasive species in the study area could allow their future dispersal into other plant communities and food crops, thus, altering further their present species composition.

In particular, according to the proposed scheme of González (2000) shown in Table 8, a strong anthropogenic influence on the Itata's estuary plant formations can be depicted, since more than 30% of the plant assemblages (Figure 4) are constituted by neophyte species. Consequently, all studied plant formations are impacted and were in a stage of secondary or tertiary plant formation. Similarly, a strong to very strong anthropogenic impact could be deduced from the degree of hemeroby following Sukopp (1976), Dierschke (1994) and Schroeder (1998) (see Table 9). This index considers three parameters, which include the percentage composition of neophytes, therophytes and the loss of native species, to allow an impact assessment. Thus, the studied plant formations can be depicted as eu- and polyhemerobe with an absence of the original plant formation (Peña-Cortés & *al*., 2006), although a lower number of therophyte species (annual plants) may be the consequence that part of the studied area covers wetlands.

Table 8. Degrees of human intervention according to the presence of neophytes in plant communities after González (2000).

Grade	Neophyten (%)	Intervention
1	< 13	Nothing
2	14 - 20	Little
3	21 - 30	Medium
4	> 30	Strong

Table 9. Hemeroby grades in the plant communities (see text). Abbreviations are: G: Grade; Int: Intervention; Neo: Neophyten; Ther: Therophyten; Ln: Loos of native. Data on percentage.

G	Hemeroby	Int	Neo	Ther	Ln
1	Ahemeroby	Null	0	<20	0
2	Oligohemeroby	Weak	<5	<20	<1
3	Mesoemeroby	Medium	5-12	<20	>1
4	Euhemeroby	Strong	13-22	21-30	>10
5	Polyhemeroby	Very strong	>22	>40	>50
6	Metahemeroby	Total			100

However, some neophyte species that occurred in the salt marsh and in dunes might have reached Chilean shores by dispersing over long distances such as via sea-currents (Ramírez & Romero, 1978). Examples of those species found in dunes and prairies comprised *Ambrosia chamissonis*, *Arctotheca calendula*, *Atriplex patula*, *Lagurus ovatus*, *Lupinus arboreus*, *L. microcarpum*, *Sporobulus indicus* and *Stenothaphrum secundatum*. In freshwaters and brackish biotopes, these neophytes dispersed by sea currents included *Barbarea verna*, *Cotula coronopifolia*, *Distichlis spicata*, *Ludwigia peploides*, *Parapholis incurva, P. strigosa*, *Polygonum hydropiperoides*, *Rumex sanguineus* and *Salsola kali*.

Further to the south of Chile, possible archeophytes from Europe and New Zealand are the species *Potentilla anserina*, *Hebe elliptica* and *H. salicifolia*. In addition, the neophyte *Spartina densiflora* might have an Atlantic origin (Ramírez & Romero, 1978) although Zuloaga & *al*. (2008) and Bortolus (2006) considered it as native to Chile.

As suggested by Ramírez et al. (1989), and defined by Walter (1997), the Chilean coastal wetlands and in particular the plant formations in dunes and salt marshes could be considered 'native azonal primary communities', despite the dominance of non-native plant species. The native plants that would able to colonize such extreme environments (i.e. sandy soils) are absent (Ramírez & *al*., 1992b; 2012). The lack of original plant formations in these zones is puzzling as no succession in degradation processes could be observed when compared to other environments (Ramírez & *al*., 2014; 2016).

As a consequence of this lack of native plant populations, wind- and water-dispersed seeds of alien species could colonise these coastal habitats, forming 'autochthonous' assemblages. Remarkable is the high resilience of these neophytes (and some native species) as they are able to withstand high levels of natural disturbances including surface gravity waves, mud intrusions, earthquake induced permanent water level changes and saline intrusions due to tsunamis (Valdovinos & *al*., 2012). Furthermore, the lack of Chilean native species may also be attributed to the expansion of coastal dunes since the early 20th century. This dune development extending to the southern parts of Chile might have in part its origins in bad soil management linked to agricultural practices (Ramírez & *al*., 1992b). In Chile, salt marshes are older in origin but are also affected by natural disturbances such the flooding after tsunamis (González & *al*., 2012), but not by human interference.

Conclusions

Although human interference plays a big role in the alteration of original plant formations, the number of introduced plant species is not necessarily a good indicator of direct anthropogenic landscape manipulations. In particular, the azonal communities of the Itata salt marsh and its dunes, were dominated by alien, resilient species withstanding frequent natural disturbances. This may suggest that these assemblages constitute the primary communities of these habitats.

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Appendix 1. Nomenclature and taxonomic status of the plant species found in the estuary of the Itata River (Bío-Bío Region, Chile). The data includes phytogeographic origin and life forms. Abbreviations are: Gr: Classification group (D: Dicotyledon, M: Monocotyledon, G: Gymnosperms, H: Ferns), PO: Phytogeographic origin (N: Native, I: Introduced), LF: Life forms (F: Phanerphytes, C: Chamaephytes, H: Hemicryptophytes, Cr: Cryptophytes, T: Therophytes). The species are arranged alphabetically.

Scientific name (and author)	Family	Local name	Gr	PO	LF
Acacia caven (Molina) Molina	Mimosaceae	Espino maulino	D	N	F
Acacia dealbata Link.	Mimosaceae	Aromo blanco	D	I	F
Acacia melanoxylon R. Br.	Mimosaceae	Aromo australiano	D	I	F
Acaena ovalifolia Ruiz & Pav.	Rosaceae	Trun, Cadillo	D	N	H
Acmispon subpinnatus (Lag.) D.D. Sokoloff	Fabaceae	Porotillo	D	N	T
Adesmia filifolia Clos.	Fabaceae	Paramela	D	N	C
Adesmia viscida Savi	Fabaceae	Paramela	D	N	C
Adiantum chilense Kaulf.	Adiantaceae	Culantrillo	H	N	H
Agrostis capillaris L.	Poaceae	Chépica	M	I	H
Agrostis stolonifera L.	Poaceae	Chépica rastrera	M	I	H
Aira caryophyllea L.	Poaceae	Aira	M	I	T
Alisma lanceolatum With.	Alismataceae	Llantén de agua	M	I	H
Allium vineale L.	Liliaceae	Cebolleta	M	I	T
*Alnus glutinos*a (L.) Gaertn.	Betulaceae	Aliso	D	I	F
Alstroemeria hookeriana Schult. & Schult. f.	Alstroemeriaceae	Amancay	M	N	Cr
Alstroemeria ligtu L.	Alstroemeriaceae	Liuto	M	N	Cr
Ambrosia chamissonis (Less.) Greene	Asteraceae	Dicha grande	D	I	C
Ammophila arenaria (L.) Link.	Poaceae	Anmofila	M	I	H
Anagallis arvensis L.	Primulaceae	Pimpinela	D	I	T
*Anthemis arvensi*s L.	Asteraceae	Manzanillón	D	I	T
Anthemis cotula L.	Asteraceae	Manzanillón	D	I	T
Anthoxanthum utriculatum (Ruiz & Pav.) Schouten & Veldk.	Poaceae	Paja ratonera	M	N	H
Arctotheca calendula (L.) Levyns	Asteraceae	Filigrana	D	I	H
Aristotelia chilensis (Molina) Stuntz.	Elaeocarpaceae	Maqui	D	N	T
Arrhenatherum elatius (L.) P. Beauv, ex J. Presl. & C.Presl.	Poaceae	Pasto cebolla	M	I	H
Aster squamatus (Spreng.) Hieron.	Asteraceae	Bellorita de pantano	D	N	H
Atriplex chilensis Colla	Chenopodiaceae	Cachiyuyo	D	N	C
Atriplex patula L.	Chenopodiaceae	Cachiyuyo	D	I	T
Azara integrifolia Ruiz & Pav.	Flacourtiaceae	Corcolen	D	N	F
Azolla filiculoides Lam.	Azollaceae	Flor del pato	H	N	Cr
Baccharis racemosa (Ruiz & Pav.) DC.	Asteraceae	Chilca	D	N	F
Barbarea verna (Mill.) Aschers.	Brassicaceae	Berro amarillo	D	I	T
Bellardia trixago (L.) All.	Orobanchaceae	Pegagosa	D	I	T
Bidens aurea (Aiton) Sherff	Asteraceae	Falso té	D	I	C
Brassica rapa L.	Brassicaceae	Yuyo	D	I	T
Briza maxima L.	Poaceae	Bolitas del toro	M	I	T
Briza minima L.	Poaceae	Tembleque	M	I	T
Bromus catharticus Vahl.	Poaceae	Lanco	M	N	H
Bromus hordeaceus L.	Poaceae	Lanco	M	I	T
Calceolaria integrifolia L.	Scrophulariaceae	Topa-Topa	D	N	C
Callitriche terrestris Raf.	Callitrichaceae	Huenchecó	D	N	H
Calystegia sepium (L.) R. Br.	Convolvulaceae	Suspiro de pantano	D	I	Cr
Calystegia soldanella R. Br.	Convolvulaceae	Suspiro	D	N	C
Carduus pycnocephalus L.	Asteraceae	Cardo	D	I	T
Carex fuscula D'Urv.	Cyperaceae	Cortadera	M	N	H
Carex pumila Thumb.	Cyperaceae	Cortadera de arena	M	N	H
Carex riparia Curtis	Cyperaceae	Cortadera azul	M	N	H
Carpobrotus chilensis (Molina) N. E. Br	Aizoaceae	Doca	D	N	H
Cestrum parqui (Lam.) L'Her.	Solanaceae	Palqui	D	N	F
Chenopodium album L.	Chenopodiaceae	Quinguilla	D	I	T
Chenopodium ambrosioides L.	Chenopodiaceae	Paico	D	I	T
Chusquea cumingii Nees.	Poaceae	Colihuito	M	N	H
Cichorium intybus L.	Cichoriaceae	Viborera	D	I	H
Cirsium vulgare (Savi) Ten	Asteraceae	Cardo negro	D	I	T
Cissus striata Ruiz & Pav.	Vitaceae	Voqui naranjillo	D	N	F
Conium maculatum L.	Apiaceae	Cicuta	D	I	T

Scientific name (and author)	Family	Local name	Gr	PO	LF
Coniza bonariensis (L.) Cronq.	Asteraceae	Conisa	D	I	H
Convolvulus arvensis L.	Convolvulaceae	Correhuela	D	I	H
Cotula coronopifolia L.	Asteraceae	Botón de oro africano	D	I	H
Crepis capillaris (L.) Wallr	Asteraceae	Crepis	D	I	T
Cuscuta suaveolens Ser.	Convolvulaceae	Cabellos de angel	D	N	T
Cynodon dactylon (L.) Pers.	Poaceae	Pata de gallina	M	I	T
Cynosurus echinatus L.	Poaceae	Cebadilla	M	I	T
Cyperus eragrostis Lam	Cyperaceae	Cortadera grande	M	N	H
Cyperus rigens J. Presl. & C. Presl.	Cyperaceae	Cortadera	M	N	H
Cyperus rotundus L.	Cyperaceae	Chufa	M	I	H
Datura stramonium L.	Solanaceae	Chamico	D	I	T
Daucus carota L.	Apiaceae	Zanahoria	D	I	T
Digitaria sanguinalis (L.) Scop.	Poaceae	Pata de pollo	M	I	H
Distichlis spicata (L.) Greene	Poaceae	Pasto salado	M	N	H
Echium plantagineum L.	Boraginaceae	Viborera	D	I	H
Eleocharis pachycarpa E. Desv.	Cyperaceae	Rime	M	N	H
Eryngium paniculatum Cav. & Dombey ex F. Delaroche	Apiaceae	Cardoncillo	D	N	H
Escallonia pulverulenta (Ruiz & Pav.) Pers.	Escalloniaceae	Barraco	D	N	F
Eucalyptus nitens (H. Deane & Maiden) Maiden	Myrtaceae	Eucalipto	D	I	F
Euphorbia portulacoides L.	Euphorbiaceae	Pichoga de arena	D	I	C
Festuca rubra L.	Poaceae	Festuca	M	I	H
Foeniculum vulgare Mill.	Apiaceae	Hinojo	D	I	H
Francoa appendiculata Cav.	Saxifragaceae	Llaupangue	D	N	H
Fuchsia magellanica Lam.	Onagraceae	Chilco	D	N	F
Galega officinalis L.	Fabaceae	Galega	D	I	H
Gamochaeta americana (Mill.) Wedd.	Asteraceae	Vira-Vira	D	N	H
Glandularia corymbosa Ruiz & Pav.) N.O.´Leary & P. Peralta	Verbenaceae	Verbena	D	N	H
Griselinia racemosa (Phil.) Taub.	Cornaceae	Lamulahuen	D	N	F
Holcus lanatus L.	Poaceae	Pasto dulce	M	I	H
Hordeum chilensis Roem. et Schult.	Poaceae	Cebadilla	M	N	H
Hordeum jubatum L.	Poaceae	Cebadilla	M	I	H
Hordeum murinum L.	Poaceae	Cebadilla	M	I	T
Hydrocotyle bonariensis Comm. ex Lam.	Apiaceae	Tembladerilla	D	I	H
Hypericum perforatum L.	Hypericaceae	Hierba de San Juan	D	I	T
Hypochaeris radicata L.	Cichoriaceae	Hierba del chancho	D	I	H
Isolepis cernuus (Vahl) Roem. & Schult	Cyperaceae	Can-Cán	M	N	H
Isolepis inundata R. Br.	Cyperaceae	Chan-Chán	M	N	Cr
Jovellana violacea (Cav.) G. Don.	Scrophulariaceae	Topa-Topa azul	D	N	H
Juncus balticus Willd.	Juncaceae	Junquillo marino	M	I	H
Juncus bufonius L.	Juncaceae	Junquillito	M	I	T
Juncus imbricatus Lah.	Juncaceae	Junquillo duro	M	N	H
Juncus microcephalus Kunth	Juncaceae	Junquillo rojo	M	N	H
Juncus pallescens Lam.	Juncaceae	Hierba de la vaca	M	N	H
Juncus planifolius R. Br.	Juncaceae	Junquillo pasto	M	I	H
Juncus procerus E. Mey.	Juncaceae	Junquillo	M	N	H
Lactuca serriola L.	Cichoriaceae	Brújula	D	I	T
Lagurus ovatus L.	Poaceae	Unknown	M	I	T
Lathyrus sativus L.	Fabaceae	Arvejilla	D	I	T
Lemna valdiviana Phil.	Lemnaceae	Lenteja de agua	M	N	Cr
Leontodon saxatilis Lam.	Cichoriaceae	Chinilla	D	I	H
Libertia chilensis (Molina) Gunckel	Iridaceae	Calle-Calle	M	N	H
Lilaeopsis macloviana (Gaud.) A.W. Hill.	Apiaceae	Lilaopsis	D	N	Cr
Limosella australis R. Br.	Scrophulariaceae	Limosela	D	N	Cr
Lithraea caustica (Molina) Hook. & Arn.	Anacardiaceae	Litre	D	N	F
Lobelia tupa L.	Lobeliaceae	Tabaco del diablo	D	N	H
Lolium multiflorum Lam.	Poaceae	Ballica	M	I	H
Lolium perenne L.	Poaceae	Ballica	M	I	H
Lolium temulentum L.	Poaceae	Ballica	M	I	T
Lotus corniculatus L.	Fabaceae	Lotera	D	I	T
Lotus uliginosus Schkuhr.	Fabaceae	Alfalfa chilota	D	I	H

Scientific name (and author)	Family	Local name	Gr	PO	LF
Ludwigia peploides (Kunth) P. H. Raven	Onagraceae	Clavito de agua	D	I	Cr
Lupinus arboreus Sims.	Fabaceae	Chocho	D	I	F
Lupinus microcarpus Sims.	Fabaceae	Chochito	D	I	C
Lyhrum hyssopifolia L.	Lythraceae	Romerillo acuático	D	I	T
Lythrum maritimum Kunth	Lythraceae	Romerillo	D	N	T
Lythrum portula (L.) D.A. Webb.	Lythraceae	Romerillo rojo	D	I	H
Margyricarpus pinnatus (Lam.) Kuntze	Rosaceae	Perlilla	D	N	C
Medicago hispida Gaertn.	Fabaceae	Alfalfa	D	I	T
Medicago polymorpha L.	Fabaceae	Hualputra	D	I	T
Melilotus albus Medik.	Fabaceae	Trebol dulce	D	I	T
Melilotus indicus (L.) All.	Fabaceae	Trevillo	D	I	T
Mentha aquatica L.	Lamiaceae	Hierba buena	D	I	C
Mentha pulegium L.	Lamiaceae	Poleo	D	I	C
Mimulus briggesii Clos.	Scrophulariaceae	Berro	D	N	H
Muehlenbeckia hastulata (Sm.) I.M. Johnst.	Polygonaceae	Mollaca	D	N	F
Myoporus laetus Forst.	Myoporaceae	Mioporo	D	I	F
Myosotis arvensis L.	Boraginaceae	Nomeolvides	D	I	T
Myriophyllum aquaticum (Vell.) Verdc.	Haloragaceae	Pinito de agua	D	N	Cr
Myriophyllum quitense Kunth	Haloragaceae	Pinito de agua	D	N	Cr
Nolana paradoxa Lindl.	Nolanaceae	Suspiro	D	N	C
Notanthera heterophylla (Ruiz & Pav.) G. Don	Santalaceae	Quintral del boldo	D	N	F
Nothoscordum bivalve (L.) Britton	Iridaceae	Huilli	M	N	Cr
Noticastrum sericeum (Less.) Less. ex Phil. Phil.	Asteraceae	Unknown	D	N	H
Oenothera stricta Ledeb. Ex Link.	Onagraceae	Diego de la noche	D	I	T
Oldenlandia salzmannii (DC.) Benth & Hook.f. ex B.D. Jacks.	Rubiaceae	Oldenlandia	D	N	H
Otholobium glandulosum (L.) J.W. Grimes	Fabaceae	Culén	D	N	F
Oxalis corniculata L.	Oxalidaceae	Hierba de la perdiz	D	I	T
Oxalis perdicaria (Molina) Bertero	Oxalidaceae	Vinagrillo	D	N	Cr
Panicum urvilleanum Kunth.	Poaceae	Pasto peludo	M	N	H
Parapholis incurva (L.) C.E. Hubb.	Poaceae	Pasto alacrán	M	I	T
Parapholis strigosa (Dumort.) C. E. Hubb.	Poaceae	No conocido	M	I	T
Parentucellia viscosa (L.) Caruel	Oronbanchaceae	Pegagosa	D	I	T
Paspalum dilatatum Poir.	Poaceae	Chépica ancha	M	I	H
Paspalum distichum L.	Poaceae	Chépica angosta	M	I	H
Peumus boldus Molina	Monimiaceae	Boldo	D	N	F
Phragmites australis (Cav.) Trin. ex Steud.	Poaceae	Maicillo	M	N	Cr
Phyla canescens (Kunth) Greene	Verbenaceae	Hierba de la virgen	D	I	H
Phyla reptans (Kunth) Greene	Verbenaceae	Hierba de la virgen	D	I	H
Pinus radiata D. Don	Pinaceae	Pino insigne	G	I	F
Piptochaetium montevidense (Spreng.) Parodi	Poaceae	Quilmén	M	I	H
Plantago hispidula Ruiz. & Pav.	Plantaginaceae	Unknown	D	N	H
Plantago lanceolata L.	Plantaginaceae	Siete venas	D	I	H
Plantago truncata Cham. & Schltdl.	Plantaginaceae	Llantén	D	N	H
Poa lanuginosa Poir.	Poaceae	No conocido	M	N	H
Polygonum hydropiperoides Michx.	Polygonaceae	Duraznillo de agua	D	I	Cr
Polygonum persicaria L.	Polygonaceae	Duraznillo	D	I	T
Polygonum sanguinaria Remy	Polygonaceae	Sanguinaria	D	N	C
Polypogon australis Brongn	Poaceae	Cola de zorro	M	N	H
Polypogon monspeliensis (L.) desf.	Poaceae	Cola de zorro	M	I	H
Populus nigra L.	Salicaceae	Alamo	D	I	F
Potamogeton berteroanus Phil.	Potanogetonaceae	Huiro rojo	M	N	Cr
Potamogeton pusillus L.	Potamogetonaceae	Huiro rojo	M	N	Cr
Proustia pyrifolia DC.	Asteraceae	Tola blanca	D	N	F
Puccinellia glaucescens (Phil.) Parodi	Poaceae	Pasto azul	M	N	H
Ranunculus bonariensis Poir.	Ranunculaceae	Botón de oro	D	N	H
Ranunculus chilensis DC.	Ranunculaceae	Botón de oro	D	N	H
Ranunculus minutiflorus Bert. ex Phil.	Ranunculaceae	Botón de oro chico	D	N	H
Ranunculus muricatus L.	Ranunculaceae	Hierba del guante	D	I	H
Raphanus raphanistrum L.	Brassicaceae	Rabanito	D	I	T
Rhodophiala chilensis (L´Her.) Traub.	Amarillidaceae	Añañuca	M	N	Cr

Scientific name (and author)	Family	Local name	Gr	PO	LF
Rosa rubiginosa L.	Rosaceae	Rosa mosqueta	D	I	F
Rubus ulmifolius Schott.	Rosaceae	Zarzamora	D	I	F
Rumex acetosellla L.	Polygonaceae	Romacilla	D	I	H
Rumex conglomeratus Murr.	Polygonaceae	Romaza	D	I	H
Rumex sanguineus L.	Polygonaceae	Romaza roja	D	I	C
Salix babylonica L.	Salicaceae	Sauce llorón	D	I	F
Salix humboldtiana Willd	Salicaceae	Sauce amargo	D	N	F
Salix viminalis L.	Salicaceae	Sauce mimbre	D	I	F
Salsola kali L.	Chenopodiaceae	Salcola	D	I	F
Sambucus nigra L.	Caprifoliaceae	Sauco	D	I	F
Saponaria officinalis L.	Caryophyllaceae	Jabonera	D	I	T
Sarcocornia fruticosa (L.) A. J. Scott.	Amaranthaceae	Hierba sosa	D	N	C
*Scheonoplectus americanus (*Pers.) Volkart	Cyperaceae	Totora azul	M	N	H
Schoenoplectus californicus (C.A. Mey.) Soják	Cyperaceae	Totora	M	N	Cr
Scirpus olneyii A. Grey ex Engelm. et Gray	Cyperaceae	Unknown	M	N	H
Scrophularia auriculata L.	Scrophulariaceae	Unknown	D	I	T
Selliera radicans Cav.	Goodeniaceae	Maleza de marisma	D	N	H
Senecio chilensis Less.	Asteraceae	Palo de yegua	D	N	F
Sicyos bryoniifolius Moris	Cucurbitaceae	Calabacillo	D	I	F
Sisymbrium officinale (L.) Scop.	Brassicaceae	Mostacilla	D	I	T
Solanum nigrum L.	Solanaceae	Yaguecillo	D	I	T
Sonchus oleraceus L.	Cichoriaceae	Ñilhue	D	I	T
Spergularia rubra (L.) J. et K. Presl.	Caryophyllaceae	Taizana	D	I	C
Sporobolus indicus (L.) R. Br.	Poaceae	Unknown	M	I	H
Stachys grandidentata Lindl.	Lamiaceae	Ortiga falsa	D	N	C
Stemodia durantifolia (L.) Sw.	Scrophulariaceae	Contrayerba	D	I	T
Stenotaphrum secundatum (Walter) O.K.	Poaceae	Pasto ancho	M	I	H
Stuckenia pectinata (L.) Börner	Potamogetonaceae	Huiro	M	N	Cr
Teline mospessulana (L.) K. Koch	Fabaceae	Lluvia de oro	D	I	F
Tetragonia spinosae Muñoz	Aizoaceae	Perlilla	D	N	C
Tetragonia maritima Barn.	Aizoaceae	Aguanosa	D	N	C
Trifolium angustifolium L.	Fabaceae	Trébol hoja angosta	D	I	T
Trifolium dubium Sibth.	Fabaceae	Trébol enano	D	I	T
*Trifolium pratens*e L.	Fabaceae	Trébol rosado	D	I	C
Trifolium repens L.	Fabaceae	Trébol blanco	D	I	H
Triglochin maritima L.	Juncaginaceae	Hierba de la paloma	M	N	H
Tweedia birostrata (Hook. & Arn.) Hook. & Arn.	Asclepiadaceae	Saumerio	D	N	C
Typha dominguensis Pers.	Typhaceae	Vatro chico	M	I	Cr
Ugni molinae Turcz.	Myrtaceae	Murtilla	D	N	F
Uncinia phleoides (Cav.) Pers.	Cyperaceae	Clin-Clín	M	N	H
Verbascum thapsus L.	Scrophulariaceae	Hierba el paño	D	I	T
Verbena corymbosa Ruiz & Pav.	Verbenaceae	verbena	D	N	H
Veronica anagallis-aquatica L.	Scrophulariaceae	Nomeolvides	D	I	Cr
Vulpia bromoides (L.) S.F. Gray	Poaceae	Vulpia	M	I	T
Xanthium cavanillessii Schouw. ex Didr.	Asteraceae	Abrojo	D	I	T
Xanthium spinosum L.	Asteraceae	Clonqui	D	I	T