Flora and Vegetation of the Olivillo Forest Region (*Lapagerio roseae - Aextoxiconetum punctati* Oberdorfer 1960) in the Valdivian Coastal Landscape, Chile

Von der Naturwissenschaftlichen Fakultät
der Gottfried Wilhelm Leibniz Universität Hannover

zur Erlangung des Grades

Doktorin der Naturwissenschaften
Dr. rer. nat.

genehmigte Dissertation
von

Carla Alejandra Novoa Sepúlveda, Lic. (Chile)

2019

Referent: Professor Dr. rer. nat. Richard Pott
Korreferent: Professor Dr. a. D. Frederikus J. A. Daniëls
Tag der Promotion: 14.02.2019

Statement of Originality

I hereby declare that this Thesis has never been submitted to another examination commission in Germany or in another country for a degree in a same or similar form. The material in this thesis, to the best of my knowledge, contains no material previously published or written by another person except where due acknowledgement is made in the proper manner.

Carla Alejandra Novoa Sepúlveda

Abstract

This thesis presents a phytosociological analysis of the current vegetation communities on the western slopes of the Valdivian Coastal Range in South Chile. The goal is to describe the changes undergone by the potential vegetation in the research area, which led to the formation of non-native vegetation units and to a more diverse landscape.

The data collection was carried out between the Bonifacio and Hueicolla sectors (de Los Ríos Region) and up to an altitude of 300 m a.s.l. This area corresponds to the region where the *Olivillo* forest used to be the dominant community. A total of 169 phytosociological relevés was used to survey the vegetation. The area of the relevés ranges between 100 and 400 m^2, according to the physiognomical minimal area and to the Braun-Blanquet approach.

The collected vegetation data set was used to: *i*) construct the related full and synoptic tables, and *ii*) describe the physiognomy, floristic composition, diagnostic species, ecology and distribution of the plant communities. In particular, the diagnostic species were identified by using their fidelity values based on the Φ-coefficient as described in the literature. The vegetation units were then classified by means of the Ward's method and the Euclidean distance. Finally, a detrended correspondence analysis (DCA) was performed to identify the environmental variables with the largest influence on the relevés.

The analysis led to the classification of 12 plant communities (11 associations and 1 community) and to the identification of a total amount of 137 species. Out of the 137 species, 76 are endemic and 18 present among the IUCN conservation categories (1 is Endangered, 7 are Vulnerable, 4 are Near Threatened, 4 are Least Concerned, 1 is Data Deficient and 1 is Not Evaluated). The species are distributed over 5 classes, 62 families and 117 genera. The plant communities belong to 2 classes (Molinio-Arrhenatheretea and Wintero-Nothofagetea), 3 orders and 6 alliances. One alliance and 2 associations are newly described: the *Libertion chilensis* and *Agrostio capillariae-Eryngietum paniculatae* within Molinio-Arrhenatheretea, and *Rubo constricto-Greigietum sphacelatae* within Wintero-Nothofagetea.

The results of this thesis indicate that: *i*) the identified units show serial relationships of anthropogenic origin, and *ii*) human activity favours the development of native and non-native permanent communities in the research area. Finally, they can be used for the selection of areas suitable for ecological restoration and landscape management.

Key words: Coastal Mountain Range, database, diversity, grassland, landscape change, multivariate analysis, phytosociology, plant communities, potential natural vegetation, syntaxonomy, shrublands.

Zusammenfassung

Diese Arbeit präsentiert eine pflanzensoziologische Analyse der aktuellen Vegetationsgemeinschaften an den westlichen Hängen der validivianischen Küstengebirgskette in Südchile. Ziel ist es, die Veränderungen der potentiellen Vegetation im Untersuchungsgebiet zu beschreiben, die zur Bildung von nicht-einheimischen Vegetationseinheiten und somit zur Diversifizierung der Landschaft führten.

Die Datenerhebung erfolgte zwischen den Sektoren Bonifacio und Hueicolla (Los Ríos-Region) und bis zu einer Höhe von 300 m ü. NN. In diesem Gebiet war der Olivillo-Wald die dominierende Pflanzengesellschaft. Insgesamt wurden 169 Vegetationsaufnahmen durchgeführt. Die Flächengröße der Aufnahmen liegt entsprechend der physiognomischen Minimalfläche und der Braun-Blanquet-Methodik zwischen 100 und 400 m^2.

Die gesammelten Vegetationsdaten wurden verwendet für: *i*) die Darstellung einer vollständigen und synoptischen Tabelle und *ii*) die Beschreibung der Physiognomie, floristischen Zusammensetzung, diagnostischen Spezies, Ökologie und Verteilung von Pflanzengesellschaften. Die diagnostischen Spezies wurden insbesondere unter Verwendung ihrer auf dem Phi-Koeffizienten basierenden Genauigkeitswerte und ihrer Beschreibung in der Literatur identifiziert. Die Vegetationseinheiten wurden nach der Ward-Methode und der euklidischen Distanz klassifiziert. Schließlich wurde eine segmentierte Korrespondenzanalyse (DCA) durchgeführt, um die Umweltvariablen mit dem größten Einfluss auf die Aufnahmen zu identifizieren.

Die Analyse führte zur Klassifizierung von 12 Pflanzengemeinschaften (11 Assoziationen und 1 Gemeinschaft) und zur Identifizierung von 137 Arten. Von den 137 Arten sind 76 sind endemisch und 18 unter den IUCN-Arten (1 ist stark gefährdet, 7 sind gefährdet, 4 sind potenziell gefährdet, 4 sind nicht gefährdet, 1 hat eine ungenügende Datengrundlage und 1 ist nicht beurteilt). Die Arten sind auf 5 Klassen, 62 Familien und 117 Gattungen verteilt. Die Pflanzengemeinschaften gehören zu 2 Klassen (Molinio-Arrhenatheretea und Wintero-Nothofagetea, 3 Ordnungen und 6 Verbänden. 1 Allianz und 2 Assoziationen werden neu beschrieben: die Libertion chilensis und *Agrostio capillariae-Eryngietum paniculatae* innerhalb Molinio-Arrhenatheretea, und *Rubo constricto-Greigietum sphacelatae* innerhalb Wintero-Nothofagetea.

Die Ergebnisse dieser Arbeit zeigen, dass: *i*) die identifizierten Einheiten serielle Beziehungen anthropogener Herkunft zeigen und *ii*) die menschliche Aktivität die Entwicklung von einheimischen und nicht-einheimischen permanenten Gemeinschaften im Forschungsgebiet begöunstigt. Schließlich können sie für die Auswahl von Flächen verwendet werden, die für eine ökologische Wiederherstellung und Landschaftsgestaltung geeignet sind.

Schlüsselwörter: Küstengebirge, Datenbank, Diversität, Grünland, Landschaftswandel, Pflanzensoziologie, Pflanzengesellschaften, potentielle natürliche Vegetation, Syntaxonomie, Gebüsch

Resumen

Esta tesis presenta un análisis fitosociológico de las comunidades vegetales presentes en el paisaje actual de las laderas occidentales de la Cordillera Costera Valdiviana en el sur de Chile. El objetivo es describir los cambios experimentados por la vegetación potencial en el área de investigación, a través de la formación de unidades de vegetación de origen no nativas y por ende a la diversificación del paisaje.

La recolección de datos se llevó a cabo entre Bonifacio y Hueicolla (región de Los Ríos) hasta una altitud de 300 m.s.n.m. Esta área corresponde a la región donde el bosque *Olivillo* solía ser la comunidad dominante. Un total de 169 relevés fitosociológicos se utilizaron para estudiar la vegetación. La superficie de los rodales varió entre 100 y 400 m^2, de acuerdo a la área mínima fisonómica recomendada y a la metodología de Braun-Blanquet.

Con los datos de vegetación colectados fueron utilizados para: *i*) tabla completa y sinóptica, y *ii*) describir la fisonomía, composición florística, especies diagnósticas, ecología y distribución de las comunidades vegetales. En particular, las especies diagnósticas se identificaron usando sus valores de fidelidad basados en el coeficiente Φ y a lo descrito en la literatura. Las unidades de vegetación se clasificaron mediante el método Ward y la distancia Euclidiana. Finalmente, se realizó un análisis de correspondencia segmentado (DCA) para identificar las variables ambientales con mayor influencia en los relevés.

El análisis condujo a la clasificación de 12 comunidades vegetales (11 asociaciones y 1 comunidad) y a la identificación de un total de 137 especies. De las 137 especies, 76 son endémicas y 18 presentan categorías de conservación de la UICN (1 en peligro de extinción, 7 vulnerables, 4 casi amenazadas, 4 preocupación menor, 1 datos insuficientes y 1 no evaluada). Las especies se distribuyen en 5 clases, 62 familias y 117 géneros. Las comunidades de plantas pertenecen a 2 clases (Molinio-Arrhenatheretea y Wintero-Nothofagetea), 3 órdenes y 6 alianzas. Recientemente se ha descrito una alianza y dos asociaciones: *Libertion chilensis* y *Agrostio capillariae-Eryngietum paniculatae* dentro de Molinio-Arrhenatheretea, y *Rubo constricto-Greigietum sphacelatae* dentro de Wintero-Nothofagetea.

Los resultados de esta tesis indican que: *i*) las unidades identificadas muestran relaciones seriales de origen antropogénico, y *ii*) la actividad humana favorece el desarrollo de comunidades permanentes nativas y no nativas en el área de investigación. Finalmente, se pueden utilizar para la selección de áreas adecuadas para la restauración ecológica y la gestión del paisaje.

Palabras claves: ánalisis multivariado, Cordillera de la Costa, diversidad, praderas, cambios del paisaje, fitosociología, comunidades de plantas, vegetación potencial natural, sintaxonomía, matorrales.

Contents

List of abbreviations

A	Non-Native
a	Adventitious
Abs	Absolute
Air. G	Aíra Grassland
All	Alliance
Alt.	Altitude
ASPP	Áreas Silvestres Protegidas Privadas [Private Protected Wild Areas]
ass. nov.	Associatio nova [new association]
Ass	Association
Avg	Average Number of Species per Relevé
B	Briophytes
C	Cosmopolite
C-C. G	Chepica-Cadillo Grassland
Car. G	Cardoncillo Grassland
CAU	Chaihuin Serie
CECPAN	Centro de Estudio y Conservacion del Patrimonio Natural [Center for the Study and Conservation of the Natural Heritage]
Cen. G	Centella Grassland
Cep. G	Cepilla Grassaland
Ch	Chamaephytes
Chu. G	Chupon Grassland
CIREN	Centro de Informacion de Recursos Naturales [Natural Resources Information Center]
CL	Chile
Cla	Class
CMR	Coastal Mountain Range
CODEFF	Comite Pro Defensa de la Flora y Fauna [Committee for the Protection of Flora and Fauna]
CONAF	Corporacion Nacional Forestal [National Forest Corporation]
CONAMA	Comisión Nacional del Medio Ambiente [National Commission for the Environment]
CORFO	Corporacion de Fomento de la Produccion [Corporation for Production Promotion]
$\mathbf{Cov}_a$	Absolute Coverage
$\mathbf{Cov}_t$	Total Coverage
CP	Coastal Plains
CR	Critically Endangered

Ct	Constant Species
CTE	Correltúe Serie
DCA	Detrended Correspondence Analysis
DD	Data Deficient
Dg	Diagnostic Species
Dm	Dominant Species
DS	Decretro Supremo [Goverment Decrees]
E	Epiphytes
E (Ch-Arg)	Endemic of Chile and Argentina
E (Ch)	Endemic of Chile
EN	Endangered
Esp. S	Espinillo Shrub
EW	Extinct in the Wild
EX	Extinct
FC	Constancy Class
Fr	Frequency
$\mathbf{Fre}_a$	Absolute Frequency
$\mathbf{Fre}_t$	Total Frequency
G	Geophytes
GORE	Gobierno Regional [Regional Goverment]
H	Hemicryptophytes
HEY	Hueicoya Serie
I	Introduced
I.V.	Importance Value
ICPN	International Code of the Phytosociological Nomenclature
ID	Intermediate Depression
Ic	Continentality Index
IGM	Instituto Geografico Militar [Geographic Military Institute]
INE	Instituto Nacional de Estadistica [Statistics National Institute]
Io	Ombrothermic Index
IPNI	International Plant Names Index
IREN	Instituto de Recursos Naturales [Institute of Natural Resources]
It	Thermicity Index
Itc	Corrected Thermicity Index
IUCN	International Union for Conservation of Nature
Ju-d. G	Junco duro Grassland
Ju-h. G	Junco humedo Grassland
L	Lianas
Lat. S	Latitude South
Lat. W	Latitude West
LC	Least Concern
Lf	Lifeform
LPA	La Pelada Serie
M	Average Daily Maximum Temperature of the Coldest Month
m	Average Daily Minimun Temperature of the Coldest Month
m a.s.l.	Metres above sea level
m^2	square meters
Meg P	Megaphanerophytes
Mes P	Mesophanerophytes
Mi P	Microphanerophytes

MISC	Miscellaneous
mm	Millimeter
MMA	Ministerio de Medio Ambiente [Ministry of the Environment]
MT	Marine Terrace
N	Native
N P	Nanophanerophytes
n.d	Not Defined
nat	Naturalized
NE	Not Evaluated
Nr. Rev	Number of Releves
Nr. Sp	Number of Species
NT	Near Threatened
Olv. F	Olivillo Forest
Ord	Order
OTBC	Oficina Tecnica de Borde Costero [Coastal Edge Technical Office]
P	Phanerophytes
Pj-r. G	Paja ratonera Grassland
PO	Pacific Ocean
Pp	Precipitation
Qui. S	Quila Shrub
RCE	Reglamento para la Clasificacion de Especies Silvestres [Regulation for Wild Species Classification]
rel.	Releve
Rel.	Relative
S	Status
SD	Standard Deviation
SERNAGEOMIN	Servicio Nacional de Geologia y Mineria [National Service of Geology and Mining]
SNASPE	Sistema Nacional de Areas Silvestres Protegidas [National System of Protected Wild Areas]
SubA	Subassociation
T	Therophytes
TA	The Andes
Ta	Annual Mean Temperature
TNC	The Nature Conservancy
Total freq	Total Frequency
Tp	Above-Zero Precipitation Index
TSC	Tres Cruces Association
UACh	Universidad Austral de Chile [Austral University of Chile]
UTM	Universal Transverse Mercator
VU	Vulnerable
WRB	World Reference Base
WWF	World Wide Fund for Nature
YR	Yellow-Red
°C	degrees Celsius
β**-diversity**	Beta Diversity
Φ	Phi
σ	Standard deviations

Part I

Introduction

Chapter 1

Motivations and objectives

The Coastal Mountain Range has played a key role in the history of the Chilean vegetation. It is geologically very old and served as a refuge during the glaciations in the Quaternary period because of the local glacial and permafrost effects, which were less intense compared to other areas. The region was then colonised again during the post-glacial period (Villagrán & Armesto 2005, Villagrán 2001, Villagrán & Hinojosa 1997, Heusser 1981).
The Coastal Mountain Range is a biogeographic island for its isolation from the South American tropical and subtropical forests (Arroyo *et al.* 1996a, Villagrán & Hinojosa 1997, Armesto *et al.* 1998). This insular character is due to the Andes and, on the North, to the Atacama desert (Villagrán & Armesto 2005, Armesto 1995). For these reasons, the Coastal Mountain Range is currently listed among the world's 35 biodiversity Hot Spots and is known as "Chilean winter rainfall - Valdivian forest" (Mittermeier *et al.* 2011, Arroyo *et al.* 2004, Myers *et al.* 2000).
The forests in Central-South Chile are mainly concentrated in the Valdivian area (Smith & Armesto 2002). The forests are varied with richness and endemism of flora and fauna (Smith-Ramírez 2004; Armesto *et al.* 1994).
The region is very important from the ecological point of view because of its highly endemic species, genera and families of plants (Arroyo & Hoffman 1997). The majority of these endemisms consists of genera or families with just one species in the world (Arroyo *et al.* 2006, Armesto *et al.* 1995). Some examples of genera are *Aextoxicon*, *Fitzroya*, *Sarmienta*, *Lapageria*, *Philesia* (Smith-Ramírez 2004; Armesto *et al.* 1994).
The current flora of the Valdivian temperate rainforests can be considered as a biogeographic legacy. This is due to: *i*) the presence of Gondwana species, which are remnants from the Mesozoic; *ii*) the presence of Tertiary species of tropical origin; and *iii*) the local convergence of deciduous forests and thickets, characteristic of the Mediterranean areas in northern Chile, with the Valdivian evergreen vegetation of southern Chile (Smith-Ramírez 2004).
The region's uniqueness is not limited to plants. The same holds for several groups of vertebrates. Over 60% of amphibians and reptiles, 20% of freshwater fish and mammals, and 30% of birds are endemic (Arroyo *et al.* 2006).
The Valdivian Coastal Mountain Range has long been colonised by humans, which influenced the local flora and fauna with their activity. The degree of human intervention prior to the arrival of the Spanish colonists is unknown. Nevertheless, it is known that the region had been colonised by the Mapuches-Huilliches groups. Evidence from the archeological sites of Chan-Chan, Curiñanco, Rio Colún and others shows that they had settled in the region long before and were mainly distributed along river estuaries and shores (Adán *et al.* 2007; 2001; Otero 2006; Pino & Navarro 2005; Guarda 2001). Their agricultural

practices were in balance with the natural environment because of their extensive and self-consumptive approach (Otero 2006, Torrejón & Cisternas 2002). This, together with the population decrease due to wars and diseases, which caused the abandonment of the cultivated areas, enabled the subsequent progressive forest's recolonisation (Otero 2006). Till the time of the German colonisation (19th Century), the Valdivian Coastal Range was dominated by dense, virgin or apparently virgin forests from the mountains to the sea (Lara *et al.* 2012, Ramírez *et al.* 1996).

In the following decades the region was subject to intense anthropogenic processes. Examples are the continuous deforestation to make space for plantations of exotic species, the intensive agriculture and the over-exploitation of native species. These activities greatly threaten the ecological diversity and are one of the main reasons of species extinction and loss of natural forests (Zamorano-Elgueta *et al.* 2015, Aguayo *et al.* 2009, Barbosa & Marquet 2002).

The strong human intervention has led to the current Valdivian coastal landscape. This consists of a semi-natural vegetation mosaic with forest fragments (potential, primary vegetation) surrounded by secondary and tertiary communities[1], which coexist thanks to human intervention (Ramírez *et al.* 2012, San Martín *et al.* 2009, Ramírez *et al.* 1992).

One of the sixteen forest associations present in the primitive vegetation of the Valdivian region is the *Olivillo* forest (*Lapagerio roseae-Aextoxiconetum punctati* Oberdorfer 1960) (Ramírez & Figueroa 1985). This is an evergreen, multilayer, hygrophilic, species-rich forest with abundant climbing plants and vascular and non-vascular epiphytes (Ramírez *et al.* 1976, Alberdi *et al.* 1978, Riveros & Ramírez 1978, Sempe 1981). It thrives in low lands at the bottom of both mountain ranges and in particular in the coastal region, where it originates almost original forests thanks to its height (up to 30 m). The *Olivillo* forest was distributed southward from Concepción to the Chiloé Island, and northward to the central region and Norte Chico in gorges with high atmospheric humidity (Nuñez & Armesto 2006, Smith-Ramírez *et al.* 2005b, Villagrán *et al.* 2004, Donoso *et al.* 2006). Nowadays the *Olivillo* forest is strongly fragmented, with the forest's fragmentation being one of the main causes of biodiversity loss in the world (Turner 1996). Nevertheless, it still presents some continuity in the Valdivian Coastal Range, making up almost pure forests in areas with difficult access, hence maintaining a pristine condition (Smith-Ramírez *et al.* 2005c).

The vegetation of the *Olivillo* forests has been mainly studied in the Chiloé archipelago. As for the Valdivian Coastal areas, the investigations have focused on the oriental slope of the Cordillera Pelada. In particular, Ramírez & San Martín (2005) indicate that the *Olivillo* forest in the Valdivian Coastal Range has been destroyed by logging, transformation into farmland and urban development. These activities could be responsible for the vegetation variety and fragmentation currently observed in the region, which comprises non-native plant associations and threatens the endemic flora.

The hypothesis of this thesis is that the different associations identified in the Valdivian coastal vegetation mosaic are originated by the anthropic deterioration of the *Olivillo* forest.

The investigation presented in this work is motivated by the fact that the new units of the coastal area have been only partially investigated (Ramírez *et al.* 2003) and have not

[1]Primary communities are original of the considered region and typically comprise native species. Secondary communities replace the primary vegetation, but show a balanced presence of native and introduced species. Such communities are maintained by human intervention. Finally, tertiary communities invade secondary communities when extreme conditions are present, mainly due to inappropriate and intense management of the region. This leads to substrate degradation and cause the formation of unproductive areas which could be invaded by exotic species (Ellies & Ramírez 1994, Ellies *et al.* 1994, Fuentes 2012).

been directly related to the *Olivillo* forest. The understanding of the processes leading to the current vegetation is very important, as it allows to quantify the impact of human activities and to identify the original vegetation.
To this aim, the vegetation communities (associations) in the Valdivian coastal area were identified, together with the dynamic relationships among them and the original forest (*Olivillo*) in terms of floristic proximity. The use of the floristic proximity was motivated by the fact that the spatial and time proximity are typically either not always available or uncertain. The analysis was performed by means of the phytosociological methodology. This approach allows to describe the landscape by determining the physiognomic units (vegetation formations) via their biological spectra (Dengler *et al.* 2008) and vegetation associations, with the vegetation association being differentiated in terms of floristic composition (Mueller-Dombois & Ellenberg 1974, Knapp 1984). The floristic proximity was estimated through a classification and ordination multivariate analysis, the phytogeographic origin and the lifeforms. This strategy allows to establish the role of each vegetation unit in the considered dynamic relationships.

Chapter 2

Characteristics of the Research Area

2.1 Overview of the geography and geomorphology

The Republic of Chile borders Peru to the North, Bolivia and Argentina on the East, the Antarctic on the South and the Pacific Ocean to the West. The territories are distributed over three continents: America, Oceania and Antarctica, and are referred to as Continental Chile, Insular Chile, and Chilean Antarctic Territory, respectively. Among the three, Continental Chile is the most relevant territory for this thesis.
Continental Chile stretches over the south-western part of the Southern Cone. The latitude ranges from 17°30′ S (a few tens of kilometers from Visviri) to 56°30′ S (Diego Ramírez Islands). This corresponds to a distance of approximately 4300 km. The territory's maximum and minimum widths measure 468 km (Magallanes region) and 90 km (between Punta Amolanas and Paso de la Casa de Piedra), respectively (Errázuriz *et al.* 1998; Hudson 1994).
Four morphological units can be identified in the relief of the Chilean territory. From East to West, these are: the Andes (Cordillera de los Andes), the Intermediate Depression

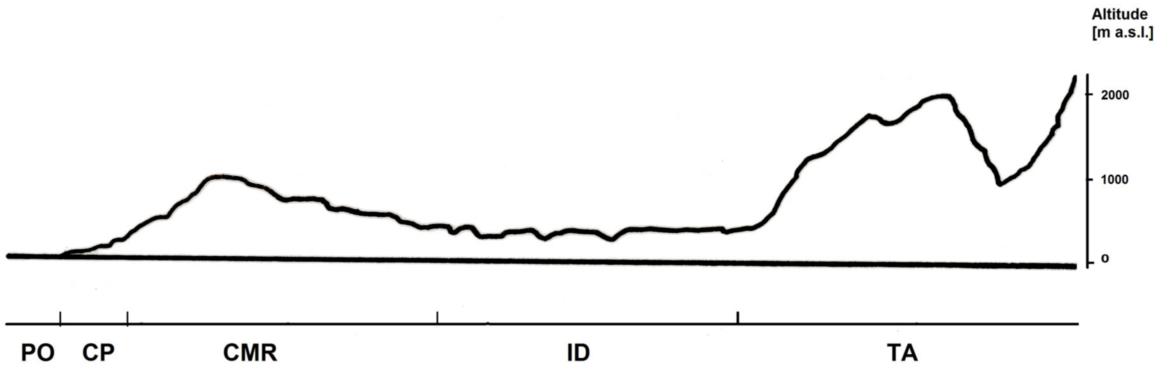

Figure 2.1: Schematic representation of the distribution of the morphological units in the Chilean territory from West (left) to East (right). The altitude is expressed in meters above sea level. The acronyms are as follows. PO: Pacific Ocean; CP: Coastal Plains; CMR: Coastal Mountain Range; ID: Intermediate Depression; TA: The Andes. Illustration by the author.

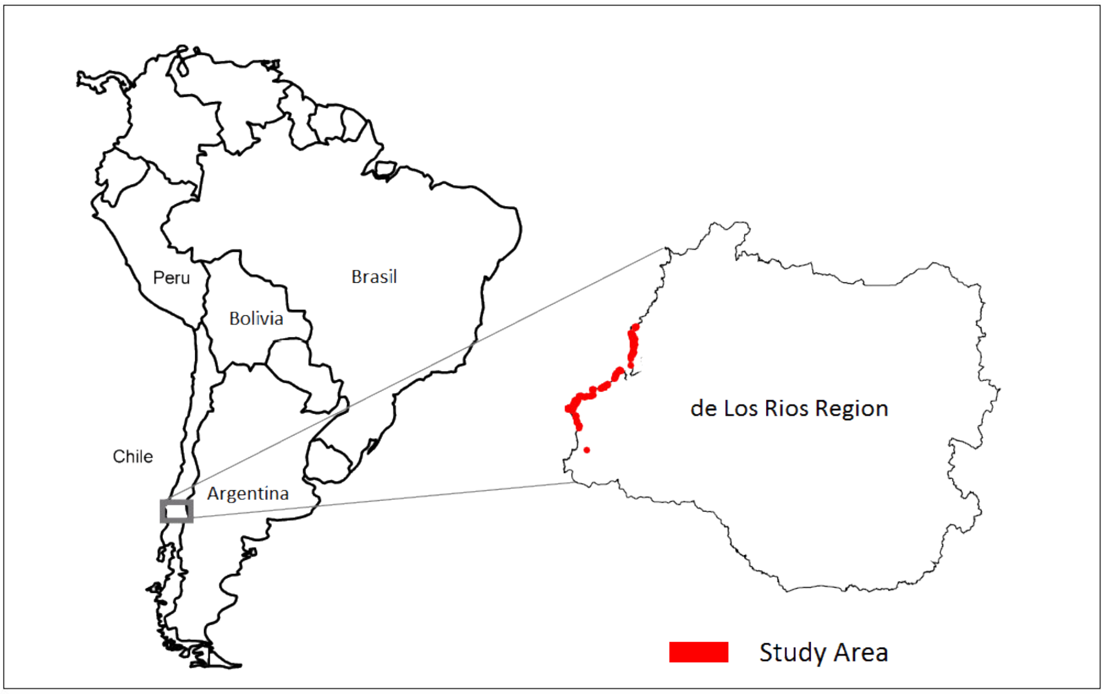

Figure 2.2: Geographic position of the research area. Illustration by the author.

(Depresion Intermedia), the Coastal Mountain Range (Cordillera de la Costa) and the Coastal Plains (Planicies Litorales), see Figure 2.1. For their influence on the analysis presented in this thesis, it is worth noting that the extension of the four units, and in particular of the Coastal Plains, varies significantly across the country (Errázuriz *et al.* 1998; Paskoff 1996; Cereceda & Errázuriz 1990).
Due to the aforementioned morphology, Continental Chile shows a great variety of climatic, geomorphological and biogeographic regions (Rivas Martínez *et al.* 2011; Morrone 2001; Börgel 1983; di Castri 1968). These enabled the development of different vegetation formations and units, which make the region a very important site from the biogeographic point of view (Moreira 2011; Conama 2008; Börgel 1983; Quintanilla 1982). One significant example is the area considered in this thesis.

2.2 Research area

The investigated region is the coastal area of the Valdivian Coastal Mountain Range, in the XIV Los Ríos Region (XIV Región de Los Ríos, 39°15′ S - 40°33′ S), see Figure 2.2 and Appendix A. The area spans the municipalities of Corral and Valdivia.
The data sample were collected in Summer 2009, 2010, 2012 and 2013 between the Bonifacio (North) and Hueicolla (South) sectors and between 0 and 300 m a.s.l. (see Figure A), in the area once occupied by the *Olivillo* forest (Mora 1985; Ramírez & Figueroa 1985; Oberdorfer 1960). All inventories, and pictures are the original work of the author. Non-original data have been cited correspondingly.
Detailed descriptions of the various aspects characterising the investigated region (climate, geology, geomorphology, hydrography, soils, protected areas and population) are given in the following sections.

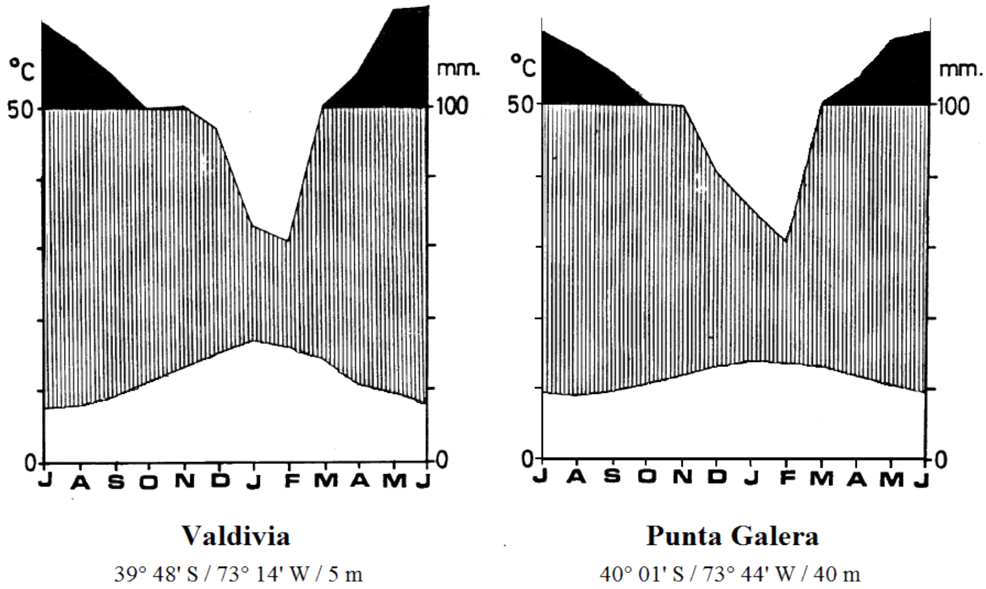

Figure 2.3: Climatic diagrams produced by the weather stations of Valdivia and Punta Galera . The horizontal axes report the months' initial letters. The left vertical axes report the temperature, the right axes the precipitation. The bottom curves refer to the left axes, the top curves to the right axes. The black area identifies the super habit. Adapted from Hajek & di Castri 1975 with permission from Ernest R. Hajek / ECOLYMA (2019).

2.2.1 Climate

The climate along the coast of the Los Ríos Region is rainy temperate oceanic without dry seasons and with warm summers (Cfb according to the Koeppen classification as recently updated by Peel *et al.* 2007). The nearest weather stations for the research area are Punta Galera and Valdivia, see Figure 2.3 and Table 2.1.
The strong oceanic influence maintains the thermal and rainfall uniformity (Figure 2.3). In Valdivia the temperature ranges between 8 °C in July and 17 °C in January, with an average of $11,9$ °C, and in Punta Galera between 9 °C in July and 14 °C in January, with an average of $11,3$ °C (di Castri & Hajek 1976). The region under consideration is one of the rainiest sites of Chile. The rainfall regime is uniformly distributed over the year, with consequent absence of dry periods. The average yearly precipitation level is 2.348 mm and 2.077 mm for Valdivia and Punta Galera, respectively (Hayek & di Castri 1975).
According to Luebert & Pliscoff (2006), which in turn is based on the bioclimatic classification of the Earth (Rivas-Martínez 1995; Rivas-Martínez *et al.* 2011), the investigated region is classified as Temperate Hyperoceanic. The region is also described as Mesotemperate Perhumid according to the bioclimatic classification of Amigo & Ramírez (1998), see Table 2.1.

2.2.2 Geology

The geology of the investigated region includes: *i*) quaternary deposits of glacial, estuarine, riverine and coastal origin, *ii*) Miocene marine and continental sediments, *iii*) Cretaceous intrusive rocks, and *iv*) metamorphites of the Palaeozoic-Triassic (Arenas *et al.* 2003; Mella *et al.* 2012; Sernageomin 2003).

Table 2.1: Climatic parameters recorded by the weather stations in the investigated area. The parameters are reported as follows. Lat. S.: latitude South; Lat. W.: latitude West; Alt.: altitude; Ta: annual mean temperature; M: average daily maximum temperature of the coldest month; m: average daily minimum temperature of the coldest month; It: Thermicity Index; Ic: Continentality Index; Itc: Corrected Thermicity Index; Pp: Precipitation; Tp: Above-zero Precipitation Index; Io: Ombrothermic index. Source: Amigo & Ramírez 1998.

	Weather Station	
	Valdivia	Punta Galera
Lat. S.	39°48′	40°1′
Lat. W.	73°14′	73°44′
Alt. [m a.s.l.]	5	40
Ta [°C]	12.2	11.3
M [°C]	11	11.3
m [°C]	4.7	6.4
It	279	290
Ic	9.3	4.8
Itc	262	228
Pp [mm]	2532	2077
Tp	1464	1356
Io	17.3	15.3

The majority of the Coastal Mountain Range, also referred to as the Bahía Mansa Metamorphic Complex or Western Series, consists of metamorphic rocks originating in the Late Palaeozoic and Early Triassic (Duhart *et al.* 2001; Hervé *et al.* 2007). These are mainly Pelitic schists, Green schist (quartz-chlorite-epidote-albite), Grayschist (quartz-albite-muscovite) and metagreywackes. Oceanic-type mafic metavolcanic rocks at different metamorphic levels[1] are also present (Illies 1970; Troncoso *et al.* 1994). Additionally, Granitic rocks from the Late Cretaceous have been found on the South of Valdivia (Illies 1970; 1960).

For a more detailed description, see Mella *et al.* (2012), Cembrano & Lara (2009), Arenas *et al.* (2004), SERNAGEOMIN (2003), Duhart *et al.* (2001), Massone *et al.* (1986), di Base & Lillo (1973), Muñoz-Cristi (1973), Aguirre *et al.* (1972), Illies (1970; 1960), González - Bonorino (1970), González - Bonorino & Aguirre (1970).

2.2.3 Geomorphology

The most relevant macroforms characterising the investigated region are the Coastal Mountain Range and the Littoral Plains. The Coastal Mountain Range stretches from North to South over almost 3000 km, parallel to the Andes. It begins in Morro de Arica and covers the whole territory down to the Taitao's Peninsula, where it becomes submerged in the Pacific Ocean. The highest peak is located in the northern end (3114 m a.s.l. in Sierra Vicuña Mackenna, 24°27′ S and 70°3′ W), and the altitude decreases southward (Errazuriz *et al.* 1998, Börgel 1983). The Mountain Range is divided lengthwise by the intersection of various fluvial valleys and is referred to by a number of local names.

[1] The foliated quartzite with mica, slate, and in particular, the mica schist are commonly referred to as Piedra Laja (Illies 1970, 1960; Subiabre & Rojas 1994).

The Littoral Plains are located between the sea and the Coastal Mountain Range. They are discontinuous in northern Chile due to the Cliffed Coast (Farellon Costero), and more regular in the direction of the Chacao Channel.
In the Los Ríos region, the Coastal Mountain Range consists of the Mahuidanchi and Pelada Coastal Ranges (see Appendix A). The former is limited by the Queule and Valdivia rivers, the latter by the Valdivia and Maullin rivers in the Los Lagos region (Region de los Lagos). The altitude of the Mahuidanchi Coastal Range is higher than 600 m a.s.l. at its northern end. The Cerro Oncol (715 m a.s.l.) is the highest hill in this region. The altitude decreases southward in the direction of the Valdivia river, beyond which it increases again to above 1000 m a.s.l. El Mirador (1075 m a.s.l.) and the Campanario (1010 m a.s.l.) are the highest mountains in this area.
The Coastal Plains of the Valdivian area are narrow. This is due to the Coastal Mountain Range, which consists of cliffs emerging directly from the sea and defining small rocky terraces. The terraces are larger close to the mouths of the rivers, where small coves are populated by fishermen.

2.2.4 Hydrography

The investigated region is characterized by a significant amount of mixed-regime rivers, with the regime influenced by the lakes from which the rivers originate (Niemieyer & Cereceda 1983). The most important basins are the Valdivia and Bueno rivers. Smaller catchments are located in the Coastal Mountain Range, with the most significant being the Chaihuin, Colún and Hueicolla Rivers (GORE Los Ríos 2009; Steffen 2005).

2.2.5 Soils

The origin of Chilean soils, as well as their characteristics and properties, are determined by a number of local factors such as: geography, climate, fluvial influence, volcanic activity, vegetation and parent material (Luzio *et al.* 2010; Valdés 1969).
Luzio & Alcayaga (1992) classify the soils of the investigated region as Haplohumults-Haplaquets. Based on the parental material, two kinds of soil are identified: Metamorphic Rocks and Ancient Volcanic Ash (Red Clayey) (Schlatter *et al.* 2003; Besoain 1985). The soils along the Valdivian Coastal Range developed from a variety of volcanic materials. These materials were deposited on the metamorphic basement during most of the Pleistocene, in particular during the Holocene (Cembrano & Lara 2009; Luzio *et al.* 2009; Besoain 1985; Wright 1965). It is worth noting that some soils, such as those made of metamorphic rocks, show the characteristics and properties of volcanic soils, although they did not originate from pleistocenic or holocenic rocks. These soils have been contaminated with volcanic ashes (Luzio *et al.* 2003).
Based on the soil-usage capacity, the dominant classes in the investigated area are the Classes IV and VII (CIREN 2003). Class IV corresponds to terrains converted into cultivated areas. It is worth mentioning that the local farming is subject to a number of restrictions, such as those on cultivation choices and on terrain-use methods. The soils in Class IV can be exploited for two or three years. However, the corresponding productive capacity is often low compared to the invested resources. Class VII corresponds to lands with limited usage and, in general, is not suitable for cultivation due to, e.g., significant slopes and thin soils. Terrains in Class VII are mainly used for activities such as shepherding and forestry.
The soils taxonomic classification is organised according to Soil Taxonomy (Soil Survey Staff 2006; 2014). For the sake of completeness, the classification based on the World

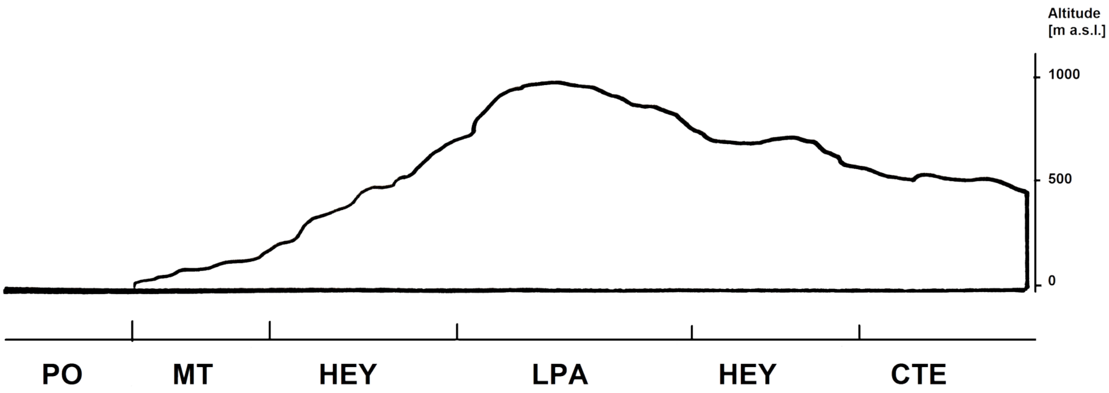

Figure 2.4: Schematic representation of the soil distribution in the Tres Cruces Association, from West (left) to East (right). The acronyms are as follows. PO: Pacific Ocean; MT: marine terrace; HEY: Hueicoya Series; LPA: La Pelada Series; CTE: Correltue Series. Illustration by the author based on CIREN 2003.

Reference Base (Driessen *et al.* 2001 in Salazar *et al.* 2005; WRB, FAO *et al.* 1998) is also provided throughout the text. The various WRB classes are reported in parentheses after those based on Soil Taxonomy.
According to CIREN (2003), two soil series and one soil association are present in the region under consideration (see Figure 2.4). From North to South, these are the Tres Cruces Association and the Chaihuin and Hueicoya Series. A concise description of the corresponding, dominant soils is reported below.

Tres Cruces Association

The Tres Cruces Association (TSC) is a topographic association on the North of the Valdivia River, in the Coastal Mountain Range. It consists of the Hueicoya, La Pelada and Correltúe Series. From West to East, the TSC territory is structured as follows (for a schematic representation, see Figure 2.4):

- Ancient, very dissected marine terraces. The corresponding soils are thin and with good drainage. They show significant depth variation, from moderately deep to very deep. The local topography is dominated by low ridges and hills with slopes between 20% and 50%.
- Hueicoya Series (HEY). The corresponding soils are located at higher altitudes compared to the marine terraces, and are characterised by a very uneven and steep topography.
- La Pelada Series (LPA). The corresponding soils are distributed at the highest altitudes, with a topography characterized by gentle slopes. These soils developed from metamorphic rocks characterised by a sandy silty-clayey texture and belonging to the Oxic Dystrudepts Family of the Inceptisol Order (Cambisol Hiperdistrico).
- The soils of the Hueicoya Series appear again at an altitude of approximately 300 m a.s.l.

- Correltue Series (CTE). The corresponding soils originated from ancient volcanic ashes with silty loam texture and are members of the Andic Palehumultus Family of the Inceptisol Order (Acrisol Umbri-Vetico).

As the soils of the HEY Series are present in the region on the South of the Valdivia river as well, a more detailed description is given below in a separate section. For further details on the LPA and CTE soil series, see ”Estudio Agrológico de la X Región” (CIREN 2003) and ”Estudio de Suelos de la Provincia de Valdivia” (IREN-CORFO-UACh 1978).

Chaihuín Series

The Chaihuín Series (CAU) is located along the coast up to an altitude of 80 m a.s.l. The topography is complex and moderately uneven, with dominant slopes between 4% and 15% and, occasionally, greater than 30%. The soils consist of volcanic ashes, metamorphic rocks[2] and marine sediments mixed with volcanic ashes at an altitude between 60 and 100 m a.s.l. They are deep or moderately deep. On the surface, the texture is silty-clayey and the colour matrix is dark brown in the 7.5 YR. At depth, the texture is moderately fine or fine and the colour is dark reddish brown or dark brown. The soil belongs to the Inceptisol Order (Umbrisol Haplico) and to the fine, mixed and mesic family of the Andic Dururepts.

Hueicoya Series

The Hueicoya Series (HEY) is mainly located in the Coastal Mountain Range, on the South of the Valdivia river. The part on the North of the river belongs to the TSC association. The HEY Series is a member of the fine, mixed and mesic family of the Typic Haplohumults of the Ultisol Order (Acrisol Umbri-Vetico). The topography is steep, with the dominant slopes greater than 30%. On the western and eastern slopes, the soils are located between 100 and 750 m a.s.l. and between 400 and 750 m a.s.l., respectively. They consist of mica schists, show different weathering levels, are well structured and, despite variations, moderately deep. The texture is loamy-silty and brownish-red in the 5 YR colour matrix on the surface, dark brown in the 7.5 YR colour matrix in depth.

2.2.6 Fauna

The Olivillo forests host a great variety of threatened vertebrate species, included in the IUCN List of Threatened Species. Examples are the Darwin’s Fox (*Lycalopex fulvipes*, Martin 1837), the Pudú (*Pudu puda*, Molina 1782), the Huillín (*Lontra provocax*, Thomas 1908), the Little Mountain Monkey (*Dromiciops gliroides*, Thomas 1894) and the Huiña Cat (*Leopardus guigna*, Molina 1782). They also serve as refuge for different birds, such as the Chucao (*Scelorchilus rubecula*, Kittlitiz 1830), the Giant Hummingbird (*Patagona gigas*, Vieillot 1824) and the Magellanic Cormorant (*Phalacrocorax magellanicus*, Gmelin 1789), and of amphibians, such as the Darwin’s Frog (*Rhinoderma darwinii*, Duméril & Bibron 1841), see Figure 2.5.
For further information about the fauna in the research area, see: Farias *et al.* (2014)Lobos *et al.* (2013), Celis *et al.* (2011), CECPAN & MMA (2012), Barththeld *et al.* (2011), Jiménez (2010), Cornelius *et al.* (2005), Díaz (2005), Ortiz & Ibarra-Vidal (2005), Méndez *et al.* (2005), Medina-Vogel (2005).

[2]The Metamorphic rocks consist of compact and cemented sandstone. They are locally referred to as Cancagua Rock (Piedra Cancagua).

Figure 2.5: Some of the threatened species present in the research area. First row, from left to right (photo credits in parentheses): Darwin's Fox (Fernando Borquez) Pudu (Jaime Jimenez), Huillín (Jorge Oyarce). Second row, from left to right: Guiña (Foto Austalis, Jerry Laker), Little Mountain Monkey (Jose Luis Bartheld), Chucao (Jose Cañas). Third row, from left to right: Magellanic Woodpecker (Arturo Nahum), Magellanic Cormorant (Jose Cañas), Darwin's Frog (Johara Bourke).

2.2.7 Protected Areas

The forests of the Valdivian Coastal Mountain Range are extremely important due to the endemic flora and fauna (Smith-Ramírez 2004; Smith-Ramírez *et al.* 2003, Armesto *et al.* 1996). Nevertheless, this is one of the least protected areas of the country. Deforestation, monocultures, urbanization, cattle raising and river contamination are causing the rapid deterioration and the irreversible loss of the original habitat (Otero 2006; Smith-Ramírez & Armesto 2002; Armesto *et al.* 1994, 1992; Sáez 1992).
The Los Ríos region hosts protected areas, both public (SNASPE[3]) and private (ASPP[4]).

[3]Sistema Nacional de Areas Silvestres Protegidas (National System of Protected Wild Areas).
[4]Areas Silvestres Protegidas Privadas (Private Protected Wild Areas).

Public and private protected areas are present in the investigated region as well. The public area is the Alerce Costero National Park (250 km^2) whereas the Valdivian Coastal Reserve (597 km^2) is the largest local private area. In particular, the latter is a private initiative of The Nature Conservancy (TNC) Organization, with the financial and technical support of the World Wide Fund for Nature (WWF) and other national and international organizations. Further private areas are the Oncol Park (394 km^2) and the Punta de Curiñanco Reserve (8 km^2). The Punta de Curiñanco Reserve belongs to the National Committee for the Defense of Flora and Fauna (CODEFF[5]) and hosts a residual coastal *Olivillo* forest with trees as old as 250 years. These form a set of parks and nature reserves called ”Parque Selva Valdiviana”[6].

2.2.8 Population

Across the investigated area, the main urban centres are small towns. From North to South, these are located in the Niebla-Los Molinos urban complex and in Corral. The total population consists of approximately 6000 inhabitants. Along the northern and southern coastal areas, a number of villages and hamlets are distributed over rural, sparsely populated areas with approximately 2000 inhabitants[7].

The southern coastal area of the Los Ríos region is characterised by a number of settlements from the pre-Hispanic period. The Huilliche are the principal indigenous population of the research area. The current population of the coastline, has shaped by the migration to Altos Hornos de Corral during the XIX century by others indigenous, workers and timber workers (Andrade & Pacheco 2009; Otero 2006; Godoy 2003).

The population is mainly active in fishing, agriculture and livestock farming (subsistence economies), together with seasonal harvesting of fruits and algae as an addition to the domestic economy (GORE Los Ríos 2010; OTBC 2009; INE 2005; Martínez & Yañez 2005).

[5]Comité Pro Defensa de la Flora y Fauna (Committee for the Protection of Flora and Fauna).

[6]For a more detailed overview, see http://parques-selvavaldiviana.cl.

[7]North: Los Pellines, Curiñanco, Bonifacio and Pilolcura. South: San Juan, Caleta Amargos, San Carlos, Los Liles, Huape, Chaihuín, Cadillal Alto y Bajo, Huiro and Colún.

Chapter 3

Vegetation of the research area

3.1 Overview of the vegetation classifications in Chile

The Chilean territory presents a broad spectrum of climatic, topographical and geomorphological characteristics. These vary significantly from North to South and from the Ocean to the Mountain Chain. Thus, various vegetation units are present, each one with its own characteristics. This outstanding variety has led to different classifications of the natural landscapes, based on criteria such as territorial, ecological and/or economic organization.

Reiche (1938; 1934) started the description of the Chilean vegetation from a geographic point of view. Pisano (1956; 1954) suggested a classification scheme based on physiognomic and floristics features, thereby identifying five vegetation areas. Di Castri (1968) established fifteen ecologic regions based on bioclimatic criteria. Quintanilla (1979; 1974) classified the vegetation from the cartographic point of view. One example are wood formations, which are defined according to their bioclimatic type and altitude. Classifications based on wood species with commercial purposes were developed by Donoso (1981) and Yudelevich *et al.* (1967), who both made use of the concept of forest type. Gajardo (1994) defined eight vegetation regions, occasionally divided into sub-regions, formations and vegetation associations or communities. The most recent classification was suggested by Luebert & Pliscoff (2006). These authors made use of the concept of vegetation belt, which is described by particular climatic, vegetation and altitude-based criteria. For further classifications, see, among others: Morrone (2001), Dinerstein *et al.* (1995), Donoso (1993; 1982), Etienne & Prado (1982), Veblen & Schlegel (1982), Hueck & Seibert (1981), Udvardy (1975), Cabrera & Willink (1973), Hueck (1966) and Mann (1960).

Schmithüsen (1956) was the first to describe the vegetation associations, on both regional and national scale. The study was based on phytosociological criteria. Oberdorfer (1960) proposed the first syntaxonomic scheme by defining the main Chilean phytosociological units. Subsequently, various authors contributed to the description of the woodlands in central and southern Chile (see reviews by Amigo & Ramírez 1998; Ramírez 1981; 1980a; 1980b; 1979), thus improving Oberdorfer's initial suggestion (op. cit).

Despite this vast bibliography, a revision and a syntaxonomic update of the vegetation classification in Chile is required. One example in this direction is Amigo & Flores (2013; 2012), who worked on the Sclerophyll forest in the Central Region. However, it is worth noting that the need for revision does not concern only woodlands, but also scrublands and grasslands in the Central and Southern region, as these are the new permanent replacement units after the destruction of the original woodlands (Ramírez *et al.* 1996, 1992; Montaldo 1975). A revision is also motivated by the fact that several investigations do not fulfil the

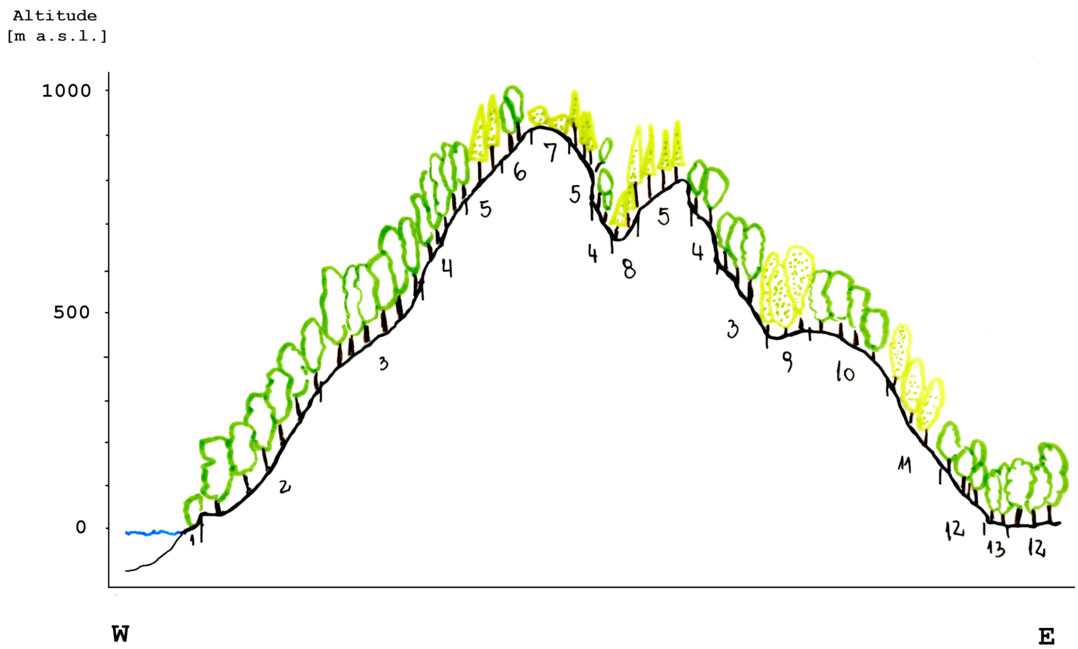

Figure 3.1: Schematic representation of the potential vegetation of the Coastal Cordillera Pelada. From West (left) to East (right): 1: *Patagua Marina* coastal shrub; 2: *Olivillo* forest; 3: *Tepa-Tieneo* forest; 4: *Chilote* forest; 5: *Alerce* forest; 6: *Magallanes* forest; 7: *Chilca-Nirre* shrub; 8: *Cipres de las Guaitecas* forest; 9: *Rauli* forest; 10: *Coihue-Ulmo* forest; 11: *Roble-Laurel-Lingue* forest; 12: *Boldo* forest; 13: *Temo-Pitra* swamp forest. The dark green denotes evergreen forests,dotted light green deciduous forests. The altitude is expressed in m a.s.l.. Illustration by the author based on Ramírez *et al.* (1996).

validity criteria of the International Code of Phytosociological Nomenclature (Weber *et al.* 2000).

3.2 Potential natural vegetation

The potential vegetation of a given area is defined as the stable community which would exist according to the progressive succession, under stable climatic and edaphic conditions and in case of no human influence on the natural ecosystem (Rivas-Martínez 1987). However, the concept of potential vegetation can be used as synonymous with primitive vegetation, potential natural primitive vegetation or current potential natural vegetation. The first two refer to the vegetation which had existed in a given area before human intervention or which has not changed yet (Dierschke 1994), and the last to the result of a process of secondary succession (Rivas-Martínez 2005). In the investigated area, the potential vegetation can be referred to as Valdivian Forest, Valdivian Rainforest, Valdivian Temperate Rainforest or Valdivian Laurel-Leaved Forest, depending on the considered bibliographic source.
It is worth mentioning that the definition of Valdivian Forest is still debated due to its characteristics and geographical limits (Luebert & Pliscoff 2005). With respect to the Valdivian Rainforest, the definition used in this work follows Ramírez & Figueroa (1985), where forests include:

- *Lapagerio roseae-Aextoxiconetum punctati* (Oberdorfer 1960), *Olivillo* forest.

- *Nothofago dombeyi-Eucryphietum cordifoliae* (Schmithüsen 1956), *Coigue-Ulmo* forest.
- *Myrceugenielletum apiculatae* (Dimitri 1964), *Arrayan* forest.
- *Laurelio philippianae-Weinmannietum trichospermae* (Oberdorfer 1960), *Tepa-Tineo* forest.

These types of forest are evergreen, with moderate thermicity and distributed at low altitudes. They are rich in species and endemism, especially the *Olivillo* forest (Ramírez & Figueroa 1985).
Around the year 1800, almost all of the original vegetation in the region consisted of forest (Lara *et al.* 2012). The altitudinal distribution of the primitive forest in the Valdivian Mountain Coastal Range and coastland is shown in Figure 3.1. Sclerophyllous and temperate deciduous forests were present at the lowest altitudes on the Eastern side. Coniferous and swamp forests were distributed on the peak and under flooding conditions, respectively. The hygrophilous temperate forest was located on the western side (Ramírez *et al.* 1996; Ramírez & San Martín 2005).
On the western side of the Coastal Range, the vegetation was more homogeneous due to the stronger oceanic influence. In the area of rocks, cliffs and fossil dunes on the coastline it was dominated by the *Patagua Marina Coastal* scrub (*Griselinio jodinifoliae-Pernettyetum poeppigii* Hildebrand 1983). From the shoreline up to about 300-400 m a.s.l., the vegetation consisted of *Olivillo* forest (*Lapagerio rosea-Aextoxiconetum punctati* Oberdorfer 1960), followed by the *Tepa-Tineo* forest (*Laurelio philippianae-Weinmannietum trichospermae* Tomaselli 1981). These two associations mixed gradually, with a transition zone located between 400 and 600 m a.s.l. The *Chilote* forest (*Nothofagetum nitidae* Oberdorfer 1960), *Alerce* forest (*Fitzroyetum cupessoides* Oberdorfer 1960), *Magallanes* forest (*Nothofagetum betuloidis* Oberdorfer 1960) and *Chilca-Nirre* shrub (*Baccharido-Nothofagetum antarticae* Ramírez *et al.* 1996) followed at increasing altitudes.

3.2.1 Vegetation units

The most important vegetation units of the coastland are the *Patagua Marina* coastal scrub, the *Olivillo* forest and the *Tepa-Tineo* forest. A brief description of these units is reported below, with focus on the *Olivillo* forest. The order of the description follows the units' altitudinal distribution on the western side. For an overview of the other associations, see Ramírez & San Martín (2005), Ramírez *et al.* (1996) and Ramírez & Figueroa (1985).

Coastal Scrub of Patagua Marina
***Griselinio jodinifoliae-Pernettyetum poeppigii* Hildebrand 1983**
The coastal scrub (see Figure 3.2) is evergreen and stunted. It is distributed on rocks and on established dunes, twenty meters above the shoreline (see number 1 in Figure 3.1). The height ranges between two and four meters. The coastal scrub is dominated by the *Patagua Marina* (*Griselinia jodinifolia*) and *Ñipa* (*Escalonia rubra*). In the lowest shrub layer it is possible to find *Gaultheria poeppigii* (*Pernettya poeppigii*), *Ugni molinae* and *Baccharis elaeloides* (Ramírez *et al.* 1996; Hildebrand 1983).

Figure 3.2: Coastal scrub of *Patagua Marina* (*Griselinio jodinifoliae-Pernettyetum poeppigii* Hildebrand 1983) on the old Pacific marine terrace in Curiñanco (top) and Playa Colún (bottom). Photographed by the author in January 2012.

Olivillo Forest
***Lapagerio roseae-Aextoxiconetum punctati* Oberdorfer 1960**
The *Olivillo* forest (see Figure 3.3) is one of the sixteen plant communities which contributed to the primitive vegetation of the Valdivian region (Ramírez & Figueroa 1985). It is an evergreen, multistratified and hygrophilous forest, very rich in species and with abundant climbing plants (e.g. *Lapageria rosea*, characteristic species of the association and Chilean national flower, see Figure 3.4 Top, or *Cisus striata*), vascular epiphytes (e.g. *Sarmienta scandens*, *Luzuriaga polyphylla*) and non-vascular epiphytes (*Hymenophyllum sp.*, Figure 3.4 Middle and Bottom) (San Martín *et al.* 2008; Ramírez & San Martín 2005; Mora 1986; Sempe 1981; Alberdi *et al.* 1978; Riveros & Ramírez 1978; Ramírez *et al.*

Figure 3.3: Inside view of the *Olivillo* forest in Playa Pelche. The trees average height is 25 m. Trunks are partially covered by Ephiphytes. Photographed by the author in February 2012.

1976).

The *Aextoxicon punctatum* Ruiz *et* Pav. is the characteristic species of this forest. It is the only representative of the *Aextoxicaceae* family and it is endemic of the temperate forest of the Southern Cone (Donoso *et al.* 2006). This species is distributed across a broad latitude range ($30° - 43°$ S): relict woods are present in Norte Chico ($30° - 33°$ S), and isolated woodlands can be found in the Central ($33° - 39°$ S) and Southern ($39° - 43°$ S) zones from the Tolten River to the Gualfo Island (see Figure 3.5). Currently, the distribution is smoother along the coast, in particular in the provinces of Valdivia, Osorno and Llanquihue. In this area, the *Olivillo* can form an almost pure forest, as it can reach a height between 30 and 40 meters (Figure 3.3).

Figure 3.4: Examples of climbing plants (*Lapageria rosea*, top) and of vascular and non-vascular Epiphytes (*Luzuriaga* sp. and of the *Hymenophyllaceae* family (bottom) in the *Olivillo* forest. The *Lapageria rosea* is the characteristic species of the association and Chilean national flower. The *Luzuriaga* sp. and of the *Hymenophyllaceae* family are on an *Olivillo* trunk. Photographed by the author in February 2012.

The *Olivillo* forest is also present on the western side of the Andean Mountain Range and on the edge of the great lakes distributed in the Los Ríos and Lagos regions. It is also distributed along the coast of the Isla Grande de Chiloé, as well as in the group of the Guapiquilan Islands (43° S) and in the Isla Mocha (38° S) (Smith-Ramírez *et al.* 2005; Donoso 2006; Smith-Ramírez 2004; Mora 1986). It is likely that these forests had presented a continuous distribution in the Central South Chile prior to the arrival of the European colonists (Pérez & Villagrán 1994; Villagrán *et al.* 1974).

Tepa-Tineo forest
***Laurelio philippianae - Weinmannietum trochospermae* Oberdorfer 1960**
The *Tepa-Tineo* forest is evergreen and is characterised by significant growth, as trees can

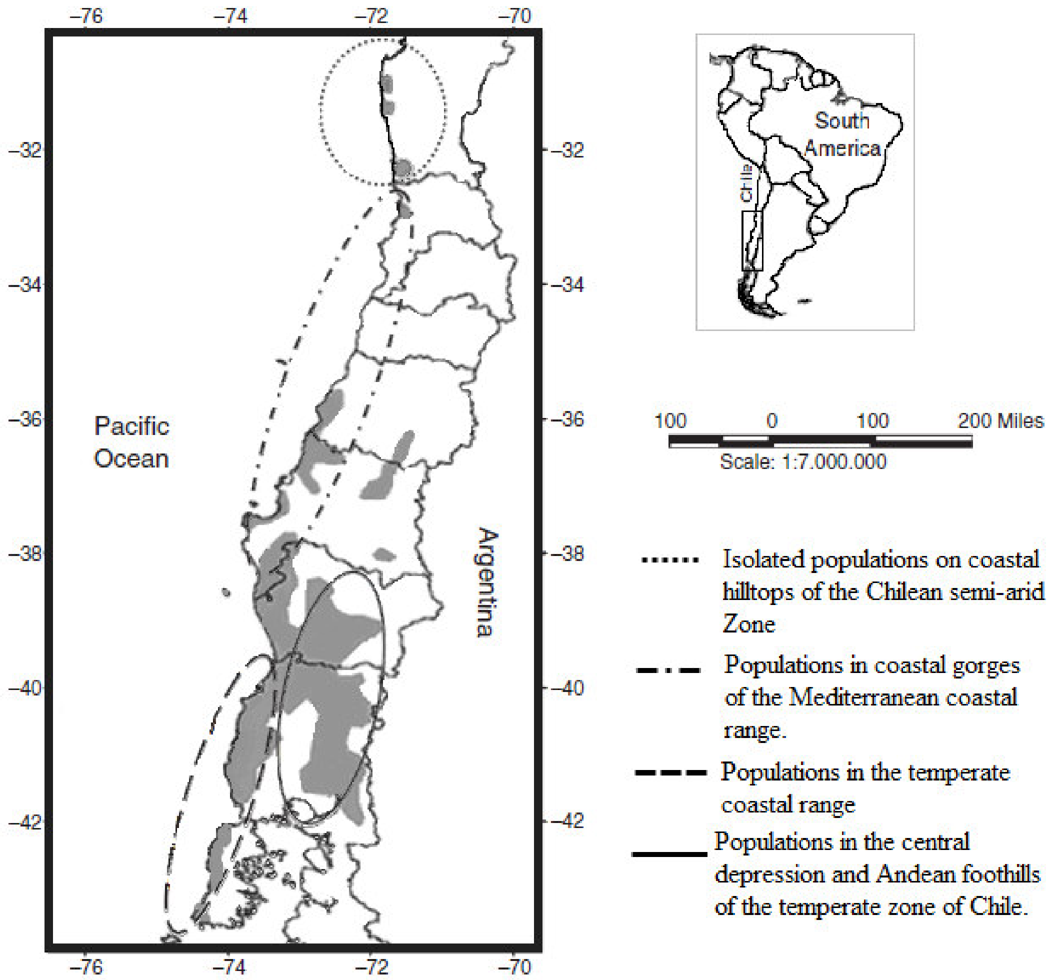

Figure 3.5: Geographic distribution of *Aextoxicon punctatum* Ruiz *et* Pav. (*Olivillo*) across the Chilean territory. The horizontal and vertical axes denote the longitude and latitude, respectively. Adapted from Nuñez- Ávila *et al.* (2006) with permission from CSIRO Publishing.

be as high as 45 m. The tree layer is dominated by *Laureliopsis philippiana* (*Tepa*), *Weinmannia trichosperma* (*Tineo*), *Dasyphyllum diacanthoides* (*Palo Santo*) and *Saxegothaea conspicua* (*Mañio hembra*). The *Tepa-Tineo* forest is located in regions with significant slopes and it is therefore well preserved (Ramírez & San Martín 2005). The altitude at which it is distributed ranges between 500 and 800 m a.s.l., and on both sides of the Coastal Range (see number 3 in Figure 3.1).

3.2.2 Syntaxonomy

The associations on the western side of the Valdivian coastal landscape belong to the climatic class of the Austro-Chilean vegetation circle Wintero-Nothofagetea (Oberdorfer 1960) in the order Laurelietalia philippianae (Oberdorfer 1960) and Aristotelietalia chilensis (Hildebrand 1983). Considering the syntaxonomic suggestions by Oberdorfer (1960) and Hildebrand (1983), and according to ICFN (2003), the aforementioned vegetation associations can be classified as follows:

Cla. Wintero-Nothofagetea Oberdorfer 1960

Ord. Laurelietalia Philippianae Oberdorfer 1960
All. Nothofago-Eucryphion Oberdorfer 1960
SubA. Aextoxiconion punctati Oberdorfer 1960
Ass. *Lapagerio roseae-Aextoxiconetum punctati* Oberdorfer 1960
SubA. Nothofago-Eucryphienion cordifoliae Oberdorfer 1960
Ass. *Nothofago dombeyi-Eucryphietum cordifoliae* Oberdorfer 1960

Ord. Wintero-Nothofagetalia betuloidis Roig, Dollenz *et* Mendez 1985
All. Nothofago-Winterion Oberdorfer 1960
SubA. Weinmannienion trichospermae Oberdorfer 1960
Ass. *Laurelio philippianae-Weinmannietum trichospermae* Oberdorfer 1960
Ass. *Fitzroyetum cupessoidis* Oberdorfer 1960
All. Nothofagion betuloidis (Oberdorfer 1960) Roig, Dollenz *et* Mendez 1985
Ass. *Nothofagetum betuloidis* Oberdorfer 1960

Ord. Myrceugenietalia exsuccae Oberdorfer 1960
All. Myrceugenion exsuccae Oberdorfer 1960
Ass. *Myrceugenielletum apiculatae* Villagran 1980 in Amigo *et al.* 2000

Oll. Aristotelietalia chilensis Hildebrand 1983
All. Berberidion buxifoliae Oberdorfer 1960
Ass. *Griselinio jodinifoliae-Pernettyetum poeppigii* Hildebrand 1983

C: Nothofagetea pumiliomis-Antarcticae Oberdorfer 1960
Ass. *Nothofagetum nitidae* Oberdorfer 1960
Ass. *Baccharido-Nothofagetum antarticae* Ramírez 1996

3.3 Current vegetation

The current or real vegetation is defined as the vegetation community existing on a given area as a consequence of the various human activities (Rivas-Martínez 2005; 1987). The current vegetation of the Valdivian coastal landscape can be described as a mosaic of vegetation formations (see Figure 3.6). Examples are:

- Woodlands of primary origin and with different preservation/intervention degrees;
- Scrublands of secondary origin and grasslands of anthropogenic origin (Ramírez *et al.* 1992; Montaldo 1975);
- Areas with different degrees of human intervention (see Figure 3.7), such as plantations with exotic species (*Pinus radiata* and *Eucalyptus globulus*), croplands, pastures for livestock and urban areas (see Figure 3.8).

This variety originates from the partial or total destruction of the original forest (Otero 2006; Ramírez & San Martín 2005; Donoso 1983; Montaldo 1975; 1975a). The partial destruction is caused by the need of wood for the construction of houses or for combustible,

Figure 3.6: Overview of the Valdivian coastal landscape, a example between Huiro and Punta Galera. 1: *Patagua Marina* coastal scrub; 2: mixded vegetation; 3: *Olivillo* forest; 4: *Eucalyptus globulus* plantation; 5: mixed forest. Photographed by the author in February 2012.

the total destruction by fires lighted to turn the territory into arable land and grassland for pasture.
Human intervention affects the original soils by changing their physical and chemical properties (Ellies 1995; Ellies *et al.* 1993; 1991; Seguel *et al.* 1992). This change depends on the kind of activity performed and on its intensity (Ramírez *et al.* 2005; 2003; 1997; 1992). As a consequence of human intervention, secondary and tertiary vegetation communities with permanent character have developed (Meaza 2000; Añazco *et al.* 1981; Tüxen 1975), thus preventing the regeneration of the original vegetation (Moraga *et al.* 1985; Ramírez *et al.* 1983). These communities represent an anthropogenic climax as defined by Montaldo (1975a), which is based on the factors impacting the original soil (Pott 1995; 1988).
The vegetation formations of secondary and anthropological origin (Montaldo 1975) consist mainly of non-native species which were accidentally or intentionally introduced (Otero 2006; Matthei 1995). These are now naturalized or invasive (Fuentes *et al.* 2014; Quiroz *et al.* 2009; Montaldo 1975; Reiche 1938) and consist mainly of weeds with low nutritional values (Oberdorfer 1966).

3.3.1 Vegetation units

The secondary communities/associations correspond to shrublands and grasslands. In the investigated area, nine associations are described in the literature: seven grasslands and two shrublands. The following grasslands were recognised:

Figure 3.7: Overview of the current landscape in the Bonifacio Sector. A similar landscape is present in the Valdivian coastal region as well. Exotic-species plantations (1) (*Pinus radiata* and (2) *Eucaliptus globulus*; (3) Grasslands used for shepherding; (4) mixed forest; (5) Quila Scrub on the Pacific's Cliff; (6) rest of forest together with natural grasslands. Photographed by the author in February 2012.

- *Acaeno ovalifoliae-Agrostietum capillaris* Oberdorfer 1960 (*Chépica-Cadillo* grassland);
- *Airo caryophyllae-Agrostietum capillaris* Ramírez *et al.* 1985 (*Aíra* grassland);
- *Junco imbricatae-Agrostietum capillaris* Ramírez *et al.* 1998 (*Junco duro* grassland);
- *Juncetum proceri* Oberdorfer 1960 (*Junco húmedo* grassland);
- *Centello asiaticae-Agrostietum capillaris* Ramírez *et al.* 1985 (*Centella* grassland);
- *Centello asiaticae-Anthoxanthetum utriculati* San Martín *et al.* 1992 (*Paja ratonera* grassland);
- *Trifolio repenti-Vulpietum bromidis* Finot & Ramírez 1998 (*Cepilla* grassland).

The following shrublands were identified:

- *Fuchsio magallanicae-Chusqueetum quilae* Hildebrand 1983 (*Quila* shrubland);
- *Rubo constricto-Ulicetum europaei* Hildebrand 1983 (*Espinillo* shrubland).

These communities of secondary character are mainly grouped into pastures of the order AGROSTIETALIA CAPILLARI (San Martín *et al.* 1993) and PLANTAGINETALIA (Tüxen 1950) and into scrubs of ARISTOTELIETALIA CHILENSIS (Hildebrand 1983).

3.3.2 Syntaxonomy

Following Oberdorfer (1960), Hildebrand (1983), Ramírez *et al.* (1998, 1985) and San Martín *et al.* (1993, 1992), the syntaxonomy of the current vegetation can be summarised with the following schema:

Cla. PLANTAGINETEA Tüxen *et* Preising 1950 in Oberdorfer 1960
  Ord. PLANTAGINETEA Tüxen 1937 in Oberdorfer 1960
      ASS. *Trifolio repenti-Vulpietum bromidis* Finot *et* Ramírez 1998

C: MOLINIO-ARRHENATHERETEA Tüxen 1937
  Ord. AGROSTIETALIA CAPILLARIS San Martín, Medina, Ojeda *et* Ramírez 1993
    All. AGROSTIDION CHILENSIS Oberdorfer 1960
      ASS. *Acaeno ovalifoliae-Agrostietum capillaris* Oberdorfer 1960
      ASS. *Airo caryophyllae-Agrostietum capillaris* Ramírez *et al.* 1985
      ASS. *Junco imbricatae-Agrostietum capillaris* Ramírez *et al.* 1998
    All. CENTELLION ASIATICAE San Martín *et al.* 1992
      ASS. *Centello asiaticae-Agrostietum capillaris* Ramírez *et al.* 1985
      ASS. *Centello asiaticae-Anthoxanthetum utriculatis* San Martín *et al.* 1992
    All. JUNCION PROCERI Oberdorfer 1960
      ASS. *Juncetum proceri* Oberdorfer 1960

Cla. WINTERO-NOTHOFAGETEA Oberdorfer 1960
  Ord. ARISTOTELIETALIA CHILENSIS Hildebrand 1983
    All. BERBERIDION BUXIFOLIACEAE Oberdorfer 1960
      ASS. *Fuchsio magallanicae-Chusqueetum quilae* Hildebrand 1983
    All. GAULTHERION PHILLYREAEFOLIAE Hildebrand 1983
      ASS. *Rubo constricto-Ulicetum europaei* Hildebrand 1983

3.4 Previous studies

The Coastal Mountain Range was therefore considered for many different investigations (see Smith-Ramírez *et al.* 2005). The Valdivian Coastal Range has been considered for various studies as well, with focus on the La Pelada Mountain Range (see overview by de Sanhueza & Gil 2004).
Various investigations on the *Olivillo* forest can be found in the literature. One example is Peréz & Villagrán (1994), who studied the climatic influence on the floristic, vegetational and edaphic changes of the *Olivillo* distribution. Peréz (1994) focused on the sclerophyllous indices and on the mineral content in the soils of the *Olivillo* forests. Le Quesne *et al.* (1999) studied the vegetation dynamics on the Mocha Island during the late Holocene, and Squeo *et al.* (2004) the ecophysiology of the relict forests in the Fray Jorge National Park. Nuñez & Armesto (2006) examined the genetic structure and diversity of the various populations of *Olivillo* forest and how these reflect their biogeographic history.
The *Olivillo* forest in the Valdivian Coastal Range has been investigated by several authors. Mora's phytosociological studies of the coastal and lacustrine woodlands are among

the most relevant (1986). Ardiles (1977) divided the associations of the La Pelada Mountain Range into three altitude-based levels. Cárdenas (1976) described the flora and the vegetation of the *Olivillo* forest. Riveros & Ramírez (1978) performed an analysis of the epiphytic vegetation, and Riveros & Alberdi (1978) investigated the seasonal fluctuations of the fallen-leaves accumulation in this forest. These last three searches were carried out in Fundo San Martín (Valdivia). Saravia & Uribe (1991) focused on the herbaceous layer of these woodlands, and San Martín *et al.* (2008) on the composition and structure of the epiphyte vegetation in Predio Rucamanque (Temuco). Researches about the dynamics and perturbations of the *Olivillo* forests have been performed in the Southern temperate coastal range in the regions of Fray Jorge and Santa Inés (Squeo *et al.* 2004; Francois 2004; Le Quesne *et al.* 1999; Armesto *et al.* 1996), leading to the conclusion that auto-regeneration occurs through the small "windows" which are opened in the forest's canopy when trees fall.
As mentioned in section 3.3, the current landscape shows primary and new vegetation communities, with the latter replacing the former as a consequence of human activity. This has been the topic of a number of investigations on the current vegetation along the Valdivian coast, and in particular on its phytosociology (Ramírez & San Martín 2005; Ramírez *et al.* 1996b; 1993; 1985; Oberdorfer 1960), synecology (Ramírez *et al.* 1999; Montaldo 1975) and vegetation dynamics (Ramírez *et al.* 2003; 2000; 1985).
Various investigations have been performed on the soil alteration due to human activity. Ramírez *et al.* (1995; 1992a) and San Martín *et al.* (2009) evaluated anthropogenic grasslands by using ecological indicators. The impact of the different management (forestry, agriculture and cattle grazing) on the flora, vegetation and on the soil's physical and chemical properties have been studied by Ramírez *et al.* (2005; 2003; 1993a; 1997; 1997; 1996), Ellies (1995), Ellies & Contreras (1997), Ellies *et al.* (1996; 1995; 1993a; b; c), Seguel (2002a; b), Dörner *et al.* (2009 a; b). These investigations were performed mainly on the Eastern side of the Coastal Mountain Range and of the Intermediate Depression in Central and Southern Chile, as the soils in these regions are of volcanic origin and are important from an agricultural and forestal point of view (Bonelli & Schlatter 1995; Ellies *et al.* 2000; Sadzawka *et al.* 1995; Luzio *et al.* 2003; Ramírez *et al.* 1996a).

Figure 3.8: Examples of the current landscape in the research area. Top: area of *Olivillo* forest converted into potatoes crops (Huiro sector). Bottom: cultivable fields, shepherding and urban areas (Guape sector). Photographed by the author in February 2012.

Part II

Analysis and results

Chapter 4

Methodology

4.1 Flora

The floristic list is based on the species identified in the considered vegetation relevés. The *in situ* identification of the native flora follows Marticorena *et al.* (2010), Riedemann & Aldunate (2006), Rodríguez *et al.* (2005; 1983) and Hoffman (1991). Rodríguez *et al.* (2009), Larraín (2009), Ardiles *et al.* (2008) and Gunkel (1984) were consulted for the recognition of Bryophytes, and Matthei (1995) for the adventitious plants. The species common name is based on Baeza (1930), Muñoz (1966) and on support from the local population.
The nomenclature used for Bryopsida is based on He (1998), and the ones for Polypodiopsida, Pinopsida and Angiosperms on Marticorena & Rodríguez (2003, 2003a; 2001; 1995) and on Zuloaga *et al.* (2008). The nomenclature considered in this thesis is consistent with the one in The Plant List (2013), Catalogue of Life (Roskov *et al.*, 2014) and IPNI (2004).
The study of the phytogeographic origin was performed following Marticorena & Quezada (1985) and Zuloaga *et al.* (2008), see Table 4.1.
The lifeforms of the species were determined according to Ellenberg & Müller-Dombois

Table 4.1: Phytogeographic origins of the species and corresponding abbreviations. A: according to Marticorena & Quezada (1985) and B: according to Zuloaga *et al.* (2008).

Phytogeografic origin	Abbreviation
A	
Native	N
Non-native (Adventitious, Introduced, Naturalized)	A
B	
Endemic (Chile)	E (Ch)
Endemic (Chile - Argentina)	E (Ch-Arg)
Native	N
Cosmopolite	C
Naturalized	nat
Introduced	I
Adventitious	a

Table 4.2: Raunkiaer's System of plant lifeforms according to Ellenberg & Müller-Dombois (1967).

Lifeforms	Abbreviation
Phanerophytes	P
Nanophanerophytes	N P
Microphanerophytes	Mi P
Mesophanerophytes	Mes P
Megaphanerophytes	Meg P
Hemicryptophytes	H
Therophytes	T
Chamaephytes	Ch
Geophytes	G
Epiphytes	E
Lianas	L
Bryophytes	B

Table 4.3: Conservation-status categories according to the International Union for Conservation of Nature version 3.1 (IUCN) and corresponding abbreviations.

Status	Abbreviation
Extinct	EX
Extinct in the Wild	EW
Critically Endangered	CR
Endangered	EN
Vulnerable	VU
Near Threatened	NT
Least Concern	LC
Data Deficient	DD
Not Evaluated	NE

(1967), see Table 4.2. The lifeforms were used to prepare the related biological spectra by considering the absolute frequency and coverage of the species.

The conservation-status categories of the species are based on the International Union for Conservation of Nature (IUCN version 3.1, see Table 4.3). For each species, the corresponding category was assigned as suggested by Gardner (2013), Rodríguez *et al.* (2009; 2005), Zizka *et al.* (2009), García & Ormazábal (2008), Hechenleitner *et al.* (2005), Gonzáles (1998), Prado (1998), Hoffmann (1991), Benoit (1989), and Government Decrees (DS[1][2]). These bibliography resources were used by the Chilean Environment Ministry to draw up the National Species List[3]. It is worth nothing that some of the conservation status categories in the list were determined based on the Species Classification Regulations (RCE[4]) (Ministerio de Medioambiente 2013).

[1]Decreto Supremo.

[2]DS N° 151 de 2007, DS N° 50 de 2008, DS N° 51 de 2008, DS N° 23 de 2009 and DS N° 33 de 2012.

[3]Inventario Nacional de Especies. Available from: especies.mma.gob.cl.

[4]Reglamento para la Clasificación de Especies Silvestres.

Table 4.4: Minimal areas considered for the plant communities in the investigated region according to Nuñez (1987).

Vegetation Form	Area of the relevé [m^2]
Grassland	100
Shrubland	200
Woodland	400

Table 4.5: Equivalence between the original Braun Blanquet cover-abundance scale, the percentage cover values and the van der Maarel ordinal transformation scale, which are often used for numerical analysis.

Braun-Blanquet	Abundance	Cover range [%]	Scale
r	1	< 1	1
+	2-5	< 1	2
1	6-50	≤ 5	3
2	more then 50	6 - 25	5
3	any	26 - 50	7
4	any	51 - 75	8
5	any	76 - 100	9

4.2 Vegetation

4.2.1 Phytosociological method

The vegetation units of the Valdivian Coastal area were identified during preliminary prospecting work by the author. For this purpose, relevés were performed in the floristically, physionomically and ecologically homogeneous sectors (Dierschke 1994; Knapp 1984) according to the phytosociological methodology of the Sigmatist European School (Braun-Blanquet 1964) as updated by Géhu & Rivas-Martínez (1981). The size of each relevé corresponds to the minimal area suggested by Nuñez (1987) and recommended in the literature (Dengler *et al.* 2008, van der Maarel 2005; Frey & Lösch 2004; Steubing *et al.* 2002; Pott 1998; Knapp 1984 and Table 4.4).
In each sampled area, the list of the present species was created and the percentage cover value (Abundance-Dominance) estimated (Müller Dombois & Ellenberg 1974). As suggested by Knapp (1958; 1954), the following notation was used for values smaller than 1%:

- "+" when various species individuals were present;
- "r" when only one species individual was present.

The percentage cover values were also converted into the Braun-Blanquet cover-abundance scale, see Table 4.5. For the sake of completeness, Table 4.5 reports the equivalent values of the widely-used van der Maarel scale as well (van der Maarel 1975).
Total tree, scrub and herbs cover were recorded in each sampled plot by following the guidelines in Mucina *et al.* (2000), as well as vegetation high, altitude, aspect, exposition and slope. The information was collected in a TURBOVEG database for the processing of phytosociological data (Hennekens & Schaminée 2001; Hennekens 1996).

4.2.2 Tabulation and phytosociological analysis

All relevés were used to create the initial phytosociological table, according to the Braun-Blanquet procedure (Müller-Dombois & Ellenberg 2002). The table was analysed as a function of the species and of the relevés. The initial table reports the absolute frequency and the importance value for each species. In particular, the importance value (I.V.) is used to identify the significant species in the investigated area or units (Ramírez *et al.* 1997). It is calculated as follows (Wikum & Shanholtzer 1978):

$$\text{I.V.} = [A] + [B]\ .$$

In the above formula, the quantities $[A]$ and $[B]$ are the relativity frequency and coverage, which are defined as:

$$[A] = \left(\frac{\text{Fre}_\text{a}}{\text{Fre}_\text{t}}\right) \cdot 100 \quad \text{and} \quad [B] = \left(\frac{\text{Cov}_\text{a}}{\text{Cov}_\text{t}}\right) \cdot 100\,,$$

where Fre_a and Cov_a are the absolute frequency and coverage, and Fre_t and Cov_t the total frequency and coverage.

It is worth nothing that both the relative frequency and coverage for each species were considered for the calculation of the I.V. Moreover, the I.V. has a maximal value of 200 and is only valid for the table in which it was calculated.

The vegetation units were identified by *i*) ordering the table via traditional methodology based on differential species (Dengler *et al.* 2008; Frey & Lösch 2004; Ramírez & Westermeier 1976), and *ii*) following Daniëls' suggestion (1982) on the determination of differential species when comparing vegetation types with each other.

For a given vegetation unit, the diagnostic (or character, differential) species are those showing a distinct occurrence or abundance concentration. They can be used for the in situ identification of previously described vegetation units and to delimit associations (Braun-Blanquet 1921; Westhoff & van der Maarel 1973; Dierschke 1994).

The diagnostic species were identified by calculating the fidelity values with the Phi-coefficient (Φ) (Sokal & Rohlf 1995), which estimates the strengthness of the association between species and units (Chytrý *et al.* 2002). The coefficient is calculated via standardization of the group's size according to Tichý & Chytrý (2006). It is used to generate the lists of the diagnostic species for each relevé group. The Phi coefficient is based on only presence/absence data. Hence, the species cover and abundance do not contribute to the calculation of the fidelity values.

The Φ values range between -1 and 1. For the sake of clarity, such values were multiplied by 100. To select the diagnostic species, an arbitrary fidelity threshold of 30 was set. Diagnostic species were also identified by the condition of showing a significant concentration in the respective vegetation unit ($p > 0.05$) according to the Fisher's exact test (Chytrý *et al.* 2002).

Thresholds were set for the identification of the constant and dominant species as well. The former are the species with frequent occurrence, the latter those showing high cover values in particular vegetation units. For constant species, the threshold on the frequency value was 60%. Dominant species were selected as those showing a percentage cover larger than 80% in half or more of the relevés.

A synoptic table was created from the phytosociological table. In the synoptic table, species are represented by two indicators: cover range (Table 4.5) and constancy class (Table 4.6). The data were analysed with the JUICE programme (version 7.0.1510) (Tichý 2002) used for the phytosociological analysis.

Table 4.6: Constancy classes (based on Müller-Dombois & Ellemberg 1974, Braun-Blanquet 1964, Tüxen 1974).

Class	Frequency (%)	Interpretation
I	$< 20\%$	Rare
II	$20,1 - 40\%$	Low
III	$40,1 - 60\%$	Intermediate
IV	$60,1 - 80\%$	Moderately High
V	$80,1 - 100\%$	High

4.2.3 Syntaxonomy

The identified vegetation communities were used to create a synthetic table (Dierschcke 1994). This provided the reference information for the suggested syntaxonomical schema of the vegetation in the investigated area. Were detected associations which were previously described, checking this validity and in some cases complementing it by assigning lectotypes. The new associations were described according to suggestion of International Code of the Phytosociological Nomenclature (ICPN).
The classification of associations to higher syntaxonomic levels was done according the classical syntaxonomy described for the research area (Oberdorber 1960; Hildebrand 1983; Tüxen 1983, San Martín *et al.* 1993)
All recognized syntaxonomical units are based on the latest update of the ICPN (Weber *et al.* 2000)

4.3 Statistical Analysis

The data was analysed by following multivariate, classification and ordination statistical approaches. The data-analysis procedure is summarised in this section, and the results are reported in the following chapters.

Classification analysis

As mention in Subsection 4.2.1, the initial phytosociological table, including 169 relevés (cases) and 137 species (variables), was converted into presence/absence data and into the van der Maarel scale (ordinal transformation). Subsequently, the data in the table was analysed with a classification procedure based on the Ward's agglomerative technique and the Euclidean distance as measure of the floristic similarity (Murtagh & Legendre 2014; Leyer & Wesche 2007; Székely & Rizzo 2005; Backhaus *et al.* 2003; Lapointe & Legendre 1994; Ward 1963). Following this approach, the most similar sites from a vegetation point of view were progressively clustered into a bottom-up hierarchical structure. The cluster analysis was performed with the PAST data-analysis software (version 3.11) (Hammer 2015; Hammer *et al.* 2001). This approach enabled the recognition of the various vegetation groups (clusters) and their characteristic species. The result was then used for a quantitative estimate of the vegetation dynamics across the collected relevés.

Ordination analysis

The ordination analysis was based on an indirect gradient approach. This was performed via a Detrended Correspondence Analysis (DCA, see Hill & Gauch 1980). The DCA was carried out with the Juice-R function of the JUICE 7.0 software (Tichý 2002). Calculations and *ad-hoc* output plots are run with the R software (release 2.9.0) and by using Vegan package (Oksanen *et al.* 2009).

Chapter 5

Floristic results

The results in this section are based on the floristic catalogue, which was created from the initial phytosociological table. The catalogue is reported in Appendix B, with the species grouped into Classes, Orders and Families and listed alphabetically. The lifeforms and the phytogeography origins of each species, as defined in Zuloaga *et al.* (2008), are also considered in the catalogue, see Section 4.1.

5.1 Systematics

The flora of the investigated area consists of 137 species. These are grouped into 5 classes, 62 families and 117 genera. Two class distributions were considered, based on the frequency and coverage of the species (Figure 5.1).
With regards to the frequency-based distribution, the most represented classes are the

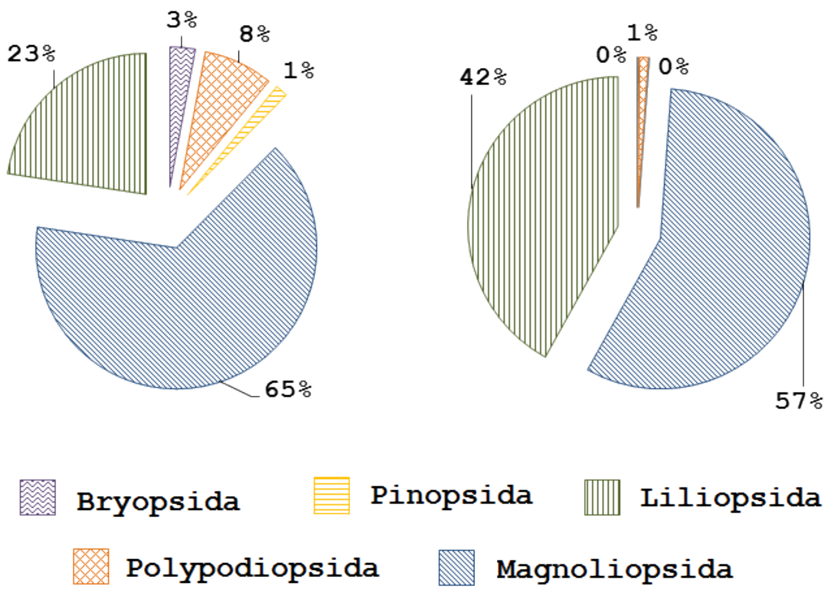

Figure 5.1: Class distribution of the species. A: Frequency-based distribution; B: Coverage-based distribution. For the sake of clarity, the values in the figure have been rounded to the closest integer. Source: Own Data.

Table 5.1: Lifeform spectrum in the investigated area. The frequency-based spectrum is shown in the first and second column, the coverage-based spectrum in the third and fourth. The following notation was used. P: Phanerophyte; Mes P: Mesophanerophyte; Mi P: Microphanerophyte; N P: Nanophanerophyte; L: Liana; Ch: Chamaephyte; H: Hemicryptophyte; G: Geophyte; T: Therophyte; E: Epiphyte; B: Bryophyte. Source: Own Data.

	Frequency	[%]	Cover	[%]
P	43	31.39	9461	45.18
Mes P	7	5.11	4107	19.61
Mi P	17	12.41	1014	4.84
N P	19	13.87	4340	20.73
L	6	4.38	416	1.99
Ch	6	4.38	196	0.94
H	46	33.58	9822	46.91
G	7	5.11	17	0.08
T	14	10.22	763	3.64
E	10	7.3	220	1.05
B	5	3.65	44	0.21
Total	137	100	20939	100

Magnoliopsida and Liliopsida. With 89 and 31 species respectively, the two classes cover 65% and 23% of all species. Lower frequency values characterize the Bryopsida, Polypodiopsida and Pinopsida classes. As for the coverage-based distribution, the class with the highest value is the Liliopsida (57%), with the Magnoliopsida showing a lower coverage (42%). The contribution of the other classes is comparable to or smaller than 1%.

5.2 Lifeforms and biological spectrum

The lifeforms in the investigated area are listed in Table 5.1. According to the frequency-based classification, the Hemicryptophyte and Phanerophyte are the most represented lifeforms. With 46 and 43 species respectively, they include 34% and 31% of all species. Therophyte, Epiphyte and Geophyte are present with 14, 10 and 7 species respectively, corresponding to 10%, 7% and 5%. Lower contributions come from Liana and Chamaephyte (6 species each) and Bryophyte (5 species), each covering 4% of the whole flora.The coverage-based classification offers the same ranking. The Hemicryptophyte and Phanerophyte represent 48% and 46% of the total coverage, followed by Therophyte (3%), Liana (2%) and Epiphyte (1%). The remaining lifeforms have values lower than 1%.
Table 5.1 offers an insight into the Phanerophyte class: the Nanophanerophyte are present with nineteen species, followed by Microphanerophyte and Mesophanerophyte with seventeen and seven, respectively. The ranking changes in the case of the coverage-based distribution, with Nanophanerophyte (21% coverage) followed by Mesophanerophyte and Microphanerophyte (19% and 5%, respectively).

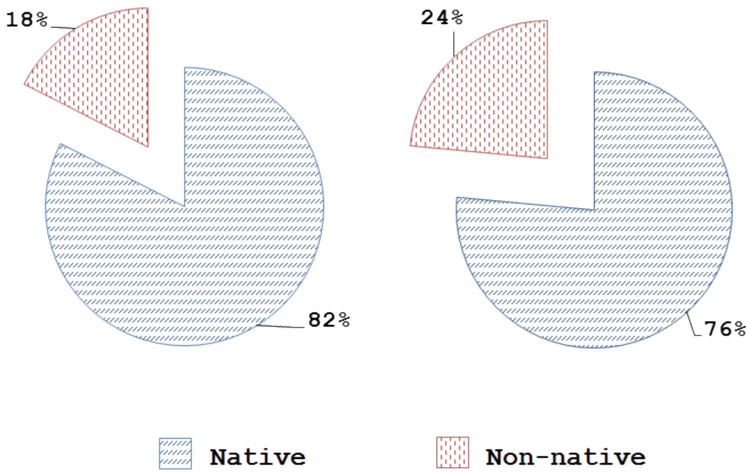

Figure 5.2: Phytogeographic distribution of the species. A: Frequency-based distribution; B: Coverage-based distribution. For the sake of clarity, the values in the figure have been rounded to the closest integer. Source: Own Data.

Table 5.2: Phytogeographic origin of the species in the investigated area according to Zuloaga *et al.* (2008). The frequency- and coverage-based percentage values are reported in the third and fifth column, respectively. The following notation was used. E (Ch): Endemic of Chile; E (Ch-Arg): Endemic of Chile and Argentina; N: Native; C: Cosmopolitan; nat: Naturalised; i: Introduced; a: Adventitious. Source: Own Data.

	Frequency	[%]	Cover	[%]
E (Ch)	25	18.25	5007	23.91
E (Ch-Arg)	51	37.23	6189	29.56
N	37	27.01	4820	23.02
c	3	2.19	2	0.01
nat	2	1.46	1233	5.89
i	4	2.92	1932	9.23
a	15	10.95	1756	8.39
Total	137	100	20939	100

5.3 Phytogeographic origin

The distribution of the species' phytogeographic origin as defined by Marticorena & Quezada (1985) is shown in Figure 5.2. The native species are dominant compared to the Adventitious ones: 82% vs 18% in the case of frequency-based distribution, 76% vs 24% for coverage-based spectra.
Based on the definition of native species in Zuloaga *et al.* (2008), 37% of the species are Endemic of Chile and Argentina, 18% are Endemic of Chile and 27% are Native. The corresponding coverage-based values are 29%, 24% and 23%, respectively (see Table 5.2).

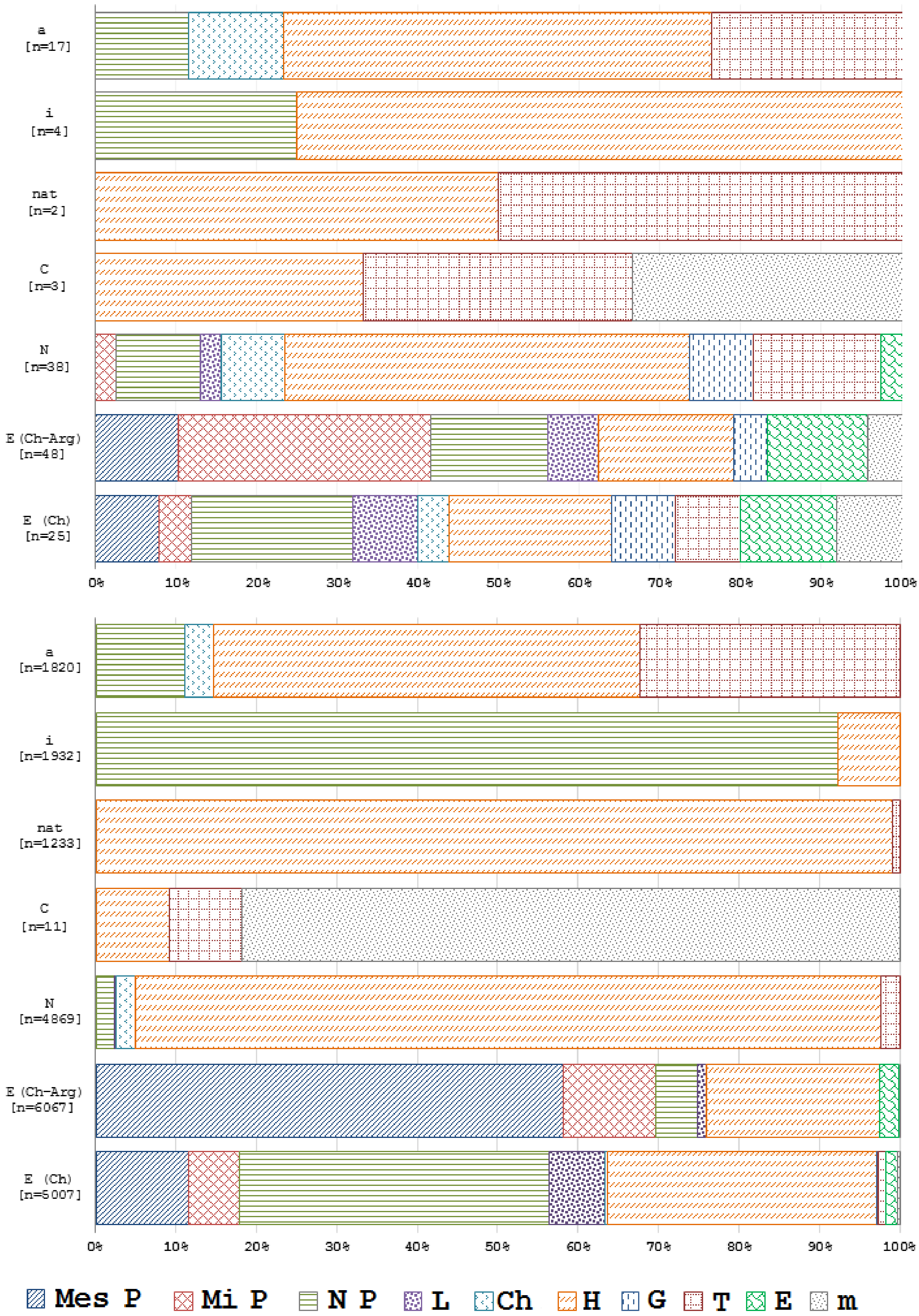

Figure 5.3: Phytogeographic origin of the biological spectrum in the investigated area. The results are expressed in frequency (top) and coverage-based (bottom) percentage values. The notations used for status and lifeforms follows Table 4.1 and 4.2, respectively. The n values give the number of species (top) or the total cover (bottom). Source: Own Data.

The non-native species are Cosmopolitan, Naturalised, Introduced and Adventitious. The corresponding number of species amounts to three, two, four and fifteen, respectively. The coverage values are 10% and 8% for the Introduced and Adventitious species, 6% for the Naturalised specie and less than 1% for the Cosmopolitan ones (see Table 5.2).
By considering the phytogeographic origins of the lifeforms, the non-native species are mainly Hemicryptophytes, Therophytes, Chamaephytes and, to a lower extent, Nanophanerophytes (see Figure 5.3). Among the Hemicryptophytes, the main species are *Agrostis capillaris*, *Leontodon saxatilis* and *Holcus lanatus*, while the *Vulpia bromoides* and *Aira caryophyllea* are the most important within the Therophyte group (see Appendix B). Regarding the Nanophanerophyte, a major role is played by *Ulex europaeus* and *Rubus constrictus*, *Trifolium pratense* and *Prunella vulgaris* are the main species among the Chamaephyte (see Appendix B). In general, these lifeforms are Introduced and Adventitious and offer the grasslands and scrubs of secondary and tertiary character of anthropic origin (see Table 5.2 and Figure 5.3).
The native species (Endemic of Chile, Endemic of Chile and Argentina and Native) are mainly Phanerophytes (Mesophanerophytes, Nanophanerophytes and Microphanerophytes), Lianas and Epiphytes, and part of the original forest.
The main species in each group are the following (see Appendix B for further details):

- **Mesophanerophyte:** *Aextoxicon punctatum*, which is the characteristic species of the *Olivillo* forest together with *Eucryphia cordifolia*, and the Myrtaceae *Blepharocalyx cruckshanksii*, *Amomyrtus luma* and *Amomyrtus meli*, which are also important for the *Olivillo* forest;

- **Microphanerophyte:** *Aristotelia chilensis* and *Drimys winteri*, which are part of both the original wood and the secondary scrubs, with the latter being the community replacing the original vegetation;

- **Epiphyte:** *Fasicularia bicolor* (Bromeliaceae), *Mitraria coccinia* and *Sarmienta scandens* (Gesneriaceae), *Hymenophyllum caudiculatum*, *Hymenophyllum cuneatum* and *Hymenoglossum cruentum* (Hymenophyllaceae), and *Luzuriaga radicans* and *L. polyphylla* (Alstromeriacecae);

- **Liana:** *Lapageria rosea*, which is characteristic of the *Olivillo* forest, together with *Raukaua valdiviensis* and *Hydrangea serratifolia*.

It is worth noting that the majority of the lifeforms are mainly Endemic of Chile and Argentina (see Table 5.2 and Figure 5.3).

5.4 Importance value

The importance values of each species are reported in Appendix C. These were calculated from the initial phytosociological table as explained in Chapter 4. The ten species with the highest important values are listed in Table 5.3.
The first is *Aextoxicon punctatum*, with an importance value of 16.97. The second and third species are *Chusquea quila* (12.06) and *Greigia sphacelata* (9.94), both of endemic origin. The fourth is *Ulex europeaus* (9.61), which is considered a high-potential invasive species (Fuentes *et al.* 2014). It is worth noting that eight out of the ten species in Table 5.3 are native, with the remaining two being adventitious.

Table 5.3: List of the ten species in the phytosociological table with the highest importance values (I. V.). The following notation was used, Abs.: absolute; Rel.: relative; Status: see Table 4.1. Source: Own Data.

		Frequency			Cover		I. V.
Species	Status	Abs.	[%]	Rel.	Abs.	Rel.	
Aextoxicon punctatum	E (Ch-Arg)	47	27.81	2.46	3061	14.51	16.97
Chusquea quila	E (Ch)	58	34.32	3.04	1902	9.02	12.06
Greigia sphacelata	E (Ch)	41	24.26	2.15	1644	7.79	9.94
Ulex europeaus	i	22	13.02	1.15	1783	8.45	9.61
Agrostis capillaries	nat	68	40.24	3.56	1220	5.78	9.35
Juncus procerus	N	26	15.38	1.36	1052	4.99	6.35
Eryngium paniculatum	N	20	11.83	1.05	1048	4.97	6.02
Centella asiatica	N	54	31.95	2.83	654	3.1	5.93
Leontodon saxatilis	a	48	28.4	2.51	570	2.7	5.22
Juncus imbricatus	N	33	19.53	1.73	671	3.18	4.91

5.5 Conservation status

Out of the 137 species in the research area, eighteen (13% of the considered flora) present some of the conservation categories in the IUCN (see Table 4.3). These species, together with their categories, are listed in Table 5.4. Note that the categories are based on two different versions of the IUCN, namely 3.1 and 2.3. This is due to the fact that the categories of some species had not been updated in the new version. Nevertheless, the species whose categories follow version 2.3 were considered for this investigation for their historical conservation precedents. Table 5.4 also reports the Chilean Government Decrees. Out of the 18 species, 8 are threatened: 7 are vulnerable (the Epiphytes of the Hymenophyllaceae family) and 1 is classified as endangered (the liana *Lapageria rosea*). 10 species are considered to have low risk: 4 are near threatened, 4 show least concern, and 2 have not been evaluated completely yet. The last two are *Aextoxicon punctatum* (DD: deficient data) and *Amonyrtus luma* (NE: not evaluated). Nevertheless, an investigation of the distribution in Argentina has been proposed by Prado (1998) for the former and by Walter & Gillet (1998) for the latter.
Out of the species in Table 5.4, 10 are Endemic of Chile and Argentina, 6 Endemic of Chile, and 2 are Native. Out of the categorised species, 7 are Phanerophyte, 4 Mesophanerophyte and 3 Microphanerophyte, 4 Epiphytes, 1 is a Liana, 4 are Chamaephyte and one is a Bryophyte. The species in Table 5.4 are present in the *Olivillo* forest. Examples are *Fascicularia bicolor*, *Greigia sphalaceta*, *Persea lingue*, *Podocarpus nubigenus* and *Saxegothaea conspicua*.

Table 5.4: Species with conservation categories in the research area. The following notation was used. Lifeform: see Table 4.2; Status: see Table 4.1; CS: Conservation status; DS: Government Decree (Decreto Supremo); ***** and ****:** versions 2.3 and 3.1 of the assigned IUCN conservation categories. Source: Own Data.

Species	Life form	Status	CS		Source
Aextoxicon punctatum	Mes P	E(Ch-Arg)	DD	*	Prado 1998
Amomyrtus luma	Mes P	E(Ch-Arg)	NE	*	Walter & Gillet 1998
Blechnum asperum	H	E(Ch)	VU	**	Rodriguez *et al.* 2009, Baeza *et al.* 1998
Blechnum chilense	H	N	LC	**	DS 19/2012 MMA, Baeza *et al.* 1998
Blepharocalyx cruckshanksii	Mes P	E(Ch)	NT	*	Rodriguez *et al.* 2005, Gonzalez 1998
Eucryphia cordifolia	Mes P	E(Ch-Arg)	NT	*	Gonzalez 1998
Fascicularia bicolor	E	E(Ch)	LC	**	Zizka *et al.* 2009, Hoffmann & Flores 1989
Greigia sphacelata	H	E(Ch)	VU	**	Zizka *et al.* 2009, Hoffmann & Flores 1989
Hymenoglossum cruentum	E	E(Ch-Arg)	VU	**	Rodriguez *et al.* 2009, Baeza *et al.* 1998
Hymenophyllum caudiculatum	E	E(Ch-Arg)	VU	**	Rodriguez *et al.* 2009, Baeza *et al.* 1998
Hymenophyllum cuneatum	E	E(Ch-Arg)	VU	**	Rodriguez *et al.* 2009, Baeza *et al.* 1998
Lapageria rosea	L	E(Ch)	EN	**	Serey *et al.* 2007, DS 129/1971
Lobelia bridgessi	Ch	E(Ch)	VU	**	Hechenleitner *et al.* 2005
Lophosoria quadripinnata	H	N	VU	**	Rodriguez *et al.* 2009, Baeza *et al.* 1998
Megalastrum spectabile	m	E(Ch-Arg)	LC	**	DS 13/2013 MMA, Baeza *et al.* 1998
Persea lingue	Mi P	E(Ch-Arg)	LC	**	DS 42/2011 MMA, Benoit 1989
Podocarpus nubigenus	Mi P	E(Ch-Arg)	NT	**	Gardner 2014
Saxegothaea conspicua	Mi P	E(Ch-Arg)	NT	**	Gardner 2013

Chapter 6

Vegetation results

6.1 Phytosociological table and tabulation

The initial phytosociological table includes 169 releés and 137 species (see Table D.1 in Appendix D). The related geographic information is reported in Appendix E.
The histogram of the constancy classes is shown in Figure 6.1. The most populated group is Class I, which includes 122 species (89% of the total amount). The fact that the largest fraction of species is in Class I indicates that there exists a significant floristic heterogeneity among the relevés. This implies the presence of more than one community in

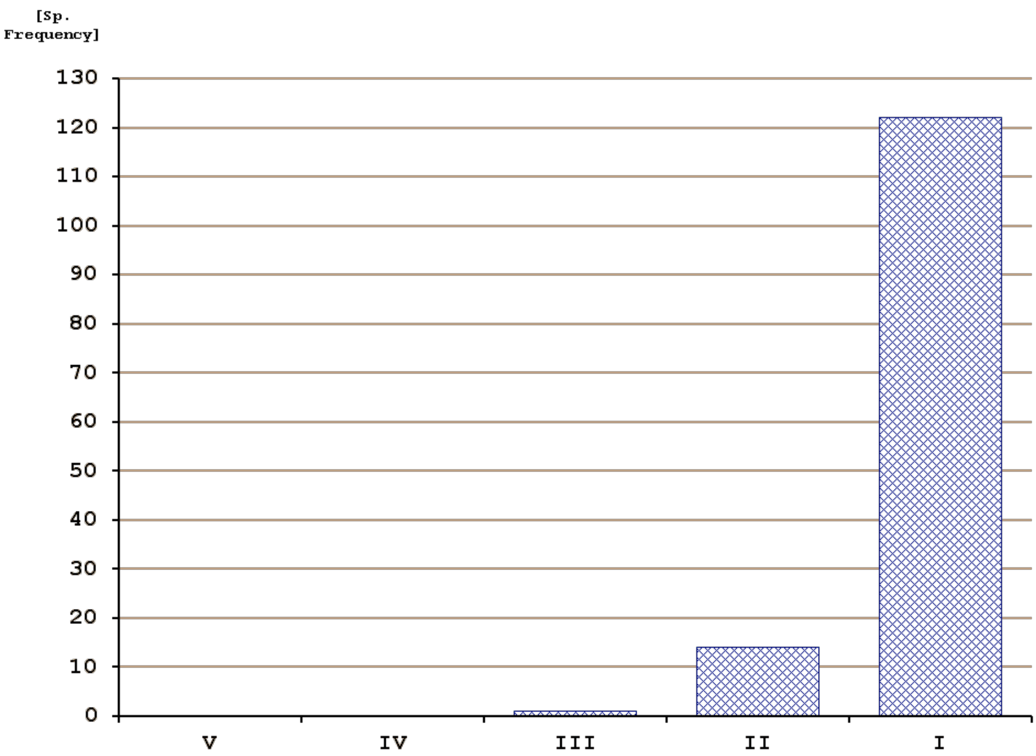

Figure 6.1: Histogram of the constancy classes. The following frequency ranges are used. I: frequency $< 20\%$; II: $20,1-40\%$; III: $40,1-60\%$; IV: $60,1-80\%$; V: $80,1-100\%$. Source: Own data.

the investigated area. The Class II and III cover 10% and 1% of the species, respectively. Class IV and V are not represented. This means that there are no dominant species in the investigated area.
The species in frequency classes II and III of the initial partial table (see Table D.1 in Appendix D) were used to determine the vegetation units. This approach enabled the identification of the following fifteen species:

> *Agrostis capillaris, Rubus constrictus, Chusquea quila, Holcus lanatus, Centella asiatica, Lapageria rosea, Prunella vulgaris, Leontodon saxatils, Lotus pedunculatus, Aextoxicon punctatum, Greigia sphacelata, Eucryphia cordifolia, Rhaphithamnus spinosus, Luzuriaga radicans, Centaurium cachanlahuen.*

Species such as *Aextoxicon punctatum*, *Lapageria rosea*, *Eucryphia cordifolia*, *Rhaphithamnus spinosus* and *Luzuriaga radicans* were used to identify the forest. The identification of the scrublands was based on *Rubus constrictus* and *Chusquea quila*. The *Greigia sphacelata* enabled the identification of a grassland unit. This is a new unit and will be discussed in the following sections. The grasslands were identified with *Agrostis capillaris*, *Holcus lanatus*, *Centella asiatica* and *Centaurium cachanlahuen* (see Table D.1 and D.2 in Appendix D).
Based on the data in Table D.2, we also identified eight species showing a coverage value between three and five despite their low frequency. The species are:

> *Ulex europaeus, Eryngium paniculatum, Juncus procerus, Anthoxanthum utriculatum, Juncus imbricatus, Aira caryophyllea, Acaena ovalifolia, Vulpia bromoides.*

The eight species were added to the aforementioned list with fifteen and enabled the identification of further units. One shrubland was identified through the *Ulex europaeus* and few types of grassland were found by considering the other species (see Table D.2 in Appendix D).
Table D.2 was analysed with the JUICE software. As outline in section 4.2, the analysis performed with JUICE enabled the calculation of the fidelity values. These were then used to identify the diagnostic species and to find the dominant and constant species.
The analysis led to the identification of 101 diagnostic species, 77 constant species and twelve dominant species (see Table 6.1). Nine of the diagnostic species are shared with other vegetation units, with Φ values ranging between 31.5 and 72.2. Out of these nine species, two are diagnostic for the *Olivillo* forest: *Chusquea quila* and *Greigea sphacelata*. The corresponding Φ values are 30 and 40. However, the values are larger in the *Quila* and *Chupón* groups (63.5 and 72.2, respectively). The other seven species are *Centella asiatica*, *Dichondra sericea*, *Gamochaeta americana*, *Lotus pedunculatus*, *Vulpia bromoides*, *Aira caryophyllea*, *Carex fuscula*.
Centella asiatica and *Dichondra sericea* are both shared among four units: the former is a diagnostic species in the *Cardoncillo*, *Junco húmedo*, *Paja ratonera* and *Centella* units, the latter in the *Chépica - Cadillo*, *Aíra*, *Junco duro* and *Cepilla* units. *Gamochaeta americana* is diagnostic in three units: *Junco duro*, *Cepilla* and *Chépica - Cadillo*. Finally, *L. pedunculatus* is diagnostic in the *Paja ratonera* and *Centella* units, *V. bromoides* in the *Aíra* and *Cepilla* units, and both *A. caryophyllea* and *C. fuscula* in the *Centella* and *Aíra* units.
The units sharing the most diagnostic species are *Aira* and *Centella* with four, *Cepilla* with three, *Paja ratonera*, *Junco duro*, *Chépica - Cadillo* and *Olivillo* with two, *Quila*, *Cardoncillo*, *Chupón* and *Junco húmedo* with one.

Table 6.1: Information obtained from the analysis of the synoptic table performed with the JUICE data-analysis software. The following notation is used. Dg: diagnostic species; Ct: constant species; Dm: dominant species. Source: Own data.

			Number of species		
Vegetation Unit	Positive fidelity	Sharpness	Dg	Ct	Dm
Olivillo forest	39.63	114.92	39	13	1
Espinillo shrub	15.46	53.72	7	2	1
Quila shrub	8.66	20.37	2	1	1
Aíra grassland	19.50	26.60	6	8	1
Cardoncillo grassland	13.22	21.97	5	5	1
Centella grassland	24.26	34.74	9	13	1
Cepilla grassland	16.01	28.54	6	5	1
Chépica - Cadillo grassland	16.19	13.67	4	10	1
Chupón grassland	10.39	16.39	7	2	1
Junco duro grassland	14.92	19.90	6	7	1
Junco húmedo grassland	9.50	18.10	4	4	1
Paja ratonera grassland	12.57	24.39	6	7	1

Table D.2 was also analysed with the PAST software. This programme was used to perform the cluster analysis, which is described in Section 6.2.

6.2 Syntaxonomic overview

Following the procedure outlined in Subsection 4.2.2, 12 vegetation units were identified in the phytosociological table: 11 vegetation associations and 1 communities (Table D.3 and D.4). Out of the 12 units, 3 are proposed by the author for the investigated area: two associations and one community. The sampled vegetation is assignable to two classes: Wintero-Nothofagetea Oberdorfer 1960 and Molinio-Arrhenatheretea Tüxen 1937.
In the class Wintero-Nothofagetea Oberdorfer 1960, 2 orders and 3 alliances are assignable. The following syntaxa were identified: Laurelietalia Oberdorfer 1960 with the alliance Nothofago-Eucryphion Oberdorfer 1960, and Aristotelietalia chilensis Hildebrand 1983 with the alliances Berberidion buxifoliae Oberdorfer 1960 and Gaultherion phyllyreafoliae Hildebrand 1983.
As for Molinio-Arrhenatheretea Tüxen 1937, 1 order and 3 alliances are assignable. The following syntaxa were found: Agrostidetalia capillari San Martín *et al.* 1993 with the alliances Agrostidion chilensis Oberdorfer 1960, Juncion proceri Oberdorfer 1960 and Libertion chilensis all. nov.
The syntaxonomic classification of the vegetation in the Valdivian coastal landscapes is summarised as follows:

Cla. Wintero-Nothofagetea Oberdorfer 1960
  Ord. Laurelietalia Oberdorfer 1960
    All. Nothofago-Eucryphion Oberdorfer 1960
      SubA. Aextoxiconion Oberdorfer 1960
        Ass. *Lapagerio roseae-Aextoxiconetum punctati* Oberdorfer 1960 [Olv. F]

Ord. ARISTOTELIETALIA CHILENSIS Hildebrand 1983
All. BERBERIDION BUXIFOLIAE Oberdorfer 1960
ASS. *Fuchsio magellanicae-Chusqueetum quilae* Hildebrand 1983 [Qui. S]
ASS. *Rubo constricto-Greigietum sphacelaetae* ass. nov [Chu. G]

All. GAULTHERION PHYLLYREAFOLIAE Hildebrand 1983
ASS. *Rubo constricto-Ulicetum europaei* Hildebrand 1983 [Esp. S]

Cla. MOLINIO-ARRHENATHERETEA Tüxen 1937
Ord. AGROSTIDETALIA CAPILLARI San Martín *et al.* 1993

All. LIBERTION CHILENSIS all. nov.
ASS. *Agrostio capillariae - Eryngietum paniculatae* ass. nov. [Car. G]

All. JUNCION PROCERI Oberdorfer 1960
ASS. *Juncietum proceri* Oberdorfer 1960 [Ju-h. G]
ASS. *Centello asiaticae-Anthoxanthetum utriculati* San Martín *et al.* 1992 [Pj-r. G]

All. AGROSTIDION CHILENSIS Oberdorfer 1960
ASS. *Acaeno ovalifoliae-Agrostietum capillaris* Oberdorfer 1960 [C-C. G]
ASS. *Centello asiaticae-Agrostietum capillaris* Ramírez *et al.* 1985 [Cen. G]
ASS. *Airo caryophyllae-Agrostietum capillaris* Ramírez *et al.* 1985 [Air. G]
ASS. *Junco imbricatae-Agrostietum capillaris* Ramírez *et al.* 1998 [Ju-d. G]
ASS. Community of *Vulpia bromoides* and *Agrostis capillaris* [Cep. G]

6.3 Vegetation description

The description of each vegetation association or community is based on the syntaxonomic point of view. Each unit was assigned an acronym. The list of acronyms is reported in Table 6.2.
The plant communities were analysed from a physiognomic, floristic, chorologic, ecologic and syntaxonomic point of view. The results are collected in Tables 6.2, 6.3 and 6.4, as

Table 6.2: Acronyms of the vegetation associations and group number used throughout the text and in the figures. Source: Own data.

Vegetation Unit	Acronym	Group number
Olivillo forest	Olv. F	1
Espinillo shrub	Esp. S	3
Quila shrub	Qui. S	2
Aíra grassland	Air. G	11
Cardoncillo grassland	Car. G	5
Centella grassland	Cen. G	8
Cepilla grassland	Cep. G	12
Chépica - Cadillo grassland	C-C. G	9
Chupón grassland	Chu. G	4
Junco duro grassland	Ju-d. G	10
Junco húmedo grassland	Ju-h. G	6
Paja ratonera grassland	Pj-r. G	7

Table 6.3: Statistical information on the plant communities. The following notation is used. Nr. Sp: number of species; Nr. Rev.: number of relevés; Avg.: average number of species per relevé; SD: standard deviation; Total freq.: total frequency. Source: Own data.

Vegetation Unit	Nr. Sp.	Nr. Rev.	Avg.	SD	Total freq.	Total cover	Relevé range
Olivillo forest	68	41	19.12	3.24	784	6482	1-41
Espinillo shrub	31	19	5.63	2.27	107	1969	42-60
Quila shrub	32	19	5.26	1.73	100	1863	130-148
Aíra grassland	17	2	12.50	4.95	25	198	128-129
Cardoncillo grassland	33	13	10.69	2.56	139	1611	61-73
Centella grassland	16	3	11.33	0.58	34	387	167-168
Cepilla grassland	21	5	9.20	2.39	46	566	112-116
Chépica - Cadillo grassland	29	11	12.55	3.78	138	1393	101-111
Chupón grassland	36	18	6.61	3.01	119	198	149-166
Junco duro grassland	33	12	11.83	2.59	142	1441	89-100
Junco húmedo grassland	45	15	10.20	1.52	153	1860	74-88
Paja ratonera grassland	32	11	11.18	1.94	123	1378	117-128

Table 6.4: Diversity components calculated with the JUICE data-analysis software. Source: Own data.

Vegetation Unit	Richness S	Shannon H	Evenness $e^{H/S}$	Equitability J'
Olivillo forest	68	4.11	0.90	0.97
Espinillo shrub	31	3.30	0.88	0.96
Quila shrub	32	3.34	0.88	0.96
Aíra grassland	17	2.72	0.89	0.96
Cardoncillo grassland	33	3.34	0.85	0.95
Centella grassland	16	2.59	0.83	0.93
Cepilla grassland	21	2.89	0.86	0.95
Chépica - Cadillo grassland	29	3.21	0.85	0.95
Chupón grassland	36	3.46	0.88	0.97
Junco duro grassland	33	3.37	0.88	0.96
Junco húmedo grassland	45	3.65	0.86	0.96
Paja ratonera grassland	32	3.35	0.89	0.97

well as in Figures from 6.2 to 6.7, where they are expressed in terms of species frequency and coverage.

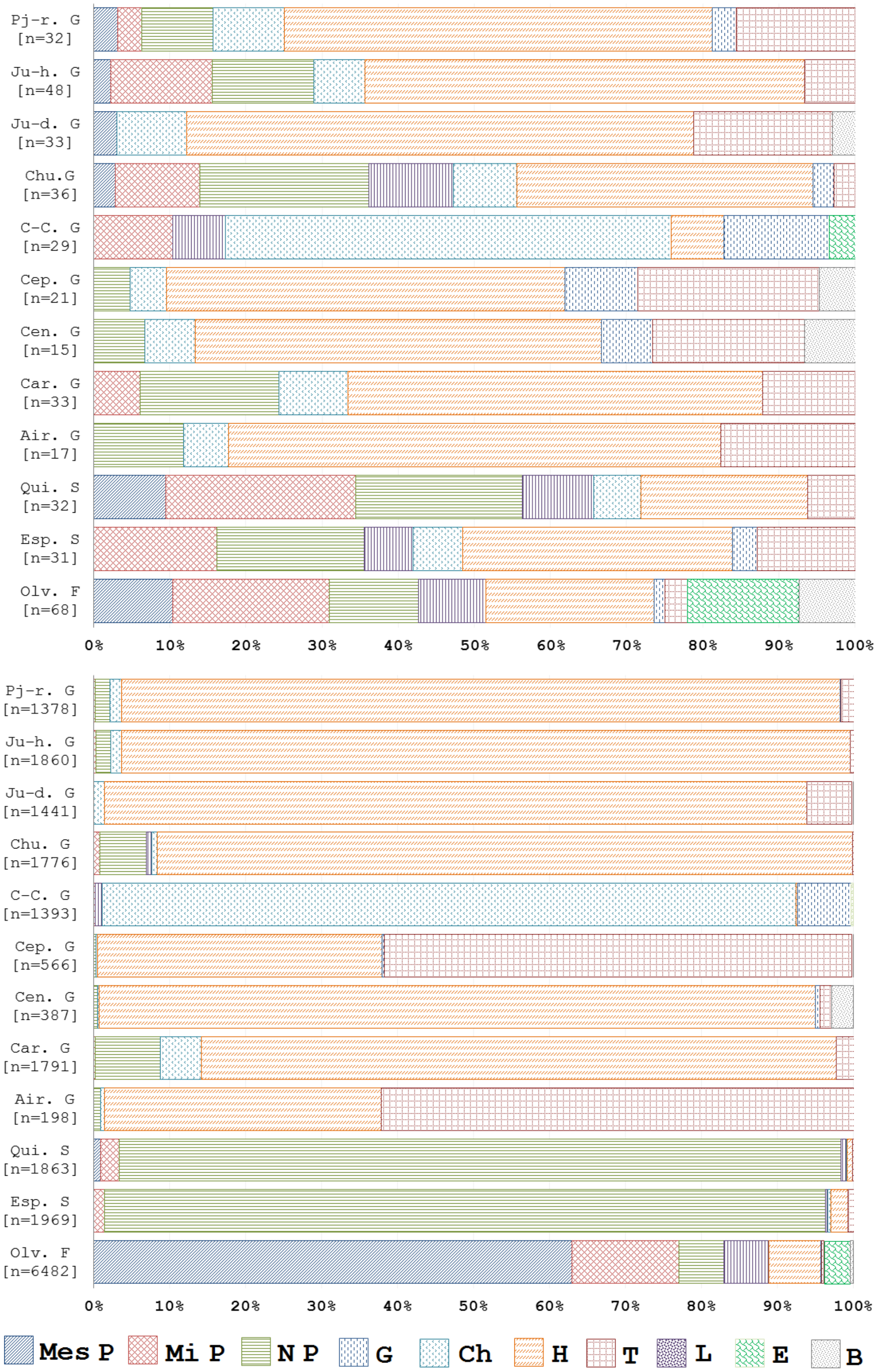

Figure 6.2: Biological spectrum of each plant community. Results expressed in terms of the frequency percentage values (top) and in terms of the coverage-based percentage values (bottom). The lifeforms and communities notations follows Table 4.2 and Table 6.2, respectively. The n values give the number of species (top) and total cover (bottom). Source: Own data.

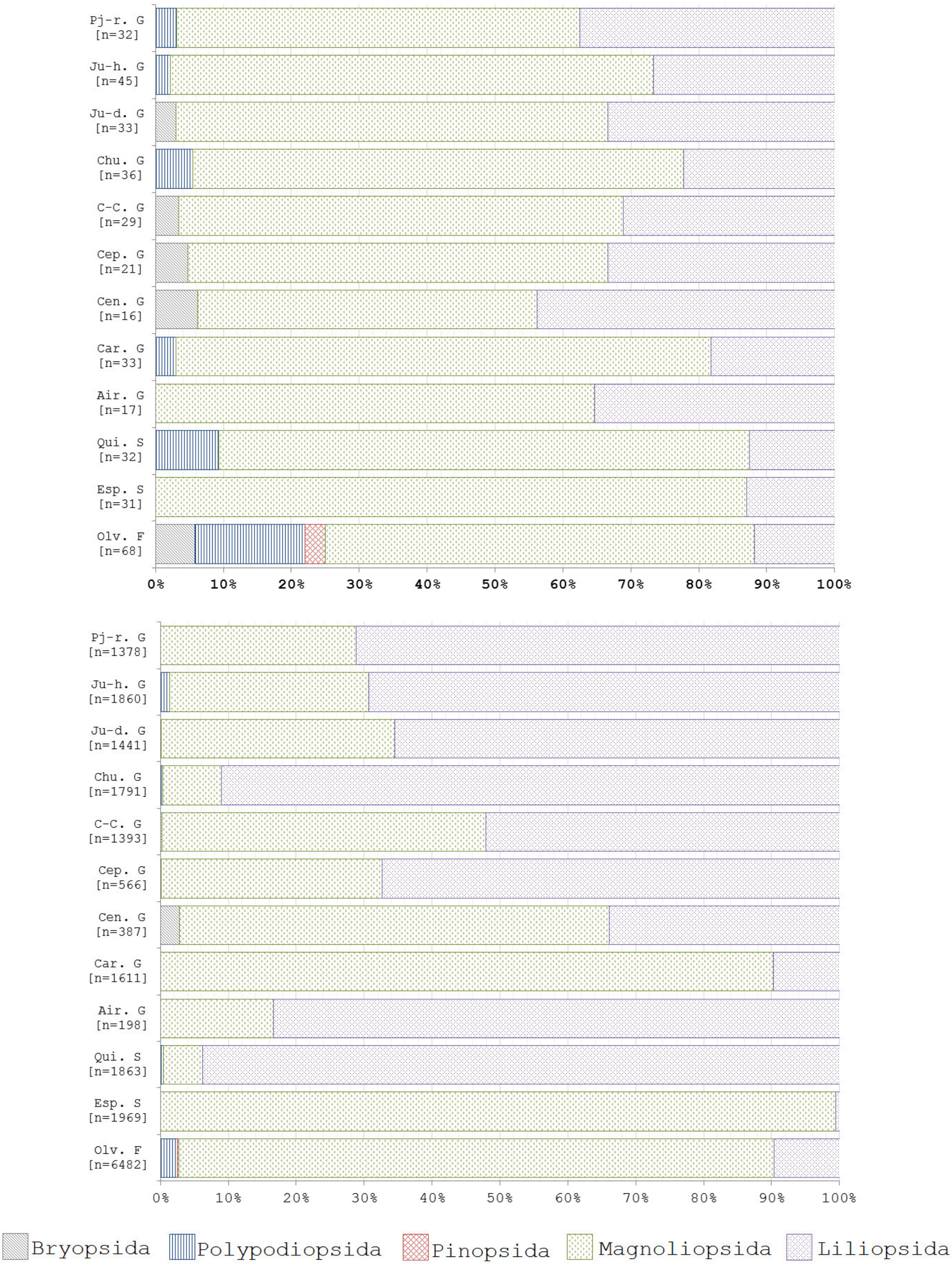

Figure 6.3: Representation of the taxa groups in each plant community. Results expressed in terms of the frequency percentage values (top) and results expressed in terms of the coverage-based percentage values (bottom). The communities notation follows Table 6.2. The n values give the number of species (top) and total cover (bottom). Source: Own data.

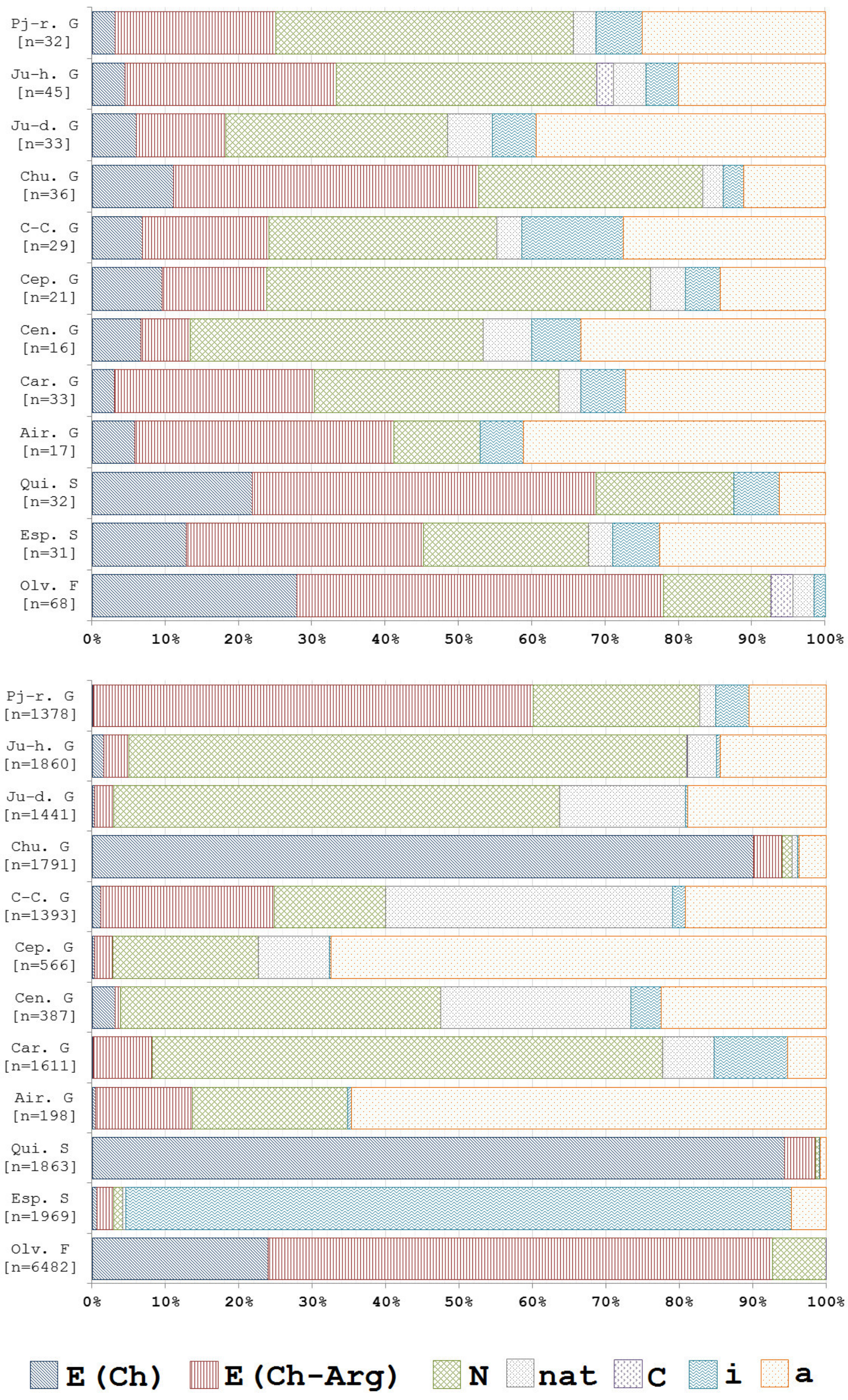

Figure 6.4: Status (Phytogeografical origin) of species in each plant community. Results expressed in terms of the frequency percentage values (top) and results expressed in terms of the coverage-based percentage values (bottom). The status and communities notations follow Table 4.1 and Table 6.2, respectively. The n values give the number of species (top) and total cover (bottom). Source: Own data.

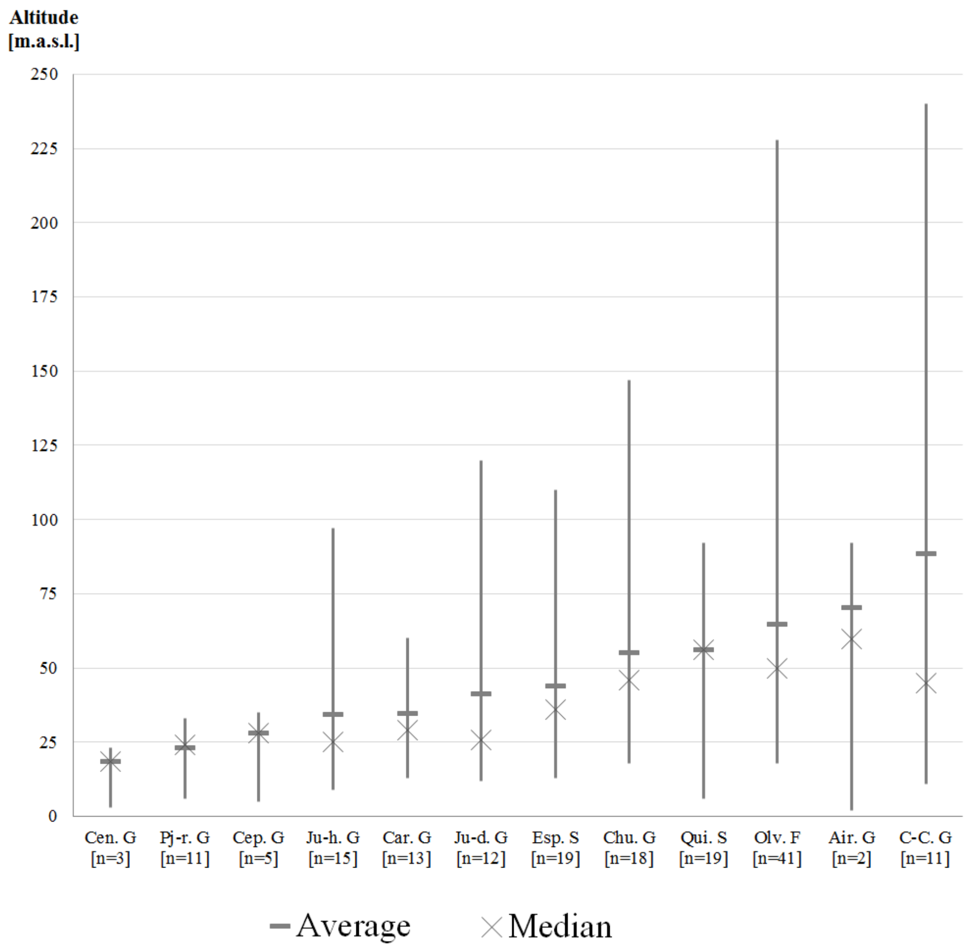

Figure 6.5: Altitudinal distribution of the vegetation units identified in the investigated area. The acronym of each community is reported in Table 6.2. The n values give the number of relevés in each community. Source: Own data.

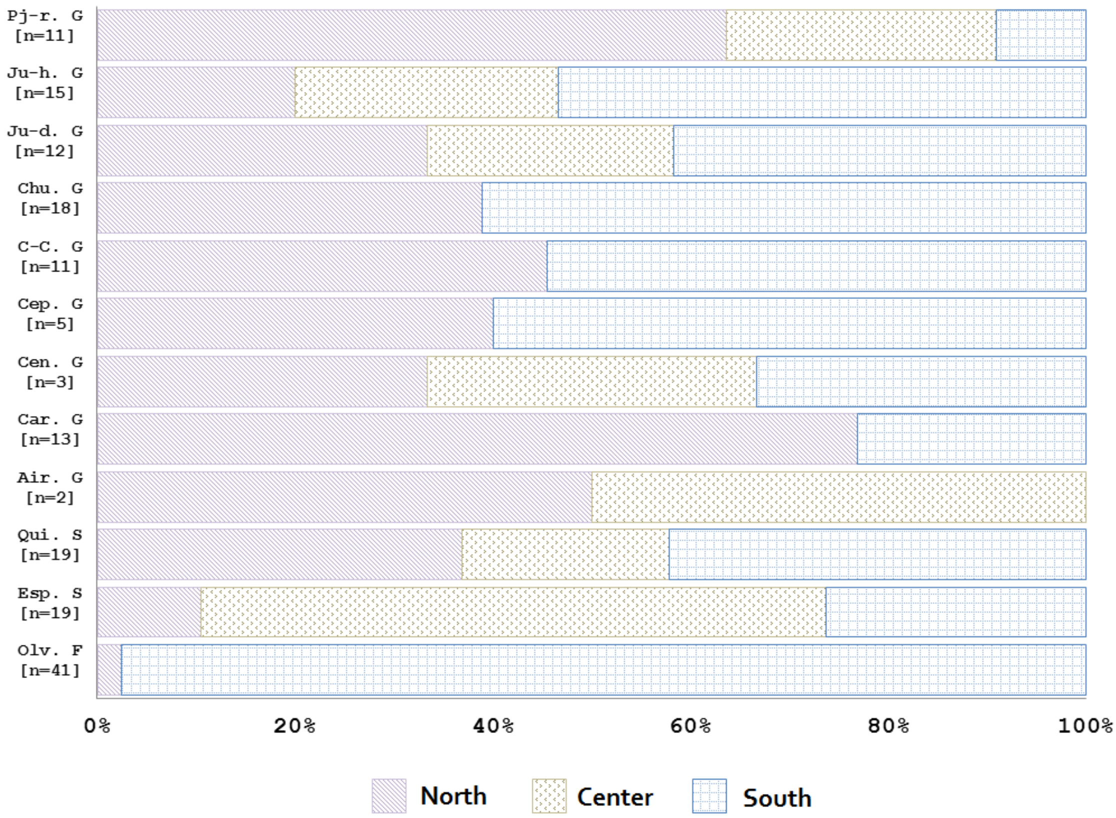

Figure 6.6: Distribution of the communities based on the territory division in sectors North (N), Center (C) and South (S).The acronym of each community is reported in Table 6.2. The n values give the number of relevés in each community. Source: Own data.

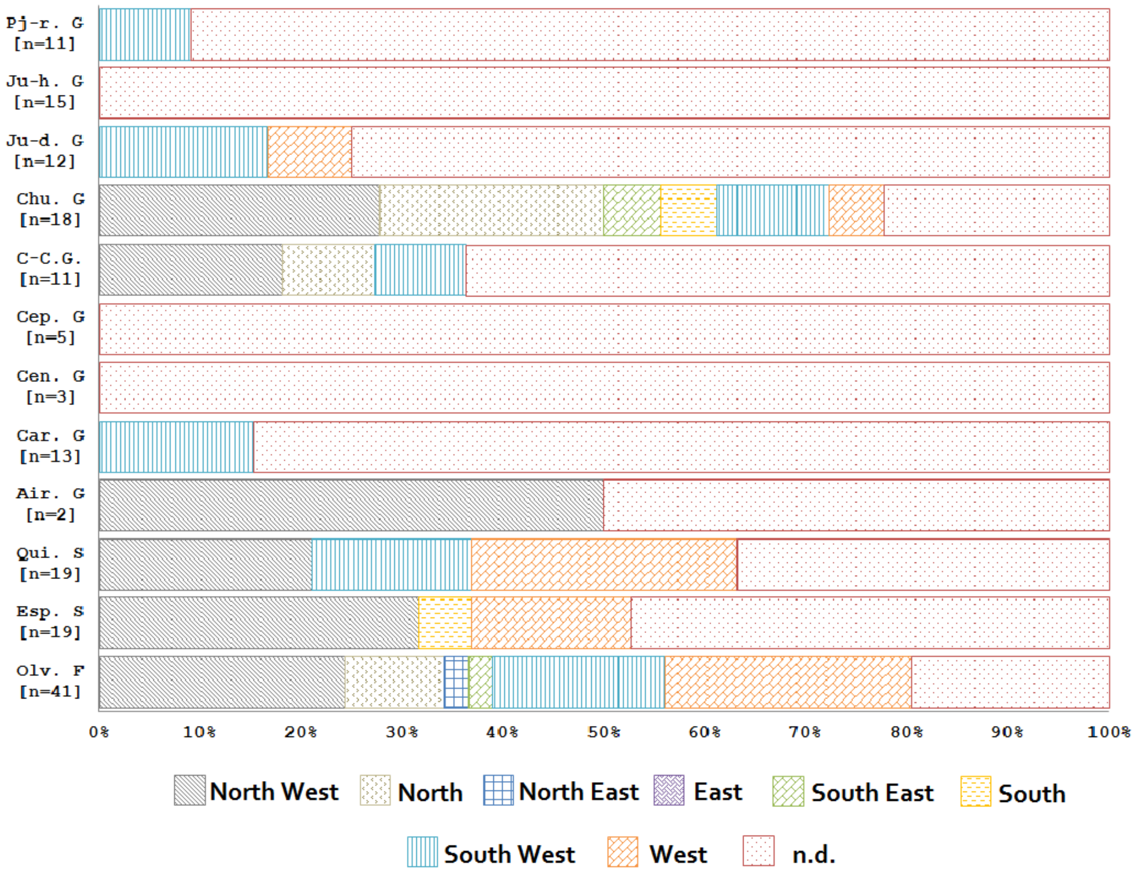

Figure 6.7: Orientation of the communities in the investigated area. The acronym of each community is reported in Table 6.2. The n values give the number of relevés in each community and n.d stands for not defined. Source: Own data.

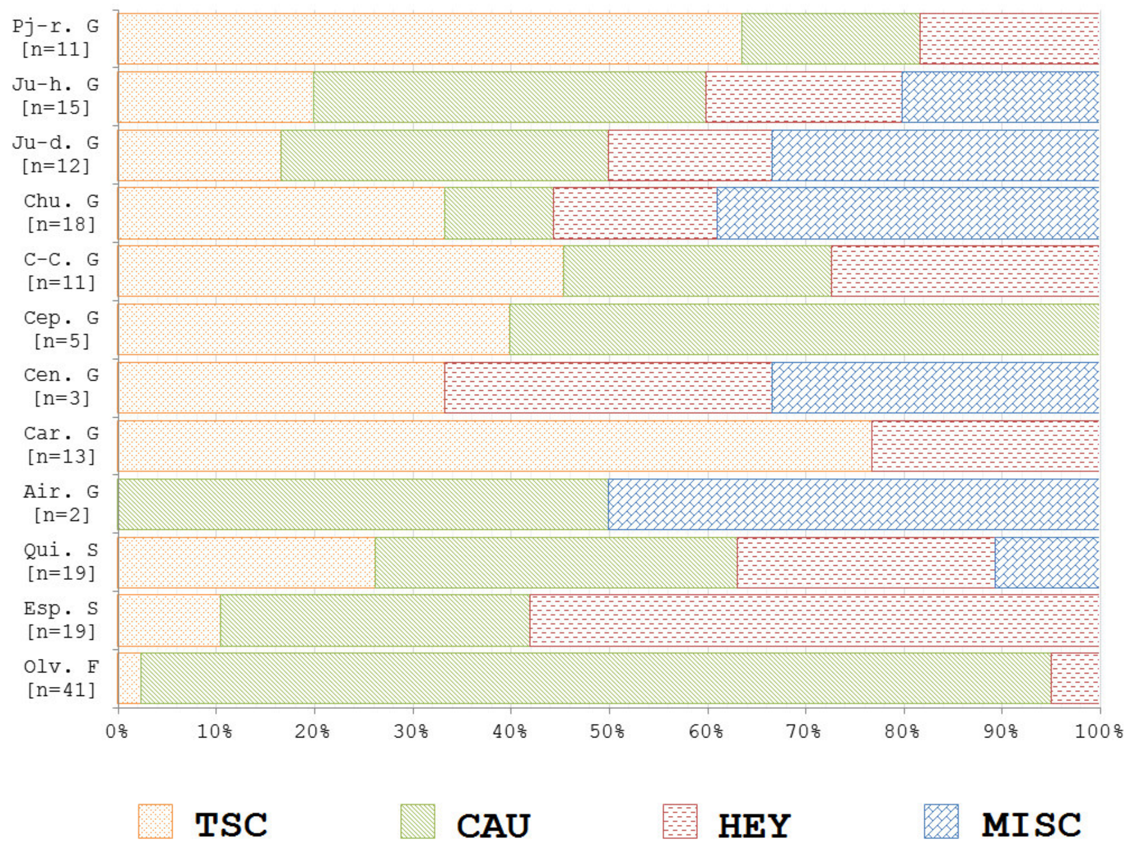

Figure 6.8: Distribution of the vegetation communities in the soil series. The result was obtained by following CIREN (2003). The acronym of each community is reported in Table 6.2, that of each soil series in subsection 2.2.5. The n values give the number of relevés in each community. Source: Own data.

6.3.1 *Lapagerio roseae-Aextoxiconetum punctati* Oberdorfer 1960

[Typus relevé : rel. 248 *Lectotypus hoc loco designatus* in Table 26, Oberdorfer 1960]

Mesophile evergreen forest on the western slopes of the Coastal Mountain Range and Andes of the mesotemperates Chile.

Olivillo forest
Table 6.5 | Group Nr. 1 | Figure 6.9 | Acronym: Olv.F

Physiognomy

Evergreen, multi-layer forest with 100% coverage. Vegetation height ranging between 25 and 30 m, with average value of 25 m (see Appendix E).
The dominant lifeforms are the Phanerophytes (frequency and coverage equal to 43% and 83%, respectively). A more detailed analysis of the Phanerophytes sub-groups provides the following frequency and coverage values: Mesophanerophytes 10% and 63%; Microphanerophytes 21% and 14%; Nanophanerophytes 12% and 6%. In order of decreasing frequency, the other lifeforms are Hemicryptophytes (22%), Epiphytes (15%), Lianas (9%),

Figure 6.9: Outside (Curiñanco, left) and inside (Caleta Huiro, right) views of the *Olivillo* forest. The inside view highlights the variety of vascular and non-vascular Epiphytes and Lianas on the trunks. Photographed by the author in January 2012.

Bryophytes (7%), Therophytes (3%) and Geophytes (2%). No Chamaephytes were found. As a function of the coverage, the ranking is as follows: Hemicryptophytes (7%), Lianas (6%) and Epiphytes (3%). The other lifeforms show values lower than 1% (see Figure 6.2).

Floristic

The unit consists of 68 species distributed over 5 classes and 40 families. As for the species frequency, the dominant classes are Magnoliopsida (63%), with 27 families; Polydiopsida (16%) and Liliopsida (12%) with 5; Bryopsida (6%) with 2 families and Pinopsida (3%) with 1. When considering the coverage, the Magnoliopsida has the highest value (88%), followed by Liliopsida (10%) and Polydiopsida (2%). The other classes show values below 1% (see Figure 6.3). As for the frequency, the most important families are Myrtaceae, Apiaceae, Rigodiaceae, Blechnaceae, Hymenophyllaceae. In terms of coverage, these Aextoxicaceae, Myrtaceae, Cunoniaceae and Philesiaceae (see Appendix B).
This unit's dominant species (Dm) is Mesophanerophyte *Aextoxicon punctatum*, which is also diagnostic (Dg) and constant (Ct). The unit has 13 constant species:

> *Lapageria rosea* (Dg, Ct) 100; *Aextoxicon punctatum* (Dg, Dm) 100; *Luzuriaga radicans* (Dg) 83; *Amomyrtus meli* (Dg) 80; *Eucryphia cordifolia* (Dg) 78; *Chusquea quila* (Dg) 76; *Rhaphithamnus spinosus* (Dg) 73; *Mitraria coccinea* (Dg) 73; *Lomatia ferruginea* (Dg) 73; *Drimys winteri* (Dg) 68; *Sarmienta scandens* (Dg) 66;

Myrceugenia planipes (Dg) 66; *Nertera granadensis* (Dg) 63.

Out of the 16 species in this forest, 11 have conservation categories: 5 vulnerable (VU), 1 endangered (EN), 3 least concern (LC), 1 data deficient (DD) and 1 near threatened (NT). *Aextoxicon punctatum* (DD) shows the largest coverage value as it is the characteristic and dominant species of the association (see Table 5.4 in Section 5.5).

Syntaxonomy

The unit includes 41 relevés. The average amount of species per relevé is 19.12 ± 3.94, see Table 6.3. The species with the highest importance value are *Olivillo* (52.36), *Amonyrtus meli* (13.11) and *Lapageria rosea* (10.37). *Nertera granadensis* and *Chusquea quila* are among the 10 species with the highest importance value (7.64 and 5.96, respectively, see Table C.2 in Appendix C). However, these species are indicators of intervention, either natural or not, as they are mainly present in forest's canopy opens.
As for the fidelity value ($\Phi > 0.3$), in this unit there are 39 diagnostic species. 26 of them are clearly exclusive (underlined), 13 are constant and 1 is dominant (see Table 6.3). The list of the diagnostic species (Dg, ranked with decreasing fidelity), as well as the constant (Ct) and dominant (Dm) ones, is reported below.
The diagnostic species are:

Luzuriaga radicans (Ct) 90.4, *Amomyrtus meli* (Ct) 88.9; *Aextoxicon punctatum* (Ct, Dm) 85.3; *Mitraria coccinea* (Ct) 84.5; *Lapageria rosea* (Ct) 83.8; *Lomatia ferruginea* (Ct) 81.1; *Sarmienta scandens* (Ct) 79.9; *Eucryphia cordifolia* (Ct) 76.4; *Myrceugenia planipes* (Ct) 75.7; *Rhaphithamnus spinosus* (Ct) 72.8; *Drimys winteri* (Ct) 72.4; *Luzuriaga polyphylla* 68.3; *Hymenophyllum caudiculatum* 68.3; *Hymenophyllum sp.* 66.5; *Nertera granadensis* (Ct) 64.0; *Uncinia phleoides* 63.0; *Gevuina avellana* 62.7; *Rhamnus diffusus* 54.6; *Hymenoglossum cruentum* 54.6; *Luma apiculata* 54.5; *Megalastrum spectabile* 47.8; *Cissus striata* 47.4; *Weymouthia mollis* 45.3; *Hymenophyllum cuneatum* 45.3; *Chusquea quila* (Ct) 4.5; *Amomyrtus luma* 43.7; *Laureliopsis philippiana* 42.6; *Hydrocotyle poeppigii* 42.6; *Dioscorea auriculata* 42.6; *Podocarpus nubigenus* 39.8; *Blechnum chilense* 37.5; *Raukaua valdiviensis* 36.9; *Fascicularia bicolor* 36.9; *Anemone hepaticifolia* 36.9; *Greigia sphacelata* 35.9; *Lophosoria quadripinnata* 32.5; *Boquila trifoliolata* 30.3; *Hydrangea serratifolia* 30.0; *Blechnum asperum* 30.0.

The positive fidelity calculated for this group is equal to 36.63, with sharpness of 114 (see Table 6.3).

Ecology and distribution

Based on the number of species and on the coverage, 93% of the species are native. 50% of them are Endemic of Chile and Argentina, 28% are Endemic of Chile and 15% are Native. Non-native species show species frequency below 1% and coverage with 5%. Among the species in this group, *Ulex europaeus* is only present in one relevé (Rel. Nr. 35 in 6.5) and has a coverage value of r. This points to a possible intervention related to the transit of people and animals.
According to the Shannon index, the Alfa-diversity of this community is 4.11. This indicates high diversity. The equitability measured with the Pielou uniformity is equal to 0.90 (see Table 6.4).

The altitudinal distribution of the relevés varies between 18 and 228 m a.s.l. The average altitude is 64.6 ma.s.l., whereas the median is equal to 50 m a.s.l. (see Figure 6.5). The relevés are mainly distributed in the Southern part of the investigated area: Punta Galera, Playa Pelche, Playa Colún and Lagunas Gemelas. Only one is located in the Northern part, i.e., in Bonifacio (see Figure 6.6 and Map A.1 in Appendix A). The relevés face mainly North-East and South-East (24% of the total), 20% do not have a defined orientation and 17% and 10% face South-West and South, respectively (see 6.7).
According to the CIREN cartography (2003), see Map A.2 in Appendix A, 93% of the relevés are distributed in the Chaihuen Series, the others in the Tres Cruces Association (see Figure 6.8).

Table 6.5: Phytosociological table of the *Olivillo* forest in the research area. Information on the header data is in Appendix E. Notation as follows: Lf.: Lifeform, see Table 4.2; Fr.: Frequency; Dm: Dominant species; Dg: Diagnostic species; ∼: relevé selected as representative.

Vegetation Unit				**Olv.F**	
Group Nr.				**1**	^ ~
Relevé Nr.				4233 213332 1	2 233 1 32 112 23211 412131
				31734728069097	883121948422015556466059371
	Species	**Lf.**	**Fr.**		
Dg	*Aextoxicon punctatum*	[Mes P]	[41]	44545544544555	554445554445545544445444444
Dg	*Lapageria rosea*	[L]	[41]	22222+222222+2	2+222222222++222222+22+222+
Alliance & Suballiance*					
Dg	*Amomyrtus meli*	[Mes P]	[33]	2232.222222223	23332..22.23+3..22+.2232.23
Dg	*Eucryphia cordifolia*	[Mes P]	[32]	.2.23222.22.+2	2+2.32222.22+222..+222+222.
Dg	*Nertera granadensis*	[H]	[26]	++22+3.22.++2+	24...3.3222+3..+.+.+.....22
Dg	*Lomatia ferruginea*	[N P]	[30]	+2+.2++++++.++	2++22.+.+++.+..2.2...+2+++2
Dg	*Gevuina avellana*	[Mi P]	[17]	..++2+.+2+.+2.	2.++.......+..........+2+2.
Dg	*Amomyrtus luma*	[Mes P]	[13]	2.2..2.+++2...	..+.+.+..++....2...........
Dg	*Hydrocotyle poeppigii*	[H]	[8]	++....+....+.+	+........+...+.............
Dg	*Rhamnus diffusus*	[N P]	[13]	..+++++.2r..+.	++2+............+..........
Order & Class**					
Dg	*Drimys winteri*	[Mi P]	[28]	222.2+222...3+	22222.+2...322.2.2++2.22..2
Dg	*Myrceugenia planipes*	[Mi P]	[28]	22..2222222..2	.+.22.+3..2..22+2232.22.22.
Dg	*Rhaphithamnus spinosus*	[N P]	[30]	22+.+++2++.+++	+.+.+2+2++++++.+.+++..+...+
Dg	*Uncinia phleoides*	[H]	[22]	..+++++++..+..	.++.+.+..+.+.+.+.+++..++..+
Dg	*Luma apiculata*	[Mi P]	[20]	22++....+22...	+.++++.++...2.2.2..++2.....
Dg	*Greigia sphacelata*	[H]	[22]	22.+.+++.r+.++	+2.+r.+....++.r..+2+....r..
Dg	*Chusquea quila*	[N P]	[31]	22+++.22+.+.+.	..++2.22+++.+2++2+3.++2+++.
Vascular Epiphytes & Liana					
Dg	*Luzuriaga radicans**	[E]	[34]	++++++2+2+.+++	++++++++2+.++++.+..+2++++..
Dg	*Sarmienta scandens**	[E]	[27]	.+.11+.+.+++++	.+++.++.+.++.++.+.+++++.+..
Dg	*Mitraria coccinea**	[E]	[30]	+++++++++..+++	++.++++++++.++..2+++...++..
Dg	*Boquila trifoliolata***	[L]	[16]	...++++.++....	..++++...+..++.+........+.+
Dg	*Luzuriaga polyphylla***	[E]	[20]	++++.++.2+..+.	+.+.++++...+..+...+...+...+
Dg	*Cissus striata**	[L]	[15]	..++..2...++..	..+.+..2++.....+.++.....++.
Dg	*Hydrangea serratifolia**	[L]	[4]	...........+..	.+......+.+................
Dg	*Raukaua valdiviensis**	[L]	[6]	...+.+.+..+..+	..+........................
Dg	*Fascicularia bicolor**	[E]	[6]	++.........+..	.....+.2......+............
Fern & Briophyte					
Dg	*Hymenophyllum sp.**	[E]	[19]	++.++..++++...	+..+....+.++.++...+++....+.
Dg	*Hymenoglossum cruentum**	[E]	[13]	++..+.++.+....	...+..+.+.+...+.......+...+.
Dg	*Hymenophyllum caudiculatum*	[E]	[20]	++.+++..+++.+.	++......+.+..++.+..+++...+.
Dg	*Blechnum chilense*	[H]	[16]	+++++.+.+.+..+	.......+.+....+.2.+.+..+...
Dg	*Hymenophyllum cuneatum*	[E]	[9]	...++.....+...	.+.+...+.......+.......+..+..
Dg	*Lophosoria quadripinnata*	[H]	[9]	...2..+.....22	+............+..+..++......
Dg	*Blechnum asperum*	[H]	[4]	............+.	.+....2.....+..............
Dg	*Megalastrum spectabile*	[B]	[10]	.....++.....+.	.+..........+...+.+...+.2..+
Dg	*Weymouthia mollis*	[B]	[9]	...+....+++...	....+.....+..........++...+.
	Blechnum hastatum	[H]	[2]	...........+..	.....+.....................
	Rigodium implexum	[B]	[2]	..........+...	........+..................
Companion					
Dg	*Anemone hepaticifolia*	[H]	[6]	..2.+.+.......	2................2.....2...
Dg	*Laureliopsis philippiana*	[Mes P]	[8]	r2+....2.r.2..	...............+2..........
Dg	*Podocarpus nubigenus*	[Mes P]	[7]	..+.+.......+.	...2.....r.+...........r....
Dg	*Dioscorea auriculata*	[G]	[8]	+++...........	.....+++.+........+.........
	Azara lanceolata	[Mi P]	[7]	.....+.+.r.+.+	.+...............+..........
	Carex fuscula	[H]	[4]	++........+...	..........+................
	Myrceugenia exsucca	[Mi P]	[3]	..........+...	..2......2.................
	Myrceugenia chrysocarpa	[Mi P]	[3]	++............	.....3.....................
	Aristotelia chilensis	[Mi P]	[3]	+r............	.....2.....................
	Osmorhiza chilensis	[H]	[3]	..+.........+..	....+......................
	Crinodendron hookerianum	[N P]	[3]	..+.+.........	...............+...........
	Persea lingue	[Mi P]	[2]	...r.......+..	....
	Saxegothaea conspicua	[Mi P]	[2]	....	...+.........+.............
	Sophora microphylla	[N P]	[2]	22............	....
	Hydrocotyle indecora	[H]	[2]	.......+......	......+....................

Single occurrence (*Sp.*[Relevé nr.|Cover|Lf.]):
Rigodium pseudothuidium [1|+|B]; *Eryngium paniculatum* [1|r|H]; *Leptinella scariosa* [24|+|H]; *Embothrium coccineum* [3|+|Mi P]; *Blepharocalyx cruckshanksii* [22|+|Mes P]; *Acrisione denticulata* [20|+|Mi P]; *Acaena ovalifolia* [7|r|T];*Ovidia pillopillo* [27|+|Mi P]; *Griselinia jodinifolia* [17|+|N P];*Asplenium sp.* [17|+|E];*Oxalis sp.* [20|+|T]; *Ulex europaeus* [35|r|N P], *Rigodium brachypodium* [1|+|B]; *Muehlenbeckia hastulata* [12|+|L]; *Weinmannia trichosperma* [6|+|Mes P];*Blechnum penna-marina* [10|+|H].

6.3.2 *Fuchsio magellanicae-Chusqueetum quilae* Hildebrand 1983

[Typus relevé: rel. 85 *Lectotypus hoc loco designatus* in Table 4, Hildebrand 1983]

Mesic shrubland on deep mineral soils on the low and high altitude of the Coastal Mountain Range, Intermediate Depression and Andes of South Chile.

Quila shrubland
Table 6.6 | Group Nr. 2 | Figure 6.10 | Acronym: Qui. S

Physiognomy

Thicket scrub, without layers. The average height is 2.5 m a.s.l. The frequency-based dominant lifeforms are Microphanerophytes (25%), Nanophanerophytes (22%), Mesophanerophytes and Lianas (9%) and Therophytes and Chamaenphytes (6.3%). The other lifeforms are not represented. The coverage-based description of the unit is dominated by the Nanophanerophytes (95%), followed by Micro- and Mesophanerophytes (2.5% and 1%, respectively). The other lifeforms are characterised by values lower than 1% (see Figure 6.2).

Floristic

This unit presents 32 species, distributed in 3 classes and 28 families. The three classes are: Liliopsida (4 families, coverage value of 94%), Magnoliopsida (22 families, coverage equal to 6%) and Polypodiopsida (2 families, coverage below 1%), see Figure 6.3. The

Figure 6.10: *Quila* shrubland in La Mision. The picture shows the thickness of this species and the width of its distribution in the considered region. Photographed by the author in February 2012.

most important families in frequency terms are Asteraceae, Myrtaceae and Blechnaceae, and Poaceae in coverage terms (see Appendix B).
Chusquea quila is both a dominant and a constant species.
This unit has 5 species with conservation category: 2 are vulnerable (*Lobelia brigesii* and *Greigea sphacelata*), 1 endangered (*Lapageria rosea*), 1 is least concern (*Amomyrtus luma*) and 1 is data deficient (*Aetoxicon punctatum*). All of them have low frequency and coverage (see Table D.4 in Appendix D).

Syntaxonomy

This unit is characterised by 19 relevés. The species average value per relevé is 5.24 ± 1.23 (see Table 6.3). The most important species are: *Chusquea quila* (112.4), *Rubus constrictus* (11.81), *Aristotelia chilensis* (8.50), *Fuchsia magellanica* (5.48), *Boquila trifoliolata* (5.27) and *Lapageria rosea* (5.27). Except for *Rubus constrictus*, all other species are native (see Table C.4 in Appendix C).
The fidelity value shows that this unit has two diagnostic species. One of them is *Chusquea quila*, which is both dominant (Dm) and constant (Ct).
The diagnostic species are:

Chusquea quila (Ct, Dm) 63.5; *Fuchsia magellanica* 42.7.

From the analysis of the synoptic table, this unit has a positive fidelity of 8.66 and a sharpness of 20.37 (see Table 6.1).

Ecology and distribution

In terms of frequency, 47% of the species are Endemic of Chile and Argentina, 22% are Endemic of Chile, 19% are Native and 6% are Introduced or Adventitious. The coverage-based analysis shows that 94% are Endemic of Chile, 4% Endemic of Chile and Argentina and the rest has values below 1% (see Figure 6.4).
Fort the present unit, 42% of the relevés are located in the Southern part (from Caleta Guadi to Hueicolla, with the majority in the Punta Galera area), 37% are in the Northern sector (in particular, 4 are in the La Misionarea) and 21% are in the central area (mainly in Chaihuin), see Figure 6.6 and Map A.1 in Appendix A.
With regard to the orientation, 37% of the relevés are in areas with no defined orientation, 26% face West and 21% North-West see Figure 6.7. The altitude varies between 6 and 92 m a.s.l., with an average value of 64.6 m a.s.l. (see Figure 6.5). According to CIREN (2003), the spatial distribution of the relevés is as follows: 37% are located in the Chaihuin Series, 26% in the Hueicolla Series and Tres Cruces Association and 11% in miscellaneous areas (see Figure 6.8).

Table 6.6: Phytosociological table of the order ARISTOLIETATIA CHILENSIS Hildebrand 1983 in the research area. Information on the header data is in Appendix E. Notation as follows: Lf.: Lifeform, see Table 4.2; Fr.: Frequency; Dm: Dominant species; Dg: Diagnostic species; + *holotypus*; ∼: relevé as representative of vegetation unit. Source: Own data.

Vegetation Unit			Qui.S	Chu.S	Esp.S
Group Nr.			2	3	4
				+	^
			~ ^	~	~
Relevé Nr.			1111111111111111111	111111111111111111	
			3333333443444434344	565665655564555665	4454545445445555655
Species	**Lf.**	**Fr.**	1658470282104533967	510548671429362309	2725044861395376098
Dg 2					
Dm *Chusquea quila*	[N P]	[26]	5555555555555555544	.+....1+..2.....+.	..............+...+
Dg *Fuchsia magellanica*	[N P]	[5]	+........+2+.+.....	....	....
Dg 3					
Dm *Greigia sphacelata*	[H]	[19]	....r..............	555545555555555554	....
Dg *Berberis darwinii*	[N P]	[3]	....	...+2.2...........	....
Dg 4					
Dm[1] *Ulex europaeus*	[N P]	[20]	.......+...........	....	5555555555555555555
Dg *Embothrium coccineum*	[Mi P]	[4]	....	....	+r+......+.........
Dg Lobelia bridgesii	[Ch]	[6]	............+..+...	....	..2..+...++........
All. C.(2&3)					
Blechnum hastatum	[N P]	[6]	+..+....+..........	+.+........+......	....
Ovidia pillopillo	[Mi P]	[4]	.......+...........	r..........+.....2	....
Blechnum chilense	[H]	[6]	...+........+......	+....+.+....+.....	....
Rhaphithamnus spinosus	[N P]	[4]	....+..............	.+......+.....+...	....
All. C.(4)					
Gaultheria mucronata	[N P]	[3]	....	...+1.............	+..................
Acrisione denticulata	[N P]	[3]	..+......+.........	....	.......r...........
Muehlenbeckia hastulata	[L]	[3]	....	.............+....	.+.....+...........
Ord. C. & Cla. C.					
Dg[2] *Rubus constrictus*	[N P]	[41]	+.....2+++++++.++..	++.22+1++.+.+..2++	+22222222222++++.+.
Dg[2] *Aristotelia chilensis*	[Mi P]	[22]	+.....2..2++.....22	.+.+.+..+...r.+...	+...2.+rr+...+2+...
Baccharis racemosa	[N P]	[13]	......++....+......	+++2+...++........	+............2..+..
Boquila trifoliolata	[L]	[14]	.+++.+........+....	.++.....+.2...+...	.+.++.....+........
Luma apiculata	[Mi P]	[3]	.+...+.............	.............r....	....
Cissus striata	[L]	[3]	......+.+..........	.+................	....
Azara lanceolata	[Mi P]	[4]	.++..+.............	....	................r..
Companion					
Eucryphia cordifolia	[Mes P]	[4]	.++..+.......2.....	....	....
Lophosoria quadripinnata	[H]	[3]	..+++..............	....	....
Drimys winteri	[Mi P]	[3]	.+..r.........2....	....	....
Aextoxicon punctatum	[Mes P]	[5]	r...r.+.........r..	.r................	....
Lapageria rosea	[L]	[7]	.+.+++..+..........	.+........+.......	....
Ugni molinae	[N P]	[6]	....	+..+2.2..+.+......	....
Galium hypocarpium	[Ch]	[4]	....	+.+..+.......+....	....
Agrostis capillaris	[H]	[3]	....	+....+.........2..	....
Prunella vulgaris	[Ch]	[7]	+..................	+.+1...+.+........	...+...............
Eryngium paniculatum	[H]	[5]	....	+..1...........1..	......2......+.....
Holcus lanatus	[H]	[8]	....	..+....+..........	++.++...+..+.......
Cirsium vulgare	[T]	[5]	....	....	...+.+.++..2.......
Hypochaeris radicata	[H]	[2]	....	....	..+...2............
Gunnera tinctoria	[H]	[2]	....	....	+...+..............
Chevreulia sarmentosa	[H]	[2]	....	....	..+.........+......
Other Class					
Buddleja globosa	[Mi P]	[4]	...............+.r.	....	.r..+..............
Lotus pedunculatus	[H]	[9]	..........+........	++....+.....+.....	+....++.....+......
Centella asiatica	[H]	[4]	....	..+..+............	...2....+..........
Leontodon saxatilis	[H]	[3]	....	..+.....+.........	..+................
Centaurium cachanlahuen	[T]	[2]	....	..+...............	...+...............
Digitalis purpurea	[T]	[2]	....	....	.....+....+........
Ranunculus repens	[H]	[2]	....	....	.....+....+........
Polypogon chilensis	[H]	[2]	....	....	++.................
Acaena ovalifolia	[T]	[2]	....	.............+....	......r............

Single occurrence (Sp.[Group|Relevé|Cover|Lf.]):

Oxalis sp. [2|131|T|+]; *Loasa sp.* [2|131|+|T]; *Amomyrtus luma* [2|135|+| Mi P]; *Corynabutilon vitifolium* [2|138|+| N P]; *Myrceugenia exsucca* [2|142|r| Mi P]; *Francoa appendiculata* [2|140|+|H]; *Uncinia phleoides* [2|133|+|H]; *Nassella poeppigiana* [3|155|+|H]; *Alstroemeria aurea* [3|161|+|G]; *Gamochaeta americana* [3|150|+|H]; *Cliococca selaginoides* [3|165|+|Ch]; *Libertia chilensis* [3|164|r|H]; *Lomatia hirsuta* [3|164|r|Mi P]; *Leptinella scariosa* [3|154|+|H]; *Lomatia ferruginea* [3|149|r|N P]; *Lotus subpinnatus* [4|47|+|T]; *Gavilea odoratissima* [4|52|+|G]; *Baccharis concava* [4|55|+|N P].

[1] Also Diagnostic and Constatnt species in Group 4

[2] Diagnostic species on Group 4 and Constant species on Group 3 and 5

6.3.3 *Rubo constricto - Ulicetum europaei* Hildebrand 1983

[Typus relevé: rel. 41 *Lectotypus hoc loco designatus*, Table 9 in Hildebrand 1983]

Anthropogenic shrubland on deep mineral soils at the Coastal Mountain Range and Intermediate depression of South Chile.

Espinillo scrubland
Table 6.6 | Group Nr. 4 | Figure 6.11 | Acronym: Esp. S

Physiognomy

Thicket, evergreen shrubland without layers. The average vegetation height is 1.7 m. The frequency-based and coverage-based dominant lifeforms are Hemicryptphytes (35%) and Nanophanerophytes (95%), respectively. No Epiphytes and Bryophytes were recorded (see Figure 6.2).

Floristic

This unit has 31 species distributed in 2 classes and 20 families. The classes are Liliopsida (2 families) and Magnoliopsida (18 families). Magnoliopsida is the dominant class both in terms of frequency and coverage (97% and 99%), respectively (see Figure 6.3). The most important families are Leguminoseae, Asteraceae and Rosaceae (see Appendix B).
This unit has one dominant and two constant species. *Ulex europaeus*, an introduced Nanophanerophyte, is both dominant and constant, whereas *Rubus constrictus* is constant. There are two species with conservation category: *Lobelia brigesii* (VU) and *Embotrium coccinium* (LC), with low coverage (+) and in frequency class II (see Table 6.6 and Table D.2 in Appendix D).

Syntaxonomic

In this unit 19 relevés were collected. The average number of species per relevés is 5.63 ± 2.27 (see Table 6.3). The species with the largest importance values are *Ulex europaeus* (108.16), *Rubus constrictus* (19.75) and *Aristotelia chilensis* (9.53), see Table C.3 and Appendix C). Both *Ulex europaeus* and *Rubus constrictus* are non native.
According to the calculated fidelity (Φ coefficient), this unit has 7 diagnostic species and 7 exclusive species (underlined), which include the constant and dominant species. Ranked in decreasing order of fidelity, these are:

> *Ulex europaeus* (Ct, Dm) 91.8; <u>*Embothrium coccineum*</u> 41.6; *Rubus constrictus* (Ct) 39.1; <u>*Lobelia bridgesii*</u> 34.7; <u>*Aristotelia chilensis*</u> 32.3; <u>*Digitalis purpurea*</u> 31.2; <u>*Cirsium vulgare*</u> 30.8.

According to the analysis of the synoptic table, this unit has a positive fidelity of 15.46. This is a rather intermediate indicator, as there are disparate species which are not exclusive of this unit and which are identified as diagnostic, constant and/or dominant mainly in grasslands, see the final phytosociological Table. Examples are *Agrostis capillaris* and *Holcus lanatus*. The sharpness is equal to 53.72, which also indicates that the unit is pretty homogeneous (see Table 6.3).

Figure 6.11: View of *Espinillo* shrubland in the research area. The top picture (in Calfuco) shows the thickness of this species and the width of its distribution. Part of the vegetation was cut to enable human exploit. The bottom image (in Punta Galera) highlights the slow but continuous invasion of the *Espinillo* in a degraded grassland. The result of this process will be a landscape similar to the one in the above picture.Photographed by the author in January (top) and February (bottom) 2012.

Ecology and distribution

According to the frequency values, 68% of the species are native and 32% non native. In terms of coverage, 32% of the species are Endemic of Chile and Argentina, 23% are Native and Adventitious, 13% are Endemic of Chile, 6% were Introduced and another 6%

Naturalised. The values change when coverage values are considered: 96% of the species are non native and 4% are native. A more detailed analysis show that 91% of the species were Introduced, 5% are Adventitious, 2% are Endemic of Chile and Argentina, 1% are Native and less than 1% are Endemic of Chile (see Figure 6.4). As mentioned before, the dominant and constant species of this unit (*Espinillo*) was introduced at the time of the German colonisation (Mattei 1996).
The Alpha diversity of this community, calculated with the Shannon index, is equal to 3.30, which indicates an intermediate diversity. The equitability is equal to 0.88 and 0.96 when calculated with the Pielou and J' indices (see table 6.1).
The relevés altitude ranges between 13 and 110 m a.s.l. The average value and the median are 44 and 36 m a.s.l, respectively (see Figure 6.5). The spatial distribution is as follows: 63% of the relevés are located in the central part of the investigated area (from Corral to Los Liles), 26% in the Southern sector (mainly in Playa Pelche) and 11% in the Northern part (Calfuco), see Figure 6.6 and Map A.1 in Appendix A.
Due to the typically low inclination, 47% of the relevés do not have a defined orientation. A large fraction, equal to 32%, faces North-East (see Figure 6.7). According to the CIREN cartography (2003), the relevés are mainly distributed in the Hueicolla and Chaihuin Series (58% and 32%, respectively). Only two relevés, corresponding to 11% of the total, are located in the Tres Cruces Association (see Figure 6.8).

6.3.4 *Rubo constricto - Greigietum sphacelati* ass. nov.

[Typus relevé: rel. 151 *Holotypus hoc loco*, Table 6.7]

Mesic high perennial grassland growing on poor soils and with limited depth at medium elevations at the western slopes of the Valdivian Coastal Mountain Range.

Chupón grassland
Table 6.6 | Group Nr. 3 | Figure 6.12 | Acronym: Chu. G

Physiognomy

High perennial grassland, without layers and with average height of 1.50 m (see Figure 6.12). The biological spectrum is mainly Hemicryptophytes both in frequency and coverage, 39% and 92% respectively (see Figure 6.2). Other lifeforms are: Mesophanerophytes, Microphanerophytes, Nanophanerophytes, Lianas, Chamaephytes, Geophytes and Therophytes. The Nanophanerophytes show the highest frequency (22%), followed by Microphanerophytes and Lianas (11%), Chamaephytes (8%) and finally Mesophanerophytes, Geophytes and Therophytes (3%). The coverage of Nanophanerophytes is equal to 6%, with other lifeforms below 1%.

Floristic

With 32 species distributed over 3 classes and 25 families. The dominant class in terms of frequency is Magnoliopsida (66%), followed by Liliopsida (28%) and Polypodiopsida (6%). The order is different with regards for the coverage, as the Liliopsida class dominates the distribution (91%) whereas the Magnoliopsida and Polypodiopsida classes have values equal to 9% and below 1%, respectively (see Figure 6.3). The most representative families in this unit are Bromeliaceae, Rosaceae and Poaceae (see Appendix B).

There is only one dominant species (Dm), which is constant (Ct) and diagnostic (Dg) as well: *Greigia sphacelata*, Hemicryptophyte, of the Bromeliaceae family, Endemic of Chile. This unit has two species with IUCN conservation category: *Greigia sphacelata* (VU) and *Lapageria rosea* (EN) (see Table 5.4 in Chapter 5). The former shows the largest coverage value as it is characteristic and dominant within the association. The latter has a low coverage as it is more common in the *Olivillo* forests (see Table 6.5).

Figure 6.12: Overview of the *Chupón* grassland in the research area. Top: in Punta Galera; bottom: *Hoc loco* in Huape. The two images highlight the density of the community, its broad distribution and the slope of the areas where it grows. Photographed by the author in January 2012.

Syntaxonomy

On the 18 considered relevés, the species average per relevís 6.61 ± 3.01, see Table 6.3. The species with the largest importance values are *Greigia sphalaceta* (104.46) and *Rubus constrictus* (14.05). The former is native (Endemic of Chile), the latter non native (Adventitious). The other species are *Baccharis racemosa* (6.50), *Ugni molinae* (5.82) and *Aristotelia chilensis* (5.38), see Table C.5 in Appendix C.
The calculation of the fidelity values indicates that this unit has two diagnostic and two constant species, with one of the diagnostic species being exclusive (underlined). It is worth noting that *Greigia sphacelata* is both diagnostic and constant.

The diagnostic species are:
Greigia sphacelata (Ct, Dm) 77.2; *Berberis darwinii* 30.2.

The constant species are:
Greigia sphacelata (Dg, Dm) 100; *Rubus constrictus* 72.

The dominant species is:
Greigia sphacelata (Dg, Ct) 89.

This unit has a positive fidelity equal to 15.46 and a sharpness value of 53.72. The values indicate that the unit is homogeneous and well defined from the floristic point of view.
The similarity of this unit with BERBERIDION BUXIFOLIAE arises from *Berberis darwini*, *Ovidia pillo-pillo*, *Fuchsia magellanica* and *Muehlenbeckia hastulata*, and with ARISTOTELIETALIA CHILENSIS from *Rubus constrictus*, *Aristotelia chilensis* and *Baccharis racemosa* (see Table D.4 in Appendix D).

Ecology and distribution

This unit is mainly native, both in frequency and coverage. As for the frequency, 42% of the species are Endemic of Chile and Argentina, 31% are Native and 11% are Endemic of Chile. Species with non-native origin are mainly Adventitious (11%), followed by Naturalised and Introduced species (3%). The species which are Endemic of Chile provide 90% of the unit's coverage, followed by species Endemic of Chile and Argentina and Adventitious (4%), Native and Naturalised (1%) and Introduced (less than 1%).
The Alpha-diversity of this community calculated with the Shannon index is 3.46. The result indicates high diversity. The equitability based on the Pielou's uniformity index is 0.90 (see Table 6.4).
The altitude distribution of the relevés ranges between 18 and 147 m a.s.l., with an average value of 55.28 m a.s.l. (see Figure 6.5). These are mainly located in the southern part of the investigated area (Punta Galera, Playa Pelche, Playa Colún and Lagunas Gemelas) and only one in the northern area (Bonifacio), see Figure 6.6 and Map A.1 in Appendix A. The relevés face mainly North-East and South-East (24% each). An amount of 20% has no defined orientation (n.d.), whereas 17% and 10% face South-West and South, respectively (see Figure 6.7).
According to the CIREN cartography (2003), see Map A.2 in Appendix A, 93% of the relevés is distributed in the Chaihuen Series, the others in the Tres Cruces Association (see Figure 6.8).

Table 6.7: Phytosociological table of the *Chupón* grassland on the research area. Information of header data, see Appendix E. Lf.: Lifeform (for notation, see Table 4.2); Fr.: Frequency; Dg: Diagnostic species; + *holotypus*; ∼: relevé as representative of vegetation unit. Source: Own data.

```
Group Nr.                                        3
                                                             +
                                                             ~
Relevé Nr.                                       11111111|1111111111
                                                 55456666|6565555565
                                                 59944563|1021278603
Species                       Lf.      Fr.

Dg  Greigia sphacelata        [H]      [18]      54554555|5555555555
    Rubus constrictus         [N P]    [13]      ++..2212|+.++.++.++

    Ugni molinae              [N P]    [6]       +.++2+2.|..........
    Ovidia pillopillo         [Mi P]   [3]       r2+.....|..........
    Eryngium paniculatum      [H]      [3]       +....1.1|..........
    Berberis darwinii         [N P]    [3]       ....2+2.|..........
    Boquila trifoliolata      [L]      [5]       ........|++2++.....
    Rhaphithamnus spinosus    [N P]    [3]       ........|+..++.....
Class & Order
    Baccharis racemosa        [N P]    [7]       +..++2..|++.+......
    Aristotelia chilensis     [Mi P]   [6]       .....+..|+..++.+..r
    Prunella vulgaris         [Ch]     [5]       +..+.1..|.+...+....
    Chusquea quila            [N P]    [5]       ......1.|+.2..+..+.
    Lotus pedunculatus        [H]      [4]       +.....+.|+........+
Companion
    Galium hypocarpium        [Ch]     [3]       +.......|.+....++..
    Blechnum chilense         [H]      [3]       +.......|.....++..+
    Blechnum hastatum         [H]      [3]       +.+.....|.+........
    Gaultheria mucronata      [N P]    [2]       ....1+..|..........
    Agrostis capillaris       [H]      [3]       +......2|......+...
    Lapageria rosea           [L]      [2]       ........|+.+.......
    Centella asiatica         [H]      [2]       ........|.+....+...
    Holcus lanatus            [H]      [2]       ........|.+...+....
    Leontodon saxatilis       [H]      [2]       ........|.+.+......
    Nassella poeppigiana      [H]      [1]       +.......|..........
    Cliococca selaginoides    [Ch]     [1]       .....+..|..........
    Libertia chilensis        [H]      [1]       ....r...|..........
    Lomatia hirsuta           [Mi P]   [1]       ....r...|..........
    Leptinella scariosa       [H]      [1]       ...+....|..........
    Lomatia ferruginea        [N P]    [1]       ..r.....|..........
    Alstroemeria aurea        [G]      [1]       ........|+.........
    Cissus striata            [L]      [1]       ........|+.........
    Aextoxicon punctatum      [Mes P]  [1]       ........|r.........
    Gamochaeta americana      [H]      [1]       ........|.+........
    Centaurium cachanlahuen   [T]      [1]       ........|.+........
    Muehlenbeckia hastulata   [L]      [1]       ........|.......+..
    Acaena ovalifolia         [H]      [1]       ........|.......+..
    Luma apiculata            [Mi P]   [1]       ........|.......r..

Number of relevés: 18 | Number of species: 36

Class          Wintero-Nothofagetea  Oberdorfer 1960
Orden          Aristolietalia chilensis  Hildebrand 1983
Alliance       Berberion buxifoliaceae  Hildebrand 1983
Association    Rubo-Greigietum sphacelatae  ass.nov.
Acronomyn      Chu. S.
```

6.3.5 *Agrostio capillariae - Eryngietum paniculatae* ass. nov.

[Typus relevé: rel. 69 *Holotypus hoc loco*, Table 6.8]

Mesic pseudosteppe on deep rich organic soil at low and mid-altitude on the western slopes of the Valdivian Coastal Mountain Range.

Cardoncillo pseudoesteppe
Table 6.9 | Group Nr. 3 | Figure 6.13 | Acronym: Car. G

Physiognomy

Mesic peseudosteppe, without layers and with average height equal to 1 m (see Figure 6.13, Appendix E). The biological spectrum is mainly Hemicryptophytes. In terms of frequency, the dominant lifeforms are Hemicryptophytes (55%), Nanophanerophytes (18%) and Therophytes (12%), Chamaephytes (9%) and Microphanerophytes (6%). As for the coverage, the dominant species is the Hemicryptophytes (85%), followed by Nanophanerophytes (8%), Chamaephytes (5%), Therophytes (2%) and Microphanerophytes ($< 1\%$), see Figure 6.2.

Floristic

The unit's recorded species sum up to 33, distributed in 3 classes and 23 families (see Figure 6.3 and Appendix B). The Magnolipsida class dominates in terms of frequency and coverage(79% and 90%, respectively). The second class is that of Liliopsida (18% in frecuency and 10% in coverage), followed by Polypodiopsida (3% in terms of frequency, less than 1% in coverage), see Figure 6.3. The most important families are Apiaceae, Asteraceae, Fabaceae, Rosaceae and Rubiaceae (see Appendix B).
This unit has one dominant species, *Eryngium paniculatum*, and 5 constant species. The *E. paniculatum* is both a diagnostic and constants pecies. The list of the constant species is as follows:

> *Eryngium paniculatum* (Dg, Dm) 100; *Centella asiatica* (Dg) 100; *Agrostis capillaris* 100; *Lotus pedunculatus* 77, *Rubus constrictus* 69.

No species have IUCN conservation cathegories.

Syntaxonomy

The unit comprises 13 relevés. The average number of species per relevé is 10.69 ± 2.56 (see Table 6.3). The most important species are *Eryngium paniculatum* (67.96), *Agrostis capillaris* (16.32), *Centella asiatica* (12.69), *Cliococca selaginoides* (8.89) and *Lotus pedunculatus* (8.44), see Table C.6 in Appendix C.
The analysis of the synoptic table enabled the identification of five diagnostic species, three of which are exclusive (underlined):

> *Eryngium paniculatum* (Ct, Dm) 83.7; <u>*Libertia chilensis*</u> 40.9; <u>*Cliococca selaginoides*</u> 39.2; *Centella asiatica* (Ct) 35.4; <u>*Galium hypocarpium*</u> 34.8.

The phytosociological table presents a humid and dry variant of the unit. The former is suggested by the presence of *Lotus pedunculatus*, *Cliococca selaginoides* and *Centaurium*

Figure 6.13: View of the *Cardoncillo* pseudosteppe in the research area. Top: *Hoc loco* in Curiñanco. Bottom: in Calfuco. The pictures show the species proximity the to the sea, the flatness of the land where it grows, the high density of the *Cardoncillo* despite the presence of other species, as well as its broad distribution. Photographed by the author in January 2012.

cachanlahuen. These are located in the relevés with no well-defined inclination. The latter is indicated by *Libertia chilensis* and *Galium hypocarpium*, which are mainly distributed on the south-western slopes (see Table 6.8).
The unit has a positive fidelity of 13.22 and a sharpness value of 21.97. For its five diagnostic species, the unit is considered homogeneous and well defined (see Table 6.1).

This association is similar to the MOLINIO - ARRHENATHERETEA class for *Holcus lanatus*, *Leontodon saxatilis*, *Prunella vulgaris* and *Hypochaeris radicata*, and to the AGROSTIDETALIA CAPILLARI order for *Agrostis capillaris*, *Centaurium cachanlahuen*, *Lotus pedunculatus*, *Anthoxanthum utriculatum* and *Trifolium repens*.
The author suggests the LIBERTION CHILENSIS alliance (Holotypus: *Agrostio capillariae - Eryngietum paniculatae* ass. nov.), with *Cliococa selaginoides*, *Libertia chilenis* and *Galium hypocarpium* as characteristic species (see Table D.4 in Appendix D). It is worth noting that this unit presents three species with similarity in another phytosociological order: ARISTOTELIETALIA CHILENSIS with *Rubus constrictus*, *Ovidia pillo-pillo* and *Aristotelia chilensis*. This suggests that the unit may be contributing to the replacement of the original forest.

Ecology and distribution

This unit shows elements which are mainly native, both in frequency and coverage. In terms of frequency, 33% of the species is Native, 27% Endemic of Chile and Argentina and Adventitious, 6% is Introduced and 3% is Endemic of Chile and Naturalised. As for the coverage, 70% are Native, 10% are Introduced, 8% are Endemic of Chile, 7% are Naturalised and 5% are Adventitious, respectively (see Figure 6.4).
The Shannon-Wiener index calculated for this community is equal to 3.34. Hence, the unit shows a relatively high diversity. The Pieolu and J' indices are equal to 0.85 and 0.95, respectively (see Table6.4).
The altitude distribution ranges between 20 and 60 m a.s.l., with an average of 34.54 m a.s.l. (see Figure 6.5). The region presents low ridges, with 77% of the relevés being located in the northern part of the investigation area and 33% in the southern sector (see Figure 6.6 and Map A.1 in Appendix A). 85% of the units are distributed over areas with no well-defined orientation, the remaining with South-West exposition, see Figure 6.7. According to the CIREN cartography (2003), 77% of them are located in the TSC and 23% in the HEY (Figure 6.8, Map A.2 in Appendix A).
No human activity was observed in this area. This is due to the fact that *E. paniculatum* does attract interest in the region.

Table 6.8: Phytosociological table of the *Cardoncillo* grassland on the research area. Information of header data, see Appendix E. Lf.: Lifeform (for notation, see Table 4.2); Fr.: Frequency; Dg: Diagnostic species; + *holotypus*; ∼: relevé as representative of vegetation unit.

Group Nr.				**5**
				+
				~
Relevé Nr.				**7676676666667**
				2903718456213
Species		**Lf.**	**Fr.**	
Dm	*Eryngium paniculatum*	[H]	[13]	4555544545555
C	*Agrostis capillaris*	[H]	[13]	2222222122222
C	*Centella asiatica*	[H]	[13]	222+222++++++
C	*Lotus pedunculatus*	[H]	[10]	++++++++++...
C	*Rubus constrictus*	[N P]	[9]	.+rr2+...2222
Typicum wet variant				
Dg	*Cliococca selaginoides*	[Ch]	[7]	2221+2.2.....
Dg	*Centaurium cachanlahuen*	[T]	[6]	.22+++..1....
Dry variante				
	Libertia chilensis	[H]	[3]	..........+2+
	Galium hypocarpium	[Ch]	[5]	.2...+....+++
Class & Order				
	Prunella vulgaris	[Ch]	[7]	1++++r+......
	Leontodon saxatilis	[H]	[5]	.2+++....2...
	Acaena ovalifolia	[H]	[3]	+22..........
	Holcus lanatus	[H]	[6]	+.....+..2+++
	Anthoxanthum odoratum	[H]	[3]	..........++.
	Trifolium repens	[T]	[3]	+........+...
Other Class				
	Ugni molinae	[N P]	[6]	3..r..rr..+2.
	Baccharis racemosa	[N P]	[5]	2.+.2.+..2...
	Gaultheria mucronata	[N P]	[3]	1.........2.+
	Ovidia pillopillo	[Mi P]	[3]	..........r.r
	Aristotelia chilensis	[Mi P]	[2]	+........r...
Companion				
	Rumex acetosella	[H]	[2]	...+.r.......
	Hypochaeris radicata	[H]	[2]	.21..........
	Lotus subpinnatus	[T]	[2]	.1+..........
	Juncus imbricatus	[H]	[2]	...1....+....
	Blechnum hastatum	[H]	[1]	............+
	Oldenlandia salzmannii	[H]	[1]	......2......
	Gamochaeta americana	[H]	[1]	+............
	Geranium core-core	[T]	[1]	......+......
	Genista monspessulana	[N P]	[1]	+............
	Ranunculus repens	[H]	[1]	.........2...
	Calceolaria integrifolia	[T]	[1]	.....+.......
	Fuchsia magellanica	[N P]	[1]	.......2.....
	Carex fuscula	[H]	[1]	...+.........

Number of relevés: 13 **|** **Number of species:** 33

Class	Molinio-Arrhenatheretea Tüxen 1937
Order	Agrostidetalia capillari San Martín *et al.* 1993
Alliance	Libertion chilensis all.nov.
Association	*Agrostio-Eryngietum paniculatae* ass.nov.
Acronomyn	Car. G

6.3.6 *Juncietum proceri* Oberdorfer 1960

[Typus relvé: *Lectotypus hoc loco designatus*: rel. 187, Table 48 in Oberdorfer 1960]

Humid prairie on deep wet organic soils at low altitude in the mesotemperate zone of Chile.

Junco húmedo grassland
Table 6.9 | Group Nr. 6 | Figure 6.14 | Acronym: Ju-h. G

Physiognomy

Grassland with average height of 1.15 m (see Appendix E). The biological spectrum consists mainly of Hemicryptophytes. The following lifeforms are also present: Meso-, Micro- and Nanophanerophytes, Chamaephytes and Therophytes. Hemicryptophytes are the main lifeform in terms of frequency (58%), followed by Micro- and Nanophanerophytes (13%), Chamaephytes and Therophytes (7%) and Mesophanerophytes (2%), see Figure 6.2. The Hemicryptophytes are the main lifeforms also in terms of coverage (96%). The others are Nanophanerophytes (2%) and Chamaephytes (1,5%), with the remaining lifeforms showing values below 1%.

Floristic

The unit comprises forty-five species (see Table 6.3 and 6.4), distributed over three classes and twenty-two families. The classes are Magnolipsida (18 families), Liliopsida (3 families) and Polipodiopsida (1 family). In terms of species frequency, the main class is Magnoliopsida (71%), followed by Liliopsida (27%)and Polypodiopsida (2%). As for the coverage, the main classes are Liliopsida (69%), Magnoliopsida (29%) and Polypodiopsida (1%). The most important families are Juncaceae, Poaceae, Asteraceae, Ranunculaceae, Myrtaceae and Rubiaceae.
This unit has four constant species, with *Juncus procerus* being also dominant and diagnostic:

> *Juncus procerus* (Dg, Dm) 100, *Centella asiatica* (Dg) 100, *Holcus lanatus* 73, *Agrostis capillaris* 67.

No species with UICN conservation category was recorded.

Syntaxonomic

The unit was identified with fifteen relevés. The average number of species per relevé is 10.20 ± 1.52 (see Table 6.3). The calculation of the importance values indicates the following most important species: *Juncus procerus* (64.10), *Centella asiatica* (20.93), *Leontodon saxatilis* (11.13), *Agrostis capillaris* (10.30) and *Holcus lanatus* (10.15). For the other species, see Table C.7 in Appendix C.
This unit presents four diagnostic species (Dg), out of which two are exclusively diagnostic (underlined):

> *Juncus procerus* (Ct, Dm) 65.9; <u>*Ranunculus repens*</u> 47.2; *Centella asiatica* (Ct) 35.4; <u>*Paspalum dasypleurum*</u> 35.2.

The positive fidelity and sharpness of this unit are equal to 9.50 and 18.10 respectively (see Table 6.1).

Figure 6.14: *Junco húmedo* grassland in the research region. Top: Los Liles. Bottom: Guape. The species is mainly distributed in the southern area. The images indicate the average height of its characteristic species (*Juncus procerus*, 1m) and the low density of the Junco húmedo distribution, mainly due to grazing. Photographed by the author in March 2012.

This units was identified as the *Juncietum proceri* association because of the *Juncus procerus*, *Centella asiatica* and *Ranunculus repens* as characteristics species.

Ecology and distribution

This unit is native both from the frequency and cover point of view (69% and 81% respectively). In terms of frequency, the value of the Native species is 36%, followed by species which are Endemic of Chile and Argentina (29%), Adventitious (20%), Endemic of Chile, Naturalised and Introduced (4%) and Cosmopolitan (2%). As for the cover, the values are: 76% for Native species, 14% for Adventicious, 4%, 3%, and 2% for Naturalised, Endemic of Chile and Argentina and Endemic of Chile respectively, and below 1% for Cosmopolitan (see Figure 6.2).
The average altitude of the relevés is 34.20 m a.s.l., with mean slopes of 2° and almost flat orientation (n.d.). Most of the relevés (53%) were located in the southern area, 27% in the central part and 20% in the northern one (see Figure 6.6 and A.1 in appendix A). According to CIREN, the releves are distributed in the Chaihuin Serie (40%), as well as in the Tres Cruces and Hueicolla Associations and in miscellaneous areas (20% each).

Table 6.9: Phytosociological table of the class MOLINIO-ARRHENATHERETEA grassland on the research area. Information of header data, see Appendix E. Lf.: Lifeform (for notation, see Table 4.2); Fr.: Frequency; Dg: Diagnostic species; + *holotypus*; ∼: relevé as representative of vegetation unit. Sorce: Own data.

Vegetation Unit			Car. G	Ju-h. G	Pj-r. G	Cen. G	C-C. G	Air. G	Ju-d. G	Cep. G
Group Nr.			5	6	7	8	9	10	11	12
			+ ~	~	~	~	~	~	~	~
Relevé Nr.					**11111111111**	**111**	**11111111111**	**11**	**1**	**11111**
			6767676766666	**888888777887778**	**21122222212**	**666**	**00000010100**	**22**	**099999999998**	**11111**
			2211709343865	**657348849216570**	**29764071385**	**978**	**73846511029**	**89**	**048216957309**	**54362**
Species	**Lf.**	**Fr.**								
Dg Group 5										
Eryngium paniculatum	[H]	[14]	5454555555454	....	....	...	....	..	........r...	.....
Cliococca selaginoides	[Ch]	[15]	.2.2+22.21...	....	...2......+	...	++++.......	..	2...........	..+..
Ugni molinae	[N P]	[13]	+32.....rrr..	.........r.....	....	+.+	........r..	+.	....	.+.+.
Galium hypocarpium	[Ch]	[9]	+.++..2+.....	......+..+.....	.+...+.....	...	....	..	....	.....
Baccharis racemosa	[N P]	[6]	.2..2+....+2.	.......+.......	....	...	....	..	....	.....
Dg Group 6										
Juncus procerus	[H]	[26]	....	555544444444344	+.22+.2..+.	...	....	..	.2+...++....	+....
Ranunculus repens	[H]	[10]	...........2.	2+2+22+........	+...2......	...	....	..	....	.....
Nertera granadensis	[H]	[4]	....	+2.....++......	....	...	....	..	....	.....
Blechnum chilense	[H]	[2]	....	.........22....	....	...	....	..	....	.....
Paspalum dasypleurum	[H]	[2]	....	...........2+..	....	...	....	..	....	.....
Dg Grup 7										
Anthoxanthum utriculatum	[H]	[12]	....	.........2.....	45554444444	...	....	..	....	.....
Juncus microcephalus	[H]	[7]	....	2..2.2.........	+..2+.1....	...	....	..	....	.....
Polypogon chilensis	[H]	[6]	....	...2...+.2.....	..2...2..2.	...	....	..	....	.....
Oldenlandia salzmannii	[H]	[15]	..........2..	++.......3.+.2.	.+2.+.++..2	+++	....	..	....	.....
Dg Group 8										
Centella asiatica	[H]	[50]	+2+2222+++2++	+2222+222322223	3222222+222	344	+2+2++.....	..	2...........	3....
Brachystele unilateralis	[G]	[4]	....	....	....	++.	...+.......	..	....	+....
Rigodium brachypodium	[B]	[8]	....	....	....	+.2	+...+...+..	..	+.....+.....	.+...
Dg Group 9										
Acaena ovalifolia	[H]	[25]	.+...22......	.......+....+..	+..1...+...	..+	33233223223	+.	2.2.....2...	...2.
Dg Group 10										
Aira caryophyllea	[H]	[16]	....	....	.......+..2	+.+	2.+.+.2+.+2	34	2..+....+...	.....
Dg Group 11										
Juncus imbricatus	[H]	[33]	.........1..+	+...2++.+2...2.	..21.......	.r.	+2+.+.2+2..	+.	443344444242	.+...
Dg Group 12										
Vulpia bromoides	[H]	[25]	....	....	.+...+.....	+.+	.2.+2.22...	2+	2.222.2.+222	44444
Libertion chilensis										
Libertia chilensis	[H]	[3]	+.2+.........	....	....	...	....	..	....	.....
Gaultheria mucronata	[N P]	[5]	21....+......	....	....	...	....	+.	+...........	.....
Juncion proceri										
Lotus pedunculatus	[H]	[36]	.+.++++.+++++	.+++++.........	++22+++.+23	22+	+.++.+.....	+.	.....++.....	..+..
Leptinella scariosa	[H]	[13]	....	..+...+....2.22	..+.2.+....	...	.+...+.....	..	......2.....	++...
Agrostidion chilensis										
Dichondra sericea	[H]	[27]	....	.+.............	....	...	+.2.2+22222	22	332222.3232.	+2+22
Anthoxanthum odoratum	[H]	[13]	+.+..........	......2........	.....+.+...	...	++2..2.2.+.	..	...++.......	.....
Gamochaeta americana	[H]	[18]	.+...........	....	....	...	+++++.2+...	..	..2+..+++++.	++.+.
Carex fuscula	[H]	[15]	.........+...	....+.......+..	..+........	++.	++.......+.	++	.+..+..+...+	.....
Dactylis glomerata	[H]	[2]	....	....	....	...	....	..	.+...+......	.....
Trifolium repens	[H]	[14]	.+.........+.	.........r.....	.........+.	...	+++.......+	..	+++..+.+.+..	.....
Plantago lanceolata	[H]	[6]	....	....	....	...	....	.+	+..+.+.+.+..	.....
Rumex acetosella	[H]	[17]	...r.....+...	....2..+...+...	....	...	.+.++..+...	++	.++.+..++.+.	.....
Cuscuta chilensis	[H]	[2]	....	....	....	...	....	..	....	++...
Ord. C. & Cla. C.										
Agrostis capillaris	[H]	[65]	2222222212222	++2.+2.+...222+	+2+2+.2.++2	333	24243443444	22	322222222223	22222
Centaurium cachanlahuen	[H]	[39]	...++22..+..1	...........+.++	+++2.+.+..+	.++	++++..+.+22	++	+..++.+.+.+.	2++++
Leontodon saxatilis	[H]	[45]	....++2..+.2.	......23+..332+	222.2+.+...	23.	232222.2.+.	++	323222.222++	2.222
Holcus lanatus	[H]	[45]	+++....+..+2.	++2.2.2.+2.22++	2+.22+2+...	+2+	+.++232.2.2	..	.+.+++++.++.	..+.+
Prunella vulgaris	[H]	[43]	.1.r+++..++..	..+....++..2++.	+++++++++..	.+.	++++.+++++.	+.	++++++++++..	.....
Companion										
Lotus subpinnatus	[T]	[12]	.....+1......	....	+.......+..	...	.+...++...2	..	+.+...+.....	+....
Hypochaeris radicata	[H]	[10]	.....12......	+..+...+.......	....	...	..+........	+.	2..+.....+..	.....
Cirsium vulgare	[T]	[4]	....	..........+.+..	....	...	....	..	.++.........	.....
Genista monspessulana	[H]	[2]	.+...........	.............+.	....	...	....	..	....	.....
Chevreulia sarmentosa	[H]	[2]	....	...........+...	....	...	.+.........	..	....	.....
Oxalis sp.	[T]	[2]	....	....	.+.........	...	....	..	....	+....
Other Class										
Rubus constrictus	[H]	[19]	2.2+2r+2.r.2.	+++..++.+.2...+	2.......+..	...	....	..	....	.....
Ovidia pillopillo	[Mi P]	[5]	r.....r......	.........r.....	.+....+....	...	....	..	....	.....
Aristotelia chilensis	[Mi P]	[3]	.+.........r.	..........+....	....	...	....	..	....	.....
Blechnum hastatum	[H]	[2]	.......+.....	....	........+..	...	....	..	....	.....

Single occurrence (*Sp.*[Group|Relevé|Cover|Lf.]):

Calceolaria integrifolia [5|71|+|T]; *Fuchsia magellanica* [5|64|2|N P]; *Geranium core-core* [5|68|+|T]; *Gratiola peruviana* [6|83|2|Ch]; *Tepualia stipularis* [6|85|r|Mi P]; *Luma apiculata* [6|85|r|Mi P]; *Gunnera tinctoria* [6|81|2|H]; *Chusquea quila* [6|81|2|N P]; *Sophora microphylla* [6|81|r|N P]; *Myrceugenia exsucca* [6|75|+|Mi P]; *Cyperus sp.* [6|74|+|H]; *Oxalis corniculata* [6|80|+|T]; *Aextoxicon punctatum* [6|79|+|Mes P]; *Myrceugenia planipes* [6|78|+|Mi P]; *Nothoscordum striatellum* [7|120|+|G]; *Berberis darwinii* [7|123|+|N P]; *Amomyrtus luma* [7|123|+|Mes P]; *Baccharis sagittalis* [7|118|2|N P]; *Leptostigma arnottianum* [9|107|+|G]; *Berberis microphylla* [9|107|+|N P]; *Paspalum distichum* [9|107|+|H]; *Ulex europaeus* [9|104|r|N P]; *Piptochaetium montevidense* [10|128|+|H]; *Modiola caroliniana* [11|94|+|H]; *Uncinia phleoides* [11|91|+|H]; *Trifolium pratense* [11|96|+|Ch]; *Daucus carota* [11|96|+|T]; *Relchela panicoides* [11|89|+|H]; *Sisyrinchium chilense* [12|112|+|G]

6.3.7 *Centello asiaticae - Anthoxanthetum utriculati* San Martín *et al.* 1992

[Typus relevé: no available]

Paja Ratonera grassland
Table 6.9 | Group Nr. 7 | Figure 6.15 | Acronym: Pj-r. G

Physiognomy

Grassland with average height of 1.04 m. The biological spectrum consists mainly of Hemicryptophytes both in frequency (56%) and cover (95%). The lifeforms are Meso-, Micro- and Nanophanerophytes, Chamaephytes, Geophytes and Therophytes. The frequency representatively of Therophytes is 16%, followed by Nanophanerophytes and Chamaephytes (9% each) and Mesophanerophytes, Microphanerophytes and Geophytes (3% each). The coverage values are 2% for Nanophanerophytes, Chamaephytes and Therophytes each. The other lifeforms have values below 1% (see Figure 6.2).

Floristic

The thirty-two recorded species are distributed in three classes (Magnoliopsida, Liliopsida and Polypodiopsida)and 19 families. The class with the largest frequency value is Magnoliopsida (59%, fourteen families), followed by Liliopsida (38%, four families) and Polypodiopsida (3%, one family). As for the cover, the Liliopsida class has a value of 71%, Magnoliopsida 29% and Polypodipsida is below 1%. The most important families are Poaceae, Asteraceae, Apiaceae and Juncaceae (see Appendix B).
This unit has one dominant species (*Anthoxanthum utriculatum*) and seven constant species, including *A. utriculatum*. The constant species (Ct) are:

> *Centella asiatica* (Dg) 100, *Anthoxanthum utriculatum* (Dg, Dm) 100, *Lotus pedunculatus* (Dg) 91, *Prunella vulgaris* 82, *Agrostis capillaris* 82, *Holcus lanatus* 64, *Centaurium cachanlahuen* 64.

No species with IUCN conservation category was recorded.

Syntaxonomic

The unit was identified with eleven relevés. The average number of species per relevé is 11.18 ± 1.94 (see Table 6.3). The largest importance values were calculated for *Anthoxanthum utriculatum* (67.00), *Centella asiatica* (20.26), *Lotus pedunculatus* (12.56), *Holcus lanatus* (9.54) and *Agrostis capillaris* (9.49). For the other species, see Table C.8 in Appendix C.
This unit has six diagnostic species (Dg), with three of them being exclusively diagnostic (underlined):

> *Anthoxanthum utriculatum* (Ct, Dm) 96.5; *Juncus microcephalus* 45.1; *Centella asiatica* (Ct) 35.4; *Lotus pedunculatus* (Ct) 31.8; *Polypogon chilensis* 31.6; *Oldenlandia salzmannii* 31.2.

The average fidelity value in this unit is 12.57. The related sharpness is equal to 24.39 (see Table 6.1).

Figure 6.15: Overview of the *Paja ratonera* grassland in the research area. Top: Curiñanco; Bottom: Los Liles. The species is distributed over both the northern and southern region and on flat terrain. The pictures highlight high density of the grassland and the openness of the spaces where it grows. Photographed by the author in January 2012.

The *Anthoxanthum utriculatum*, *Juncus microcephalus*, *Centella asiatica* and *Lotus pedunculatus* species enabled the identificiation of this unit as *Centello asiaticae - Anthoxanthetum utriculatae*.

Ecology and distribution

The *Paja ratonera* grassland is native both from the frequency and cover point of view (66% and 83% respectively). Native species show a frequency value of 41%, followed by

species which are Endemic of Chile and Argentina (22%), Introduced (6%), Endemic of Chile and Naturalised (3% each). The coverage values sum up to 60% for the species Endemic of Chile and Argentina, 23% for Native species, 11% for Adventitious, 5% for Introduced, 2% for Naturalised and below 1% for the species which are Endemic of Chile. The Shannon-Wiener, Pelieu and J' indices are equal to 3.35, 0.89 and 0.97 respectively. The values indicate that the unit has an intermediate and homogeneous diversity.
The relevés altitude distribution has an average value of 23.18 m a. s. l. (see Figure 6.5), with mean slopes of 2.27°. The vast majority (91%) of the relevés do not show a determined exposition, whereas 9% of them has south west orientation (see Figure 6.7). 64% of the relevés is located in the northern part of the research area, 27% and 9% in the central and southern part respectively (see Figure 6.6 and Map A.1 in Appendix A). According to CIREN, 64% of the relevés are located in the Tres Cruces Association, and 18% in the Chaihuin and Hueicolla Series.

6.3.8 *Centello asiaticae - Agrostietum capillaris* Ramírez *et al.* 1985

[Typus relvé: rel. 10 *Lectotypus hoc loco designatus*, Table 2 in Ramírez *et al.* 1985]

Overgrazing semi-wet meadow/prairie on organic soils, at low altitude on the western slopes of the Valdivian Coastal Mountain Ranges.

Centella grassland
Table 6.9 | Group Nr. 8 | Acronym: Cent. G

Physiognomy

Perennial meadow with average height of 13 cm, without layers and with coverage equal to 100% (see Appendix E). The biological spectrum consists of Hemicryptophytes, Therophytes, Nanophanerophytes, Geophytes, Chamaephytes and Bryophytes. The dominant lifeforms in terms of frequency are Hemicryptophytes and Therophytes (53% and 20%, respectively). In terms of coverage, the main lifeforms are the Hemicryptophytes (94%), followed by Bryophytes (3%), Therophytes (2%) and the other lifeforms (below 1%), see Figure 6.2.

Floristic

The community is characterised by sixteen species distributed in three classes and thirteen families. The Magnoliopsida has eight families and is the main class both in terms of frequency and coverage (50% and 63% respectively), followed by Liliopsida (4 families) with frequency and coverage values equal to 44% and 34%. The corresponding values for the Bryopsida class (1 family) are 6% and 3%, see Figure 6.3. The Poaceae is the most important family in terms of both frequency and coverage, see Appendix B.
This unit is dominated by the *Centella asiatica* (Dg, Ct) and has thirteen constant species:

> *Oldenlandia salzmannii* (Dg) 100; *Lotus pedunculatus* (Dg) 100; *Holcus lanatus* (Dg) 100; *Centella asiatica* (Dg, Dm) 100; *Agrostis capillaris* 100; *Vulpia bromoides* 67; *Ugni molinae* (Dg) 67; *Rigodium brachypodium* (Dg) 67; *Leontodon saxatilis* 67; *Centaurium cachanlahuen* 67; *Carex fuscula* (Dg) 67; *Brachystele unilateralis* (Dg) 67; *Aira caryophyllea* (Dg) 67.

Syntaxonomic

This unit was identified with 3 relevés. The average number of species per relevé is 11.33 ± 0.58 (see Table 6.3). The most important species are: *Centella asiatica* (50.17), *Agrostis capillaris* (34.66), *Leontodon saxatilis* (21.39), *Holcus lanatus* (14.51) and *Lotus pedunculatus* (14.51). The other species are reported in Table C.9 in Appendix C.
This unit has ten diagnostic species (Dg), which are also constant:

> *Oldenlandia salzmannii* (Ct) 68.3; *Brachystele unilateralis* (Ct) 65.3; *Rigodium brachypodium* (Ct) 53.4; *Lotus pedunculatus* (Ct) 37.4; *Holcus lanatus* (Ct) 35.4; *Centella asiatica* (Ct) 35.4; *Ugni molinae* (Ct) 33.8; *Carex fuscula* (Ct) 32.2; *Aira caryophyllea* (Ct) 31.5.

The positive fidelity of this unit is 24.26, as species such as *O. salzmannii* and *B. unilateralis* are diagnostic in just this unit. The large number of diagnostic species and the sharpness value of 34.74 (see Table 6.1) show that the unit is homogeneous and well defined.
Due to the limited number of collected relevés, the diagnosis was performed with just relevé 169. This unit was identified with the following species: *Centella asiatica*, *Agrostis capillaris*, *Holcus lanatus*, *Carex fuscula* and *Oldenlandia salzmannii* as the sintaxa *Centello asiaticae - Agrostietum capillariae*.

Ecology and distribution

The proportions of native and non-native elements in this unit are similar. The native species show larger values in terms of frequency, whereas the opposite happens when considering the coverage (see Figure 6.4).
The altitude values range between thirteen and twenty-three m a.s.l., with an average value of nineteen m a.s.l. (see Figure 6.5). The relevés are homogeneously distributed over the considered area, see Figure 6.6. All relevés are located in regions with moderate slopes, almost flat. Hence, no defined orientation is available (see Figure 6.7). According to the CIREN cartography, the relevés are distributed in TSC, HEY and CAU (see Figure 6.8).
For this unit, the Shannon index is equal to 2.59. This indicates that the unit shows normal diversity. Finally, the Pieolu index was found to be equal to 0.89 (see Table 6.4). This unit comprises multiple species indicating high humidity (*Centella asiatica*, *Oldenlandia salzmannii* and *Lotus pedunculatus*) and is characterised by low soil's nutrients.

6.3.9 *Acaeno ovalifoliae - Agrostietum capillaris* Oberdorfer 1960

[Typus relevé: rel. 241 *Lectotypus hoc loco designatus*, Table 46 in Oberdorfer 1960]

Wet-mesic anthropogenic grassland at low and mid-altitude of the coastal range of Valdivia.

Chépica-Cadillo grassland
Table 6.9 | Group Nr. 9 | Figure 6.16 | Acronym: C-C. G

Physiognomy

Grassland, with an average height of 30 cm, without layers (see Appendix E). In terms of frequency, the dominant lifeforms are Hemicryptophytes (59%), Therophytes (14%) and

Figure 6.16: View of *Chépica Cadillo* grassland in Guape. The image shows the broad distribution of the grassland, the presence of introduced species and of forest relict's on the back, as well as the openness of the space due to the ongoing grazing. Photographed by the author in January 2012.

Nanophanerophytes (10%). Chamaephytes, Geophytes and Bryophytes show values lower than 10%. The other lifeforms were not recorded. In terms of coverage, the dominant lifeforms are the Hemicryptophytes (91%), followed by the Therohytes (7%). The other lifeforms are characterised by coverage levels below 1% (see Figure 6.2).

Floristic

This unit includes 29 species, which are distributed in 3 classes and 18 families. In terms of frequency and coverage, the values of each class are as follows: Magnoliopsida with 66% and 48%; Liliopsida with 31% and 52%; Bryopsida with 3% and bellow 1% (see Figure 6.3). The most representative families are Poaceae, Asteraceae, Leguminoseae, Rosaceae. Eight species were found to be constant. *Agrostis capillaris* is both dominant and constant, four out of them are diagnostic and one dominant:

> *Agrostis capillaris* 100; *Acaena ovalifolia* (Dg) 100; *Prunella vulgaris* 82; *Dichondra sericea* (Dg) 82; *Leontodon saxatilis* 73; *Holcus lanatus* 73; *Centaurium cachanlahuen* 73; *Juncus imbricatus* 64; *Gamochaeta americana* (Dg) 64; *Aira caryophyllea* 64.

No species with IUCN conservation categories are present in this unit.

Syntaxonomic

This unit comprises 11 relevés. The average value of species per relevé is 12.55 ± 3.78 (see Table 6.3). The species with the largest importance values are: *Agrostis capillaris* (47.10), *Acaena ovalifolia* (31.30), *Dichondra sericea* (14.92), *Leontodon saxaitilis* (13.77) and *Holcus lanatus* (11.40) (see Table C.10 in Appendix C).
According to the fidelity value in Table 6.1, this unit has four diagnostic species. One out of them is exclusively diagnostic (underlined) and the other three are constant:

> *Acaena ovalifolia* (Ct) 51.6; <u>*Anthoxanthum odoratum*</u> 47.0; *Gamochaeta americana* (Ct) 38.7; *Dichondra sericea* (Ct) 33.1.

According to the analysis of the synoptic table, the sharpness and positive fidelity values indicate that the unit is not well defined, as it includes mainly herbs species which are important in other units (see Table 6.1).
Based on the species *Acaena ovalifolia*, *Aira caryophyllea*, *Juncus imbricatus* and *Vulpia bromoides*, this units has been identified as *Acaeno ovalifoliae - Agrostietum capillariae* Oberdorfer 1960.

Ecology and distribution

In terms of frequency, 31% of the species has Native origin, 28% are Adventitious, 17% Endemic of Chile and Argentina, 14% are Introduced, 7% are Endemic of Chile and 6% are Naturalised (see Figure 6.4). As for the coverage values, 65% of the species are Naturalised, 24% are Endemic of Chile and Argentina, 19% are Adventitious, 15% are Native, 2% are Introduced and 1% is Endemic of Chile (see Figure 6.4). Hence, in terms of coverage the unit is dominated by non-native species.
As for this community the Shannon-Wiener index is equal to 3.21, the unit shows high equitability. The values of the Pieolu and J' indices are equal to 0.85 and 0.95, respectively (see Table 6.4).
Relevés were collected in Curiñanco and Los Pellines, North of the investigated region, and in Huape, Guapi, Punta Galera, Fundo Galera and Puerto Ranquil in the southern part(see Figure 6.6 and Map A.1 in Appendix A). The orientation of the relevés is mainly found in not-defined areas (64%). The other orientations are Northwest (18%) and North and Southwest (9%). The relevés were found between 20 m a.s.l. and 240 m a.s.l., with an average value of 88.55 m a.s.l. (see Figure 6.5). Based on the CIREN cartography (2003), 45% of the relevés are located in the TSC series and 27% in both CAU and HEY, see Figure 6.8.

6.3.10 *Junco imbricatae - Agrostietum capillaris* Ramírez *et al.* 1998

[Typus relevé: does not exist]

Dry-Mesicanthropogenic short-grass prairie on deep mineral soils at low and mid-altitudes of the mesotemperate of Chile.

Junco duro grassland
Table 6.9 | Group Nr. 11 | Figure 6.17 | Acronym: Ju-d. G

Physiognomy

Grassland with average height of 0.1 m, without layers (see Figure 6.17 and Appendix B). The biological spectrum consists mainly of Hemicryptophytes both in frequency (67%) and coverage (92%). The other lifeforms are Mesophanerophytes, Chamaephytes, Therophytes and Bryophytes. The frequency value of Therophytes is 18%, followed by Chamaephytes (9%) and Mesophanerophytes and Bryophytes (3% both). The coverage value of Therophytes and Chamaephytes is 6% and 1% respectively. Finally, Mesophanerophytes and Bryophytes show values below 1% (see Figure 6.2).

Floristic

The 33 species in this unit are distributed over 3 classes and 17 families. In terms of frequency, the main class is Magnoliopsida (13 families, 64%), followed by Liliopsida (3 families, 33%) and Bryopsida (1 family, 3%). The opposite happens when considering coverage values: the Liliopsida class is characterised by a value of 66%, followed by Magnoliopsida (34%) and Bryopsida (below 1%), see Figure 6.4. The most important families are Juncaceae, Poaceae, Asteraceae and Convulolaceae.
There are seven constant species, with one of them (*Juncus imbricatus*) being also dominant and diagnostic:

> *Juncus imbricatus*(Dg, Dm) 100; *Agrostis capillaris* 100; *Leontodon saxatilis* 92; *Prunella vulgaris* 83; *Dichondra sericea* (Dg) 83; *Vulpia bromoides* 75; *Holcus lanatus* 67.

No species with IUCN conservation categories are present in this unit.

Syntaxonomic

The unit was identified with 12 relevés. The average number of species per relevé is 11.83 ± 2.59 (see Table 6.3). The calculation of the importance values indicate that the most important species are *Juncus imbricatus* (50.1), *Agrostis capillaris* (25.5), *Dichondra sericea* (22.7), *Leontodon saxatilis* (18.3) and *Vulpia bromoides* (10.9), see Table C.11 in Appendix C.
This unit comprises six diagnostic species (Dg):

> *Juncus imbricatus* (Ct, Dm) 47.3; *Trifolium repens* 40.8; *Dactylis glomerata* 39.4; *Plantago lanceolata* 38.6; *Gamochaeta americana* 34.4; *Dichondra sericea* (Ct) 34.1.

The positive fidelity and the sharpness of this unit are equal to 14.92 and 19.90, respectively.
This unit was identified as the *Junco imbricatae - Agrostietum capillaris* association for the *Juncus imbricatus*, *Agrostis capillaris*, *Leontodon saxatilis* and *Vulpia bromoides* species.

Ecology and distribution

In terms of frequency, the phytogeographic origin of the species is non native (52%). The data breakdown into the different species is as follows: Adventitious (39%), Native (30%), Endemic of Chile and Argentina (12%) and Endemic of Chile, Naturalised and Introduced (6%), see Figure 6.4.

Figure 6.17: *Junco duro* grassland in the research area. Top: en Playa Pelche; and bottom: in Guapi. Both pictures show the broad distribution of the grassland, which is mainly caused by grazing. The top image highlights the grass density and its low height, which is also due to intense grazing. The same holds for the bottom picture, with the difference that the local lower grazing intensity allows the characteristic species of the association (*Juncus imbricatus*) to be a bit higher than the grass in the top image. Photographed by the author in March 2012.

The unit is native when coverage values are considered. In fact, 61% of the species are native. The other species are grouped as follows: 19% are Adventitious, 17% are Naturalised and 3% are Endemic of Chile and Argentina. Finally, the species which are Endemic of

Chile and Introduced are in both cases less than 1%.
The average altitude of the relevés is 41.33 m a.s.l. (see Figure 6.5). The relevés were distributed as follows: 42% in the southern part, 33% in the northern region and 25% in the central one (see Figure 6.6 and Map A.1 in Appendix A). The average inclination is 3.25°, with 75% of the relevés distributed in areas with not-defined orientation, 17% with South West and 8% with West orientation (see Figure 6.7).
According to the CIREN cartography, 33% of the relevés are located in the Chaihuin series, 17% in the Tres Cruces and Hueicolla associations, and 3% in miscellaneous areas.

6.3.11 *Airo caryophyllae - Agrostietum capillaris* Ramírez *et al.* 1985

[Typus relevé: rel. 14 *Lectotypus hoc loco designatus*, Table 2 in Ramírez *et al.* 1985]

Semi-dry meadow on middle deep soils at low and mid-altitude of the western slopes of the Valdivian Coastal Mountain Range.

Aira grassland
Table 5.11 | Group Nr. 10 | Acronym: Air. G

Physiognomy

Grassland with height of 15 cm and coverage equal to 100% (see Appendix E). In terms of frequency, the dominant lifeforms are Hemicryptophytes (65%), Therophytes (18%), Nanophanerophytes (12%) and Chamaephytes (6%), see Figure 5.5.A. As for the coverage, the ranking is as follows: Therophytes (62%), Hemicryptophytes (36%) and Nanophanerophytes with Chamaephytes (1%), see Figure 6.2.

Floristic

The unit comprises 17 species distributed over 2 classes and 13 families. The classes are Magnoliopsida (10 families) and Liliopsida (3 families). In terms of frequency, the former presents a value equal to 65%, the latter to 35% (Figure 6.3). As for the coverage, 83% of the species belong to Liliopsida and 33% to Magnoliopsida (Figure 6.3). The most important families are Poaceae, Asteraceae and Convolvulaceae (Appendix B).
This unit presents one dominant species (*Aira caryophyllea*), which is both diagnostic and constant, and the following 8 constant species:

> *Vulpia bromoides* (Dg) 100; *Rumex acetosella* (Dg) 100; *Leontodon saxatilis* 100; *Dichondra sericea* (Dg) 100; *Centaurium cachanlahuen* 100; *Carex fuscula* (Dg) 100; *Aira caryophyllea* (Dg, Dm) 100; *Agrostis capillaris* 100.

No species with IUCN conservation category was recorded in this unit.

Syntaxonomy

This unit was identified with just two relevés. The average number of species per relevé is 12.50 ± 4.95 (see Table 6.3). The species with the largest importance values are: *Aira caryophyllea* (58.51), *Agrostis capillaris* (28.20), *Vulpia bromoides* (18.61), *Dichondra sericea* (18.10) and *Carex fuscula* (9.01) (see Table C.12 in Appendix C).
Based on the fidelity calculation, this unit has six diagnostic species, with *Aira caryophyllea* being both dominant and constant. Out of the six diagnostic species, only one is

exclusive (underlined):

> <u>*Piptochaetium montevidense*</u> 69.2; *Rumex acetosella* (C) 63.3; *Carex fuscula* (Ct) 56.3; *Aira caryophyllea* (Ct) 55.5; *Dichondra sericea* (Ct) 45.0; *Vulpia bromoides* (Ct) 42.2.

The analysis of the synoptic table indicates that this unit has a positive fidelity of 19.50 and a sharpness of 26.60 (see Table 6.1).
Despite the limited number of relevés, this grassland was identified as *Airo caryopyllae - Agrostietum capillaris* (Ramírez *et al.* 1985) because of the species *A. capillaris*, *A. caryophyllea*, *V. bromoides* and *L. saxatilis*.

Ecology and distribution

In terms of frequency, 41% of the species has Adventitious origin, followed by those that are Endemic of Chile and Argentina (35%), Native (12%) and Endemic of Chile and Introduced (6%). In terms of coverage, Adventitious species dominate with 65%, followed by Native species (21%), species Endemic of Chile and Argentina (13%) and Endemic of Chile and Introduced (1%) see Figure 6.4. In general, the unit is dominated by non-native characteristics.
For this community, the Shannon-Wiener index is equal to 2.72. This indicates high equitability. The Pielous and J' indices are equal to 0.89 and 0.95, respectively (see Table 6.4).
The relevés were collected in two areas: Bonifacio, in the northern part of the investigated area, and Chaihuin, in the southern sector (Figure 6.6 and Map A.1 in Appendix A). The orientation of the relevés is either not defined or facing North. The relevés were identified at 49 m a.s.l. and at 92 m a.s.l. (Figure 6.5). According to the CIREN cartography (2003), the relevés are located in the Chaihuin Series (CAU) and in Miscelaneos areas (MISC) (Figure 6.8).
Generally *Airo caryopyllae - Agrostietum capillaris* is associated with intensive sheep grazing and due this intensive management the principal lifeform shows perennial and annual herbs, typical by dry plant indicators such as *A. capillaris*, *A. caryophyllea*, *V. bromoides* and *L. saxatilis*.

6.3.12 *Vulpia bromoides - Agrostis capillaris* community

Dry grassland community on very dry, often compacted and stony soils at the lowlands and mild altitude of the westerns slopes of the Valdivian Coastal Range.

Cepilla grassland
Table 6.9 | Group Nr. 12 | Figure 6.18 | Acronym: Cep. G

Physiognomy

The average height is 5 cm, without layers and with vegetation cover equal to 96% (see Appendix E). The lifeforms are Hemicryptophytes, Therophytes, Geophytes, Chamaephytes, Nanophanerophytes and Bryophytes. In terms of frequency, the biological spectrum is dominated by Hemicryptophytes and Therophytes (52% and 24%, respectively), followed by Geophytes (10%) and Nanophanerophytes and Bryophytes (both 5%). As for the coverage, the main lifeforms are the Therophytes (61%) and Hemicryptophytes (37%), with the others showing values below 1% (see Figure 6.2).

Floristic

This community comprises 21 species distributed over 3 classes (Magnoliopsida, Liliopsida and Bryopsida) and 15 families. In terms of frequency, the main classes are Liliopsida (62% and four families) and Magnoliopsida (33% and 10 families). The same ranking holds when the coverage is considered (Liliopsida with 67% and Magnoliopsida with 33%, see Figure 6.3). The Bryopsida class is represented by just one family and the corresponding frequency and coverage values are below 1%. Out of the 15 families, Poaceae is the most represented one, followed by Asteraceae, Convulvolaceae, Apiaceae and Gentianaceae (see Appendix B).
The community presents 1 dominant species (*Vulpia bromoides*) and 5 constant species, including *V. bromoides*. The constant species are:

> *Vulpia bromoides* (Dg, Dm) 100; *Dichondra sericea* (Dg) 100; *Centaurium cachanlahuen* (Dg) 100; *Agrostis capillaris* 100; *Leontodon saxatilis* 80.

No species with IUCN conservation categories was recorded.

Figure 6.18: Overview of *Cepilla* grassland in Puerto Ranquil. As the other grasslands, the one in this picture is relatively broad (mainly due to grazing of sheeps). The picture shows the yellowish green colour of the region caused by the grassland's characteristic species (*Vulpia bromoides*). The bushes distributed over the represented area indicate that the region is currently being invaded by species such as Espinillo (*Ulex europaeus*) and Zarzamora (*Rubus constrictus*). Photographed by the author in January 2012.

Syntaxonomic

This community was identified with 5 relevés. The average number of species per relevé is 9.2 ± 2.4 (see Table 6.3). The calculation of the importance values shows that the most important species are: *Vulpia bromoides* (67.41), *Agrostis capillaris* (20.59), *Leontodon saxatilis* (20.59), *Dichondra sericea* (20.59) and *Centaurium cachanlahuen* (20.59), see Table C.13 in Appendix C.
This unit has six diagnostic species (Dg), of which three are exclusive (underlined), three are constant (Ct) and one is dominant (Dm):

> *Cuscuta chilensis* 61.6; *Dichondra sericea* (Ct) 45.0; *Sisyrinchium chilense* 43.2; *Vulpia bromoides* (Dm, Ct) 42.2; *Gamochaeta americana* 35.7; *Centaurium cachanlahuen* (Ct) 33.9.

The positive fidelity calculated for this group was equal to 16.01, with a sharpness of 28.54 (see Table 6.3). These values show that it is a homogeneous and well-defined unit.
This community shows affinity with the Agrostidion chilensis due to *Agrostis capillaris*, *Centaurium cachanlahuen*, *Dichondra sericea*, *Gamochaeta americana* and *Lotus subpinatus*, as well as to Agrostidetalia capillari (see Table 6.9 and Table D.4 in Appendix D).

Ecology and distribution

This unit is, in general, non native. However, in terms of frequency, it is dominated by native elements. This is due to the fact that Native species (52.4%) and species Endemic of Chile and Argentina (14.3%) are the most represented ones. On the contrary, in terms of coverage the dominant elements are non native, with non-species being the most represented ones(67.5%, see Figure 6.4).
The Shannon-Wiener index in this community is equal to 2.89. Hence, the unit can be considered equitative. The application of the Pieolu and J' indices offers values equal to 0.86 and 0.95, respectively (see Table 6.4).
The relevés were identified between 18 and 35 m a.s.l., with an average altitude of 33 m a.s.l. (see Figure 6.5). Three relevés are located in the southern area (Puerto Ranquil), the others in Curiñanco (see Figure 6.6 and Map A.1 in Appendix A). All relevés were identified in regions with almost flat inclination, without a well-defined exposition (see Figure 6.7 and Header Data in Appendix E). According to the CIREN cartography, 2 relevés are located in the TSC and 3 in CAU associations (see Figure 6.8 and Map A.2 in Appendix A).
Indicative species such as *V. bromides*, *D. sericea*, *A. capillaris* and *L. saxatilis* show that this grassland is characterised by low nutrients and alterations of the soil's physical structure. This is due to the intense shepherding of both ovines and bovines in the investigated area (see Figure 6.18).

Chapter 7

Cluster analysis and DCA ordination

7.1 Clustering overview

The initial phytosociological table was analysed with a multivariate approach, as outlined in Chapter 4. The analysis was based on both classification and ordination. The results of the clustering analysis are shown in Figure 7.1. The groups identified with this method are consistent with those obtained via the traditional approach. The name of each group is reported in Table 6.2.

The relevés were distributed over well-defined groups, which indicate the presence of non-overlapping blocks and subblocks (A, B and C). These blocks and subblocks correspond to the units identified through the phytosociological table and the diagnostic species.

Figure 7.1 indicates the presence of two large sets of relevés. The first set (A) includes Group 1 (corresponding to the *Olivillo* forest); the second, all other relevés including grassland and scrubs (B and C).

Set B is characterised by two subblocks. The first subblock comprises Groups 2 and 3, corresponding to the *Quila* shrub and the *Chupón* grassland, respectively. The second subblock consists of Group 4 (*Espinillo* shrub). The two subblocks show high floristic similarity.

Set C is also characterised by two subblocks, both corresponding to grasslands. One subblock consists of Groups 5, 6 and 7 (species indicators of edaphic moistures and of treated down soils with poor nutrients). More specifically, Group 5 consists of the *Cardoncillo* grassland, whereas Groups 6 and 7, which show high affinity between each other, of the *Junco húmedo* and *Paja ratonera* grasslands. The other subblock of set C includes Groups 8, 9 10, 11 and 12 (species indicators of fresh to dry, treated down soils with poor nutrients). The following Group pairs are characterised by high affinity: 8 and 12 (*Centella* and *Cepilla* grasslands), and 9 and 10 (*Chépica - Cadillo* and *Aira* grasslands). Finally, Group 11 corresponds to the *Junco duro* grassland.

The DCA assumes the Gaussian model of species response (Ter Braak 1987). This enables the calculation of the β-diversity in terms of standard deviations (σ) of the relevés distribution. The relevés which are close to each other in the distribution shown by the ordination diagram have high floristic similarity and comparable ecological requirements. Distances larger than 4σ among relevés indicate high floristic change.

The DCA of the species in the investigated region is shown in 7.2. The first axis separates the species as follows:

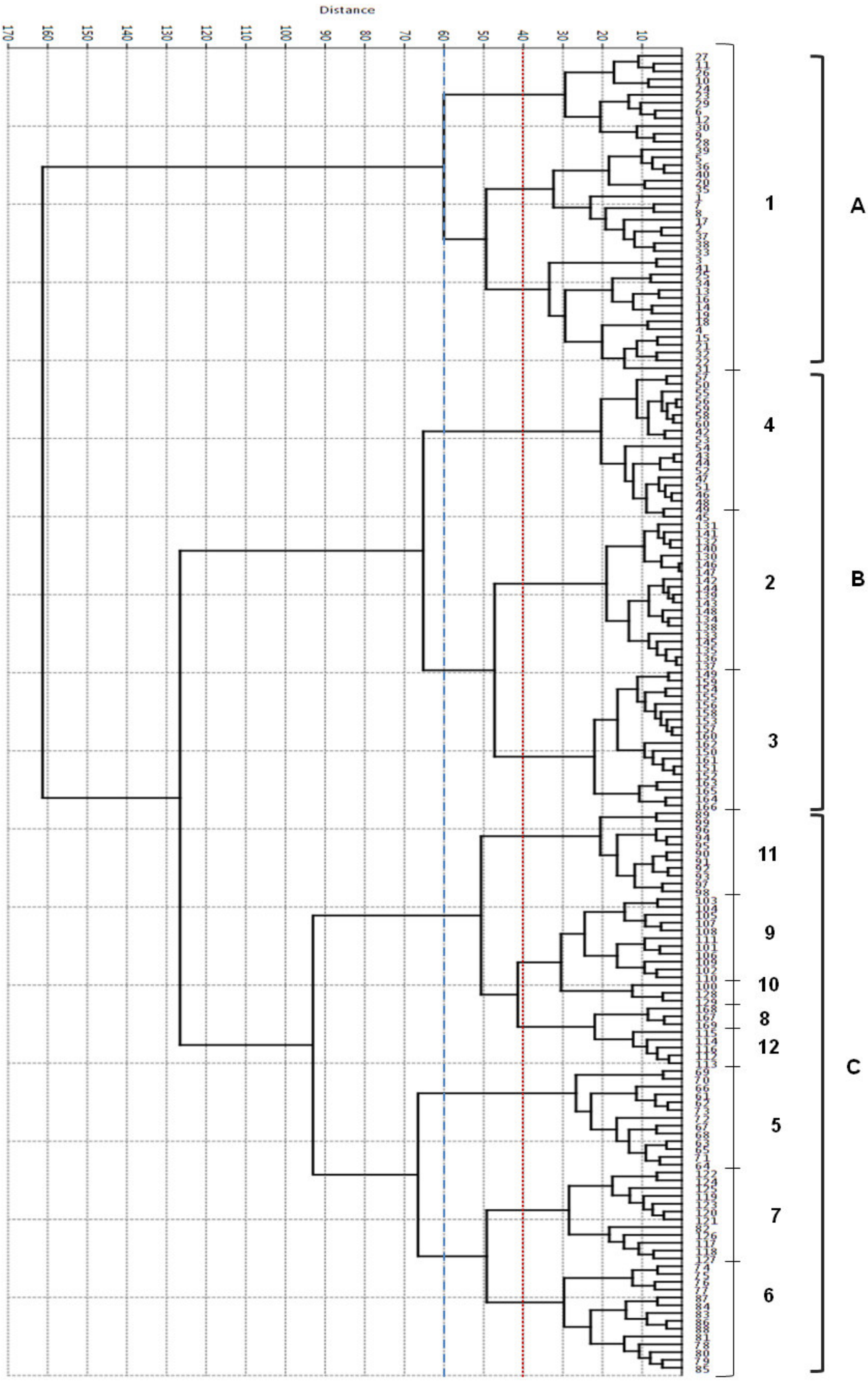

Figure 7.1: Cluster analysis performed with the Ward's algorithm and the Euclidean distance (Coph-corr 0.814). The red and blue lines mark the thresholds dividing the groups of relevés. The number of each group is in Table 6.2. Sorce: Own data.

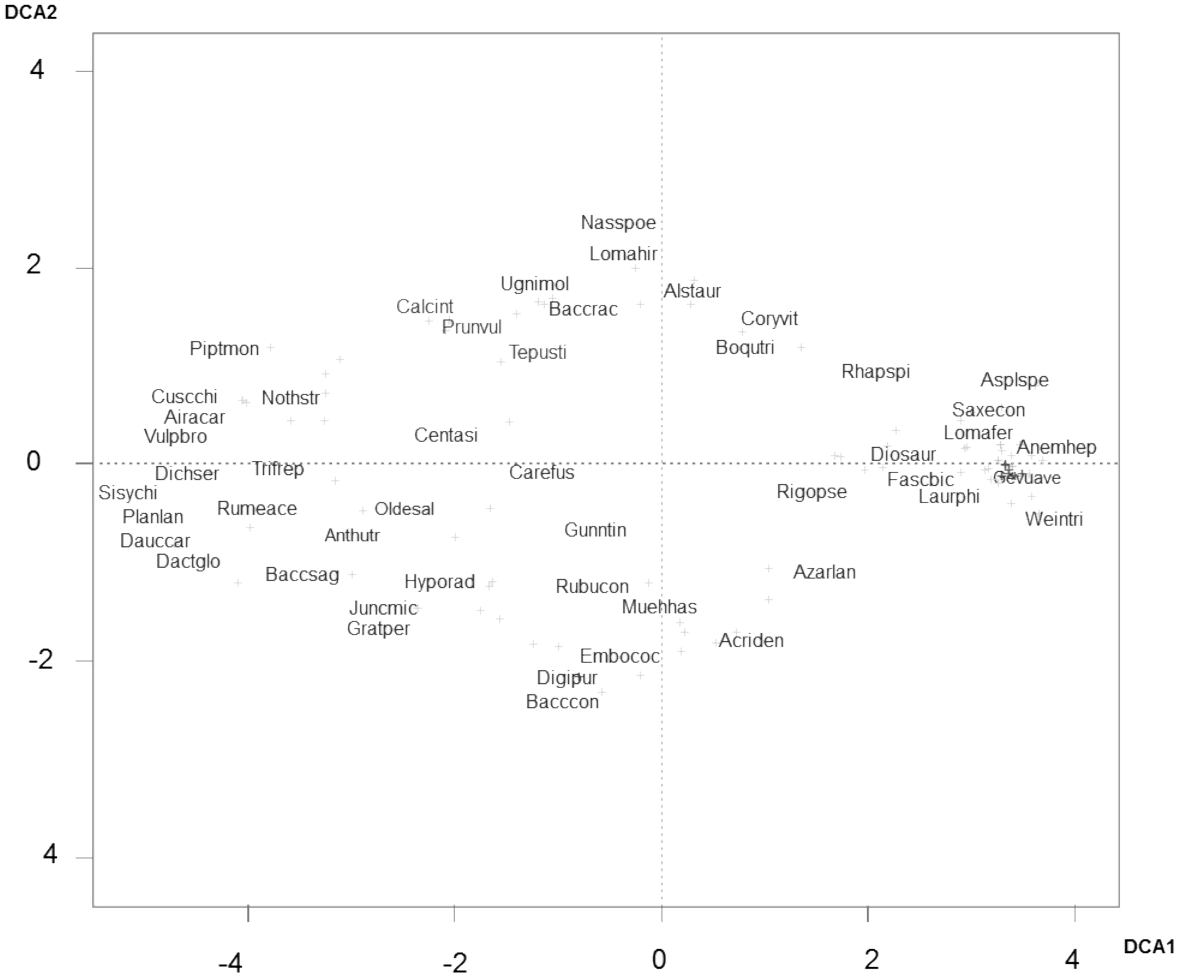

Figure 7.2: Detrended Correspondence Analysis of the species, based on 169 relevés. The points represent the species. For the lengths of the axes, see Table 7.1. Source: Own data.

- Leftwards, grassland species indicators of soils suffering deterioration from fresh to dry (e.g. *Centella asiatica*, *Agrostis capillaris* and *Anthoxanthum odoratum*), and of soils that are nutrient poor and undergoing compactation (e.g. *Vulpia bromoides* and *Leontodon saxatilis*);
- Rightwards, species that are typical of the *Olivillo* forest and indicate low or no anthropic intervention, such as *Aspelium sp.* and *Megalastrum spectabile* (Ramírez 1991).

The gradient's longitude is equal to 6.9σ for the first axis. This indicates significant heterogeneity in the considered data set (Leyer & Wescher 2007). In particular, because of the characteristics of the research area, the first axis is interpreted as an exploitation degree (loss of available water in the soil), which decreases from left to right.
The interpretation of the distribution along the second axis is more challenging. In fact, species typical of secondary shrublands and cold environments (e.g. *Lomatia hirsuta*, *Ugni molinae*, *Rubus constrictus*, *Baccharis concava* and *Fuchsia magallanica*) are present on both sides of the axis.

Table 7.1: Result of the Dentrended Correspondence Analysis. There are two kinds of Eigenvalues. The first kind (for which the name Eigenvalues is used) are the values calculated by the function decorana defined in the vegan package of the R programming language. The second kind (called Decorana values) are the values calculated by the original DECORANA programme by Mark Hill. The Decorana values are not used in this thesis and are reported for future reference. Source: Own data.

	DCA 1	DCA 2	DCA 3	DCA 4
Eigenvalues	0.8911	0.4575	0.3189	0.2957
Decorana values	0.9263	0.4270	0.2270	0.1567
Axis length	6.9278	3.9061	2.6932	2.8746

The value calculated for the second axis is 3.9σ, which is significantly larger than the results calculated for the third and fourth axes (see Table 7.1). This distribution in interpreted as a temperature gradient which decreases from the bottom to the top, (from hot to mild). Figure 7.3 shows the dispersion of the relevés on the same plane. Group 1 (*Olivillo* forest) is located on the extreme right, i.e., on soils with low or no exploitation. Groups from 4 to 12 are distributed along the other half of the axis range. In particular, the plot indicates that Groups 9, 10, 11 and 12 show high floristic similarities. This corroborates the outcome of the cluster analysis in Figure 7.1. The result suggests that the corresponding species are replacing each other, based on the soil's exploitation degree. The same holds for groups 6 and 7, whose overlap indicates high similarity and ongoing replacement between the two. Group 3 (*Chupón* grassland) is located in the positive range of the second axis and across the origin of the first axis. It is not significantly affected by the temperature and it indicates an ongoing transition along the first axis. Group 2 (*Quila* scrubland) is distributed in the quarter corresponding to minor exploitation and higher temperature, whereas Group 4 (*Espinillo* scrubland) in the quarter with higher exploitation and temperature

7.2 Vegetation-dynamics relationships

The results in the previous section suggest the following vegetation-dynamics relationships among the units (see Figure 7.4):

- The selective logging of the *Olivillo* forest and the contemporaneous use for livestock protection lead to the formation of a *Quila* scrubland. If the two factors decrease or disappear, the *Quila* scrubland gives origin to a permanent community, which could lead to forest regeneration in the future.

- In areas with middle to high slopes, the opening of trees canopies in the *Olivillo* forest due to age and/or contemporaneous cutting of trees species and livestock grazing cause the formation of a *Chupón* grassland. In areas with low or no slopes, the burning of the forest for the establishment of cropland and/or housing leads to the formation of the *Chépica Cadillo* grassland. If the *Chépica Cadillo* grassland is subject to intense grazing activity, a *Cardoncillo* grassland appears.

- A humid *Chépica Cadillo* grassland can generate either a *Junco húmedo* grassland (via intense grazing activity) or a *Paja ratonera* grassland (via potato or wheat sowing).

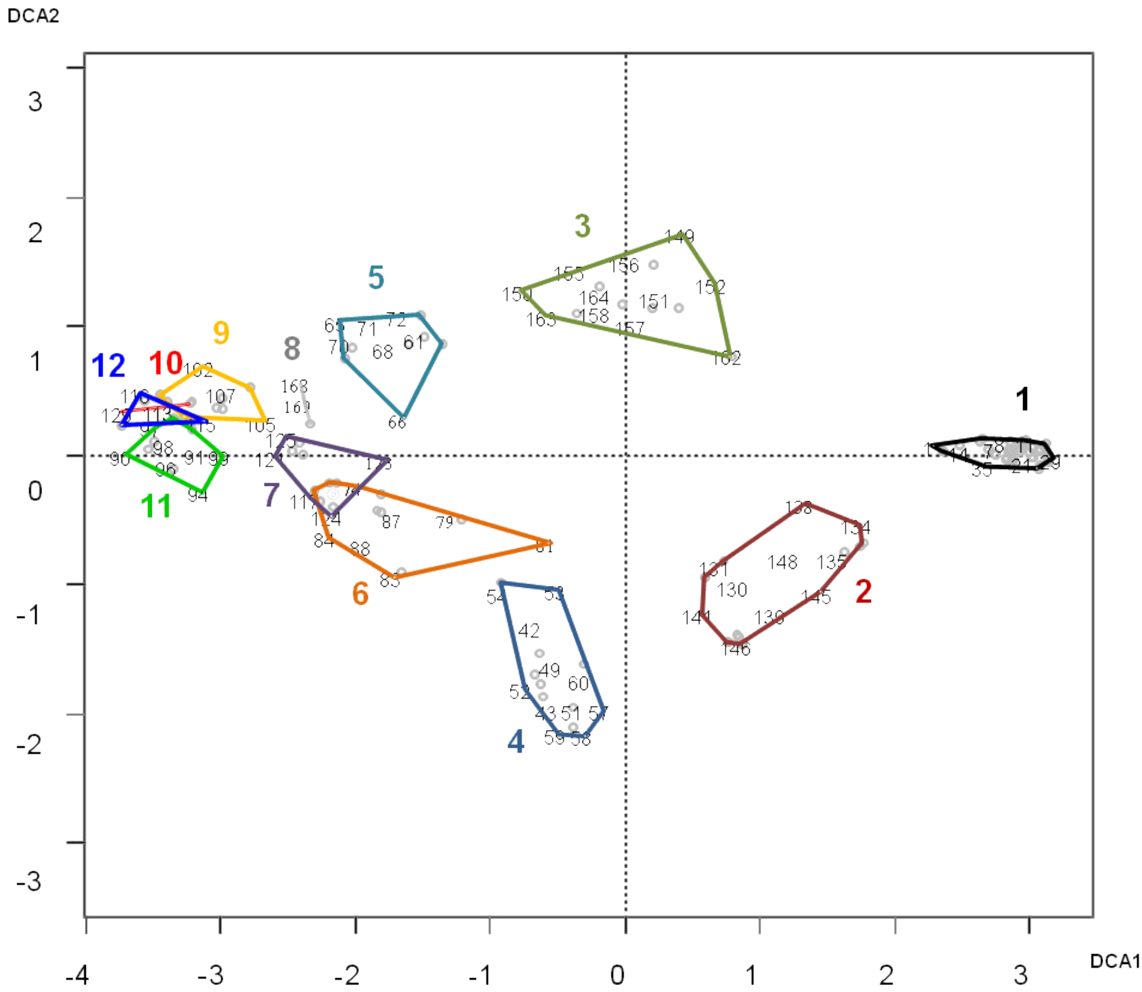

Figure 7.3: Detrended Correspondence Analysis of 12 groups, based on 137 species. The points with numbers represent the relevés. Plant association and communities are marked by lines. The number of each group is in Table 6.2. For the length of the axes, see Table 7.1. Source: Own data.

- If the *Paja ratonera* grassland is repeatedly treat down by animals or people, a *Junco duro* or a *Centella* grassland is formed, respectively.
- Intensive cow grazing on a *Chépica Cadillo* grassland with dry and poor soils leads to the formation of an *Aíra* grassland. This, in turn, can generate a *Cepilla* community in case of subsequent ovine grazing.

Finally, the aforementioned grasslands are invaded by an *Espinillo* shrubland when strongly affected by excessive grazing and another anthropic influence.

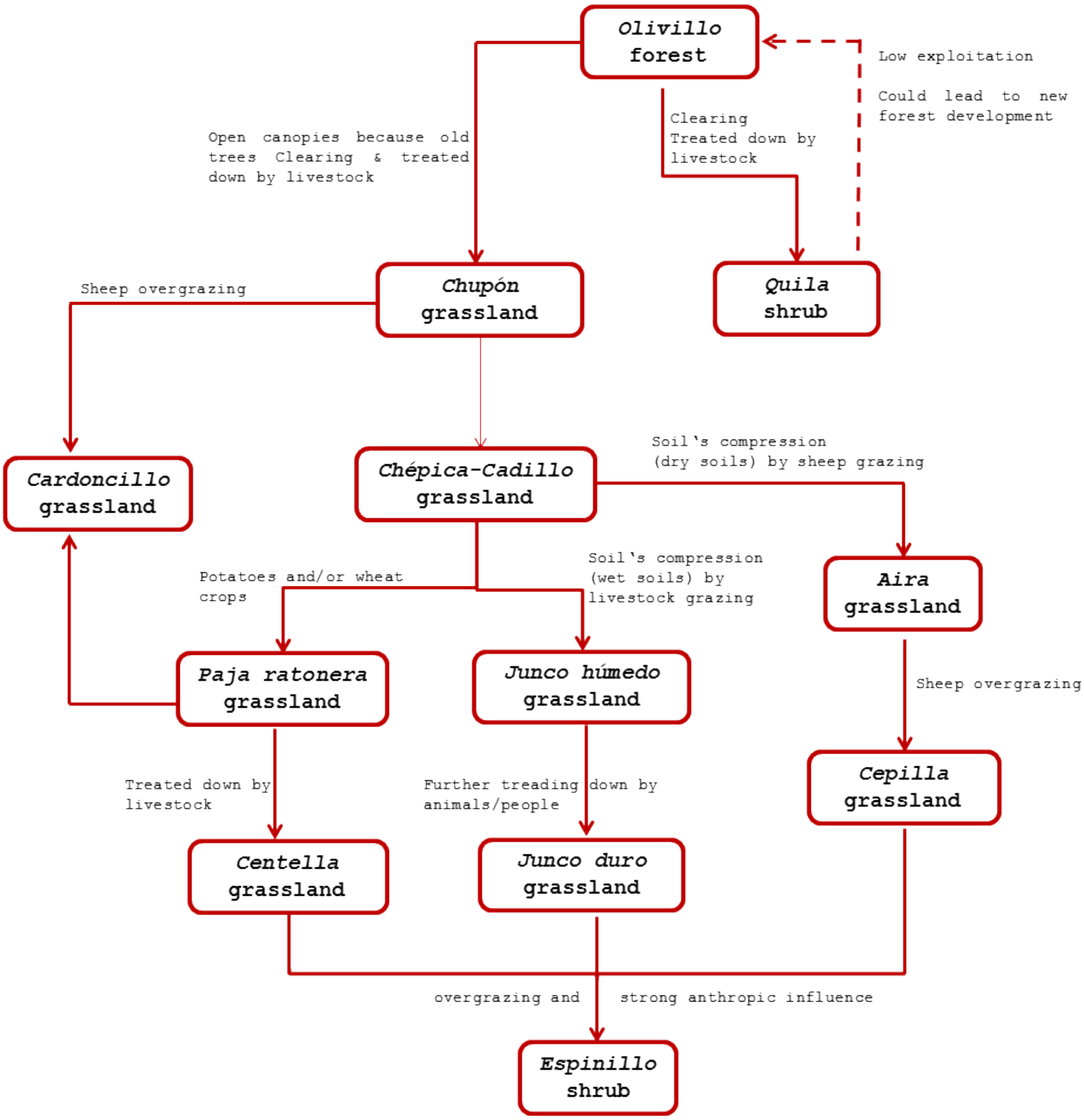

Figure 7.4: Suggested vegetation dynamics in the research area. Source: Own data.

Chapter 8

Discussion and conclusions

This thesis presented an analysis of the fragmentation impacting the original *Olivillo* forest in the western slope of the Valdivian Coastal Mountain Range in Chile. The work was conducted with a variety of analysis methods. Examples are: the construction of phytosociological and synoptic tables, the identification of diagnostic species (both characteristic and differential) and the application of statistical, multivariate analyses (cluster and detendred constrained analyses). The different approaches offered complementary descriptions of the vegetation changes occurring in the research area. The results of the performed analyses corroborate the initial hypothesis that the transformation undergone by the primary vegetation is due to human intervention. Examples of local anthropic activity are wood cutting, shepherding and grazing. These led to the development of new associations (scrublands and grasslands on top of the pre-existing *Olivillo* forest), which were used by the author to quantify the impact of the anthropic influence. A more detailed discussion of the intermediate results is provided in the next sections.

8.1 Floristc composition

The analysis of the phytogeographic origin led to the identification of 113 native species. These correspond to roughly 80% of the total amount of species found this search (137). Hence, the vast majority of the species is native. Nevertheless, not all native species are necessarily part of the original forest. Moreover, apart from being indicative of human intervention *per se*, non-native species are also originating the grasslands. As explained in the following section, they play a major role in the development of the identified associations (Hauenstein *et al.* 1988).

It is worth comparing the amount of native species identified by this search to that reported by Smith-Ramírez *et al.* (2005c). These authors performed an overall quantification of the flora over three provinces distributed along the whole Coastal Mountain Range. The work identified 577 native species, i.e., roughly five times the number reported in this thesis. However, the vastness of the regions considered by the two searches is very different. This indicates a significantly larger concentration of native species in the area investigated for this thesis. The result stresses the importance of the considered region as a representative of the primordial, original vegetation in southern Chile.

Roughly half (63) of the 113 native species identified by this search belong to the *Olivillo* forest. The number differs from the case of Mora (1986), who studied the *Olivillo* forest in the Los Ríos and Los Lagos regions (formerly known as X Region). That search identified 120 native species belonging to the *Olivillo* forest. This corresponds to roughly twice as many as this thesis.

An exact comparison of the native species in this thesis and Mora (1986) is not possible. In fact, those identified by Mora (1986) are not available. However, the geographical distributions of the relevés collected in the two analyses are very different. Only seven of the seventy-seven relevés considered by Mora (1986) are located in the western slope of the Coastal Mountain Range. On the contrary, 41 relevés of the *Olivillo* forest were collected for this thesis in the same area. The barely overlapping geographical distributions suggest that a very large fraction of the native species identified by Mora (1986) is located in regions which have not been considered for this thesis. The result leads to the following considerations:

- The *Olivillo* forest can vary significantly if disparate geographical regions are compared;
- Compared to Mora (1986), this thesis provides a more recent picture of the status of the *Olivillo* forest on the western slopes of the Coastal Mountain Range and it is based on a larger statistics;
- Mora (1986) should still be considered as reference with regards to the regions not considered by this thesis;
- It is worth extending the analysis in this thesis to the whole area investigated by Mora (1986), as this would offer a modern, more general picture of the changes undergone by the *Olivillo* forest.

Besides native species, another important aspect of the description of the *Olivillo* forest are the species with conservation category (IUCN). It is interesting to compare the case of this thesis to Ramírez *et al.* (2009). The authors applied a theoretical model to determine the amount of species with conservation category in the same area of this thesis. The outcome suggested nine species which have or could have conservation category. However, none of them was found by the author of this thesis. One explanation could be that the species became extinct in the search area. This, together with the eleven other species with conservation category reported in the thesis, suggests that the progressive loss of the primordial vegetation may have accelerated over the last years (Smith & Armesto 2002). Finally, the phytoclimate of the investigation area is phanerophytic, as it is dominated by Phanerophytes and Hemicryptophytes (Cain 1950) as a consequence of the local bioclimate. The Phanerophytes are more abundant in the *Olivillo* forest and in the *Quila* and *Espinillo* scrublands, whereas the opposite occurs in the grasslands. The result indicates that higher degradation levels lead to the decrease of the Phanerophytes and to the increase of the Hemicryptophytes, Therophytes and Geophytes (Ramírez *et al.* 1984). The large fraction of Hemicryptophytes in the vegetation of temperate forests indicate the fulfillment of the conditions for the development of grasslands. In fact, Hemicryptophytes are adapted weeds capable of surviving shepherding, and are not related to a specific phytoclimate as they are favoured by anthropic activity (Grigera *et al.* 1996, Seibert 1979, Cabrera & Willink 1973).

8.2 Vegetation analysis

The phytosociological table was constructed with 169 relevés and 137 species. The amount of collected relevés was determined by the limited available resources in terms of time and human power. In fact, the broadness of the research area prevented the author from achieving a higher relevé density. Nevertheless, it is worth noting that the number of collected relevés is comparable to that of other investigations performed in the same region. The collection of a higher number of relevés would increase the robustness of the results in this thesis. Moreover, it would be very interesting to run the same analyses as in this document on the original relevés collected by previous works in the western slope of the Valdivian Coastal Mountain Range (Ramírez *et al.* 2003, 1999, 1993, 1983, Moraga *et al.* 1985, Mora 1986, Montaldo 1975, 1975a, Oberdorfer 1960). Comparing the outcomes of the analyses on the current and original relevés would allow: *i*) to better describe the changes undergone by the primordial vegetation; and *ii*) to shed light on the transformation taking place within the primordial vegetation itself. Nevertheless, the digitalisation of the data collected on the original relevés is ongoing and the related information is not yet available. Hence, both the goals of increasing the robustness of the results presented in this thesis and of comparing them with the case of the primordial vegetation should be considered for future work.

The construction of the phytosociological table led to the identification of twelve associations: the original forest, two shrublands and nine grasslands. In particular, two of the grasslands (*Chupón* and *Cardoncillo* units) are original contribution of the author.

The high number of associations indicates significant diversity in the local vegetation. It is worth noting that the identified associations show affinity among each other. The result indicates that the associations are all involved in the transformation undergone by the primordial vegetation. Nevertheless, it is possible to distinguish different degrees of affinity based on the origin of the diagnostic species. In fact, the majority of the diagnostic species was found to be non native. Hence, the corresponding associations are less affine to the *Olivillo* forest and represent a more extreme change in the primordial vegetation. Within the twelve identified in the region, the two new associations proposed by the author show intermediate affinity values with respect to the *Olivillo* forest. This indicates that the two associations offer an insight on a gradual step of the changes occurred in the investigation area.

In the proposed syntaxonomic scheme, the first stages of the forest fragmentation are units such as *Quila* shrubland and *Chupón* grassland. These were classified in the alliance Berberidion buxifoliae Oberdorfer 1960. Hence, this alliance includes vegetation units acting as secondary replacement stages on high-quality soils such as those hosting forests (Hildebrand 1983). However, the growth of the characteristic species requires of the *Quila* unit require also a large amount of light. Hence, the replacement process is boosted by the opening of canopies in the forest via natural processes and/or human intervention.

An example of the last stages are permanent associations such as the *Espinillo* shrubland, which is classified in the Gaultherion phillyreafoliae Hildebrand 1983. This alliance establishes on poor soils and, due to its limited resilience to frost, in areas at limited altitude and with northern exposure (Hildebrand 1983). The required soil's low nutrition level points to regions which lost the vegetation coverage or underwent fires as suitable establishment areas. The alliance's vegetation unit (*Espinillo* shrubland) acts as tertiary and final replacement stage, as it establishes in regions characterised by intense human intervention. The unit's characteristic species (*Ulex europaeus* L., Espinillo) is considered exotic and invasive (Fuentes *et al.* 2014, Quiroz *et al.* 2009, Matthei 1995), and the related community is dense, compact, broadly distributed and propagates quickly (Altamirano *et al.* 2016, Fuentes *et al.* 2013). Due to its high invasive potential, the establishment of the *Espinillo* unit prevents further usage of the territory. Attempts to regain the invaded areas via fires and logging are counter-productive, as they enhance the unit's growth. The resulting redirection of human soil exploitation towards other regions may lead to the

establishment of the *Espinillo* unit in the new areas as well. Hence, the Gaultherion phillyreafoliae offers an effective example of how intense soil usage could be the vector for rapid propagation of specific vegetation communities. In the case of the *Espinillo* unit, two major consequences are: *i*) lower local biodiversity, due to the community's compact structure, and *ii*) soil's improvement via *U. europaeus* L. nitrogen-fixing property and protection from erosion (Hildebrand 1983).
The aforementioned alliances are included in the Aristotelietalia chilensis Hildebrand 1983 and in the Winthero-Nothofagetea Oberdorfer 1960.
A new class (Gaultherio phillyreafoliae-Aristotelietea chilensis) was proposed by Galán de Mera & Vicente (2006). This includes the Aristotelietalia chilensis, which is no longer part of the class Winthero-Nothofagetea, and all replacement units of the Laurel and deciduous sub-antarctic forests in Chile and Argentina.
Greigia sphacelata is one of the characteristic species of the class Gaultherio phillyreafoliae-Aristotelietea chilensis. This characterises the *Rubo-Greigietum sphacelae* ass. nov. and enables a better syntaxonomic approximation. However, the Gaultherion phillyreafoliae has been included in the Escallonion rubrae Eskuche 1968. This can be described as scrub associations that are replacement stages of the mountain, subantarctic deciduous forests. As observed by the analysis in this thesis, the same holds for the *Espinillo* scrub in the case of the Valdivian subantarctic forests. The *Espinillo* association acts as a permanent community after soil overexploitation (Muñoz 2009, Hildebrand 1983).
Further replacement stages are offered by the Agrostetalia capillaris San Martín *et al.* 1993 anthropogenic grasslands, part of Molinio-Arrhenatheretea Tüxen 1937. It is worth mentioning that the name of the order Agrostetalia capillaris as reported in Theurillat & Moravec 1996 is invalid according to article 8 (Original Diagnosis of Superior Syntaxa) of the International Code of Phytosociological Nomenclature (Weber *et al.* 2000), and that it has not been amended yet at the time of writing. Its current use in the literature is therefore inappropriate. However, the name was used in the present thesis as it groups all grasslands of anthropogenic origin mainly consisting of both European and native species in southern Chile (Álvarez *et al.* 2012).
The new association *Agrostio-Eryngietum paniculatae* was proposed among the replacement stages through grasslands. This was included in the new alliance Libertion chilensis, which comprises the units acting as replacement stages of the Berberidion buxifoliae Oberdorfer 1960. Nevertheless, further study is required to corroborate this syntaxonomic rank. Hence, a more conservative approach was considered, leading to the maintenance of the proposed syntaxonomic classification in the case of the Aristotelietalia chilensis Hildebrand 1983.
The development of associations with low affinity to the *Olivillo* forest is strongly related to changes in the soil. In fact, the related diagnostic species are non-native (mainly European) and indicative of dry, poor and compact soils (Ramírez *et al.* 1991). These characteristics are opposite to those of the soils where the *Olivillo* forest thrives.
The fidelity and sharpness values calculated for all the vegetation units on the search area indicate homogeneity and well-defined units according to the approach of Chytrý & Tichý (2003). Due to the current lack of similar analysis of the Chilean vegetation, these indices will serve as reference to evaluate the quality of the units and compare the groups identified in this work with future studies.

8.3 Cluster and DCA analyses

The results extracted by the phytosociological table were corroborated by the outcome of the cluster analysis. This approach made use of the concept of floristic similarity (to divide into groups the relevés collected for the construction of the phytosociological table. The high number of identified groups offers an independent quantification of the vegetation's fragmentation. Moreover, disparate groups were found to share common plants. This provides a very specific picture of the ongoing changes and could offer a projection of the future vegetation's development.
The aspects considered with the cluster analysis were further investigated with the DCA. This methodology offered an insight into the environmental factors which have played a major role in the transformation of the primary vegetation. The interpretation of the result suggests that these may have been the water availability in the soil and, to a minor extent, the temperature.
The DCA indicates that the water availability plays a major role in the vegetation distribution. Nevertheless, the impact is mainly due to the water present in the soil rather than in the atmosphere. The grasslands with lower affinity to the *Olivillo* forest are not of marine origin despite the proximity to the coast and thrive on dry soils. These points to human intervention, which tends to compact the soil and prevents water from filtering through it. The decreasing level of water leads then to the gradual transformation of the soil's characteristics and of the vegetation growing on it.
The minor role played by the temperature supports the hypothesis that human intervention is the main cause of the changes undergone by the primordial vegetation. In fact, the weak impact of temperature and water in the atmosphere suggest that the climatic conditions are not the main responsible for the observed vegetation transformation.

8.4 Vegetations dynamics and conservation and restoration strategy

The proposed dynamic relationships among vegetation units are consistent with previous works and in particular with the grasslands of the Mountain Coastal Range (San Martín *et al.* 1998, 1992, Ramírez *et al.* 2003, 1999, 1993, 1984). However, the inclusion of both the original forest and the scrublands and grassland in the analysis presented in this thesis contributed significantly to shedding light on such relationships.
The ongoing loss of natural vegetation as outlined in Catastro (CONAF *et al.* 2008) calls for restoration and conservation initiatives. In the research area these activities may be enabled by the units involved in the vegetation dynamics described in Chapter 7. However, restoration and conservation can be only carried out in regions where all units are available. As indicated by the present analysis, this is the case of Fundo Galera. Other motivations suggesting the southern part as suitable territory for restoration and conservation are the lower urbanisation and more difficult access compared to the rest of the region, as well as the very limited local human activity and the presence of a nearby natural reserve (Crouzeilles *et al.* 2016). A possible restoration and conservation strategy would be the radial approach outlined in Miyawaki 2004, Miyawaki & Golley 1993 and Miyawaki *et al.* 1993. This, combined with the adjacent reserve, may reduce the required time from centuries to decades. However, it is worth noting that region in Fundo Galera is private. Hence , despite its very favourable characteristics for phytosociological experimentations, it does not comply with one of the criteria for the selection of the priority sites for the conservation of the Chilean biological diversity (CONAF 1996, Muñoz *et al.* 1997).

Part III

Appendices

Appendix A

Maps of the research area and distribution of the relevés

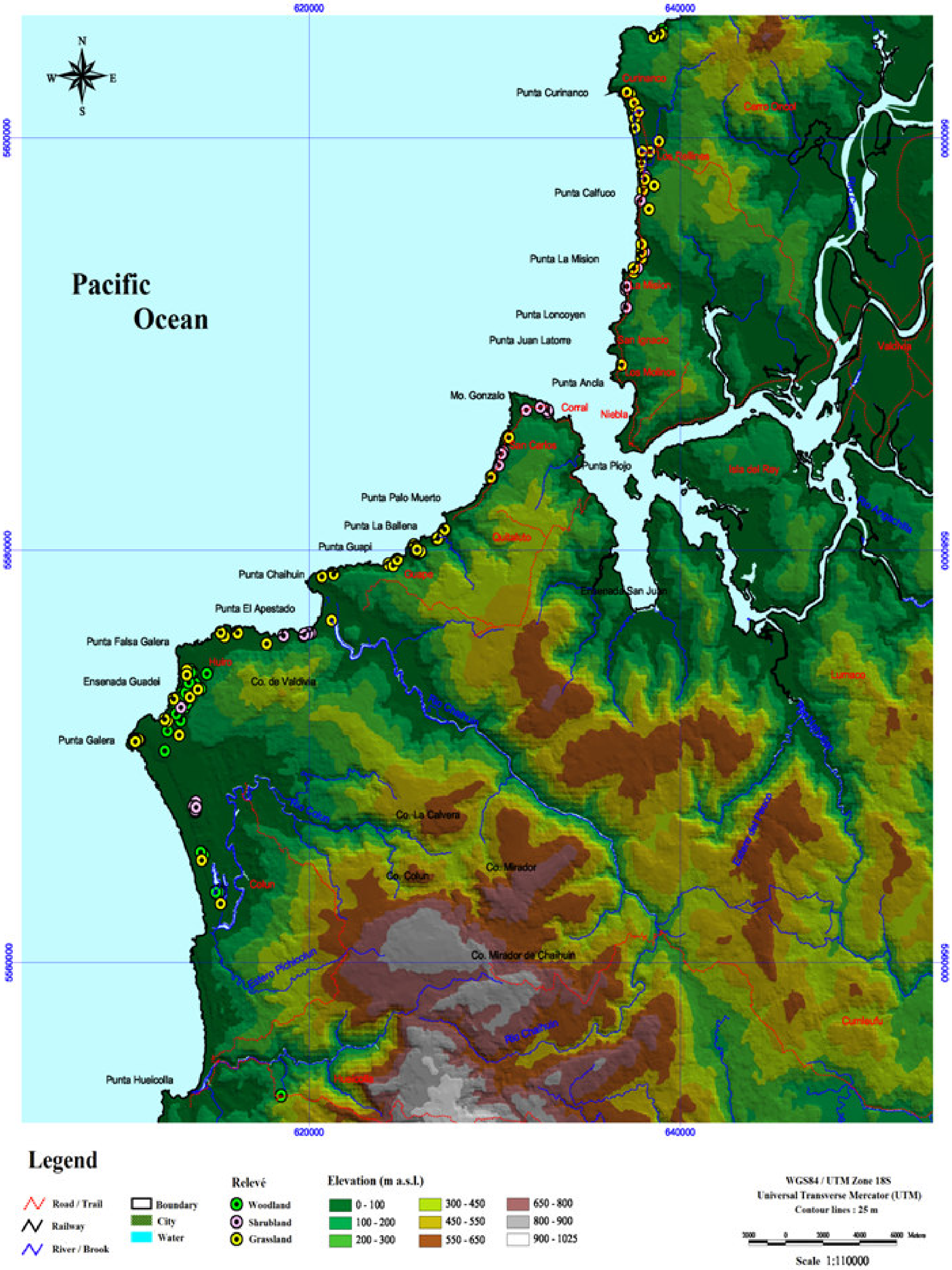

Figure A.1: Topographic map of the research area and distribution of the relevés (Based on IGM 2012).

Figure A.2: Distribution of the Soil Series and of the relevés in the research area (Based on IGM 2012).

Appendix B

Flora check list

This Appendix reports the flora check list of the research area. The list includes all species identified in the relevés considered for the present thesis, together with their taxonomical classification. The notation used for the species status and life form is defined in tables 4.1 and 4.2, respectively.

Class Order Family Genus/Species	Life Form	Status
Bryopsida		
Bryales		
Lembohyllaceae		
Rigodium brachypodium (Müll. Hal.) Paris	B	E (Ch)
Rigodium implexum Kunze ex Schwägr	B	E (Ch)
Rigodium pseudothuidium Dusén	B	E (Ch-Arg)
Leucodontales		
Meteoriaceae		
Weymouthia mollis (Hedw.) Broth.	B	C
Polypodiopsida		
Cyatheales		
Dicksoniaceae		
Lophosoria quadripinnata (J. F. Gmel.) C. Chr.	H	N
Hymenophyllales		
Hymenophyllaceae		
Hymenoglossum cruentum (Cav.) Presl	E	E (Ch-Arg)
Hymenophyllum caudiculatum Mart.	E	E (Ch-Arg)
Hymenophyllum cuneatum Kunze	E	E (Ch-Arg)
Hymenophyllum sp.	E	E (Ch-Arg)
Polypodiales		
Aspleniaceae		
Asplenium sp.	E	N
Blechnaceae		
Blechnum asperum (Kl.) Sturn	H	E (Ch)
Blechnum chilense (Kaulf.) Mett.	H	N
Blechnum hastatum Kaulf.	H	E (Ch-Arg)
Blechnum penna-marina (Pyoir.) Kuhn	H	C
Dryopteridaceae		
Megalastrum spectabile (Kaulf.) A. R. Sm. & R. C. Moran	B	E (Ch-Arg)
Pinopsida		
Pinales		
Podocarpaceae		
Podocarpus nubigenus Lindl.	Mes P	E (Ch-Arg)
Saxegothaea conspicua Lindl.	Mi P	E (Ch-Arg)
Liliopsida		
Asparagales		
Amaryllidaceae		
Nothoscordum striatellum (Lindl.) Kunth	G	N
Iridaceae		
Libertia chilensis (Molina) Gunkel	H	E (Ch-Arg)
Sisyrinchium chilense Hook.	G	N
Orchidaceae		
Brachystele unilateralis (Poir) Schltr.	G	N
Gavilea odoratissima (Poepp. & Endl.) Poepp.	G	E (Ch-Arg)
Liliales		
Alstromeriaceae		
Alstroemeria aurea Graham	G	E (Ch)
Luzuriaga polyphylla (Hook. f.) J. F. Macbr.	E	E (Ch)
Luzuriaga radicans Ruiz & Pav	E	E (Ch-Arg)
Philesiaceae		
Lapageria rosea Ruiz & Pav.	L	E (Ch)
Poales		
Cyperaceae		
Carex fuscula d'Urv.	H	N
Bromeliaceae		
Fascicularia bicolor (Ruiz & Pav.) Mez	E	E (Ch)
Greigia sphacelata (Ruiz & Pav.) Regel	H	E (Ch)

Class Order Family Genus/Species	Life Form	Status
Cyperaceae		
Cyperus sp.	H	N
Uncinia phleoides (Cav.) Pers.	H	N
Juncaceae		
Juncus imbricatus Laharpe	H	N
Juncus microcephalus Kunth	H	N
Juncus procerus E. Mey.	H	N
Poaceae		
Aira caryophyllea L.	T	a
Agrostis capillaris L.	H	nat
Anthoxanthum odoratum L.	H	i
Anthoxanthum utriculatum (Ruiz & Pav.) Schouten & Veldkamp	H	E(Ch-Arg)
Chusquea quila Kunth	N P	E (Ch)
Dactylis glomerata L.	H	a
Holcus lanatus L.	H	a
Nassella poeppigiana (Trin. & Rupr.) Barkworth	H	N
Paspalum dasypleurum Kunze ex É. Desv	H	E (Ch-Arg)
Paspalum distichum L.	H	i
Piptochaetium montevidense (Spreng.) Parodi	H	N
Polypogon chilensis (Kunth) Pilg.	H	N
Relchela panicoides Steud.	H	E (Ch-Arg)
Vulpia bromoides (L.) Gray	T	a
Magnoliopsida		
Apiales		
Araliaceae		
Raukaua valdiviensis (Gay) Frodin	L	E (Ch)
Apiaceae		
Centella asiatica (L.) Urb	H	N
Daucus carota L.	T	a
Eryngium paniculatum Cav. & Dombey ex F. Delaroche	H	N
Hydrocotyle indecora DC	H	E (Ch-Arg)
Hydrocotyle poeppigii DC.	H	E (Ch)
Osmorhiza chilensis Hook. & Arn.	H	N
Griseliniaceae		
Griselinia jodinifolia (Griseb.) Taub.	N P	E (Ch)
Asterales		
Asteraceae		
Acrisione denticulata (Hook. & Arn.) R. Nord.	Mi P	E (Ch-Arg)
Baccharis concava (Ruiz & Pav.) Pers.	N P	N
Baccharis racemosa (Ruiz & Pav.) DC.	N P	E (Ch-Arg)
Baccharis sagittalis (Less.) DC.	N P	N
Chevreulia sarmentosa (Pers.) S. F. Blake	H	N
Cirsium vulgare (Savi) Ten.	T	nat
Gamochaeta americana (Mill.) Wedd.	H	N
Hypochaeris radicata L.	H	a
Leontodon saxatilis Lam	H	a
Leptinella scariosa Cass.	H	E (Ch-Arg)
Campanulaceae		
Lobelia bridgesii Hook. & Arn.	Ch	E (Ch)
Berberidopsidales		
Aextoxicaceae		
Aextoxicon punctatum Ruiz et Pav.	Mes P	E (Ch-Arg)
Canellales		
Winteraceae		
Drimys winteri J. R. Forst. & G. Forst. var chilensis (DC.) A. Gray	Mi P	E (Ch)
Cornales		
Hydrangeaceae		
Hydrangea serratifolia (Hook. & Arn.) Phil. f.	L	E (Ch-Arg)
Loasaceae		
Loasa sp.	T	N
Dioscoreales		
Dioscoreaceae		
Dioscorea auriculata Poepp.	G	E (Ch)

Class Order Family Genus/Species	Life Form	Status
Ericales		
Ericaceae		
Gaultheria mucronata (L. f.) E. J. Remy	N P	E (Ch-Arg)
Fabales		
Fabaceae		
Genista monspessulana (L.) L. A. S. Johnson	N P	a
Lotus pedunculatus Cav.	H	i
Lotus subpinnatus Lag.	T	E (Ch)
Leguminosae		
Sophora microphylla Ait.	N P	N
Trifolium pratense L.	Ch	a
Trifolium repens L.	H	a
Ulex europaeus L.	N P	i
Gentianales		
Gentianaceae		
Centaurium cachanlahuen (Molina) B. L. Rob.	T	N
Rubiaceae		
Galium hypocarpium (L.) Endl. ex Griseb.	Ch	N
Leptostigma arnottianum Walp.	G	E (Ch-Arg)
Nertera granadensis (Mutis ex L. f.) Druce	H	N
Oldenlandia salzmannii (DC.) Benth & Hook. f. ex B. D. Jacks	H	N
Geraniales		
Francoaceae		
Francoa appendiculata Cav. var sonchifolia (Cav.) Rolfe	H	E (Ch)
Geraniaceae		
Geranium core-core Steud.	T	N
Gunnerales		
Gunneraceae		
Gunnera tinctoria (Molina) Mirb.	H	E (Ch)
Lamiales		
Calceolariaceae		
Calceolaria integrifolia L.	T	
Gesneriaceae		
Mitraria coccinea Cav.	E	E (Ch/Arg)
Sarmienta scandens (J. D. Brandis ex Molina) Pers.	E	E (Ch)
Lamiaceae		
Prunella vulgaris L.	Ch	a
Plantaginaceae		
Digitalis purpurea L.	T	a
Gratiola peruviana L.	Ch	N
Plantago lanceolata L.	H	a
Scrophulariaceae		
Buddleja globosa Hope	Mi P	E (Ch-Arg)
Verbenaceae		
Rhaphithamnus spinosus (Juss.) Moldenke	N P	N
Laurales		
Atherospermataceae		
Laureliopsis philippiana (Looser) Schodde	Mes P	E (Ch-Arg)
Lauraceae		
Persea lingue (Miers ex Bertero) Nees	Mi P	E (Ch-Arg)
Malpighiales		
Salicaceae		
Azara lanceolata Hook. f.	Mi P	E (Ch-Arg)
Linaceae		
Cliococca selaginoides (Lam.) C. M. Rogers & Mildner	Ch	N
Malvales		
Malvaceae		
Corynabutilon vitifolium (Cav.) Kearney	N P	E (Ch)
Modiola caroliniana (L.) G. Don.	H	a

Class Order Family Genus/Species	Life Form	Status
Tymelaeaceae		
Ovidia pillopillo (Gay) Meisn	Mi P	E (Ch-Arg)
Myrtales		
Myrtaceae		
Amomyrtus luma (Molina) D. Legrand & Kausel	Mes P	E (Ch-Arg)
Amomyrtus meli (Phil.) D. Legrand & Kausel	Mes P	E (Ch)
Blepharocalyx cruckshanksii (Hook. Et Arnn.) Niedenzu	Mes P	E (Ch)
Luma apiculata (DC.) Burret	Mi P	E (Ch-Arg)
Myrceugenia chrysocarpa (Berg) Kausel	Mi P	E (Ch-Arg)
Myrceugenia planipes (Hook. & Arn.) O. Berg	Mi P	E (Ch-Arg)
Myrceugenia exsucca (DC.) O. Berg	Mi P	E (Ch-Arg)
Tepualia stipularis (H. et A.) Griseb.	Mi P	E (Ch-Arg)
Ugni molinae Turcz.	N P	E (Ch-Arg)
Onagraceae		
Fuchsia magellanica Lam.	N P	E (Ch-Arg)
Oxalidales		
Cunoniaceae		
Eucryphia cordifolia Cav.	Mes P	E (Ch-Arg)
Weinmannia trichosperma Ca.	Mes P	E (Ch-Arg)
Elaeocarpaceae		
Aristotelia chilensis (Molina) Stuntz	Mi P	E (Ch-Arg)
Crinodendron hookerianum Gay	N P	E (Ch)
Oxalidaceae		
Oxalis corniculata L.	T	C
Oxalis sp.	T	N
Polygonales		
Polygonaceae		
Muehlenbeckia hastulata (Sm.) I. M. Johnst.	L	N
Rumex acetosella L.	H	a
Proteales		
Proteaceae		
Embothrium coccineum J. R. Forst. & G. Forst.	Mi P	E (Ch-Arg)
Gevuina avellana Molina	Mi P	E (Ch-Arg)
Lomatia ferruginea R. Br.	N P	E (Ch-Arg)
Lomatia hirsuta (Lam.) Diels. Ex Macbr.	Mi P	N
Ranunculales		
Berberidaceae		
Berberis darwinii Hook	N P	E (Ch-Arg)
Berberis microphylla G. Forst	N P	E (Ch-Arg)
Lardizabalaceae		
Boquila trifoliolata (DC.) Decne.	L	E (Ch-Arg)
Ranunculaceae		
Anemone hepaticifolia Hook.	T	E (Ch)
Ranunculus repens L.	H	a
Rosales		
Rhamnaceae		
Rhamnus diffusus Clos	N P	E (Ch)
Rosaceae		
Acaena ovalifolia Ruiz et Pav.	H	E (Ch-Arg)
Rubus constrictus P. J. Müll. & Lefèvre	N P	a
Solanales		
Convolvulaceae		
Cuscuta chilensis Ker Gawl.	T	N
Dichondra sericea Sw.	H	N
Vitales		
Vitaceae		
Cissus striata Ruiz & Pav.	L	E (Ch-Arg)

Appendix C

Importance values

This Appendix reports the importance values of each species in the initial plant sociological table (Table C.1) and in each plant community (Table C.2 − C.13). In each table, species are listed with decreasing importance values. The tables report for each species the frequency and cover values as well, both absolute and relative.

Table C.1: Importance values in the initial plant sociological table

	Frequency			Cover		Importance
Species	Abs.	[%]	Rel.	Abs.	Rel.	value
Aextoxicon punctatum	47	27.81	2.46	3061	14.51	16.97
Chusquea quila	58	34.32	3.04	1902	9.02	12.06
Greigia sphacelata	41	24.26	2.15	1644	7.79	9.94
Ulex europeaus	22	13.02	1.15	1783	8.45	9.61
Agrostis capillaris	68	40.24	3.56	1220	5.78	9.35
Juncus procerus	26	15.38	1.36	1052	4.99	6.35
Eryngium paniculatum	20	11.83	1.05	1048	4.97	6.02
Centella asiatica	54	31.95	2.83	654	3.10	5.93
Leontodon saxatilis	48	28.40	2.51	570	2.70	5.22
Juncus imbricatus	33	19.53	1.73	671	3.18	4.91
Anthoxanthum utriculatum	12	7.10	0.63	815	3.86	4.49
Amomyrtus meli	33	19.53	1.73	577	2.74	4.46
Lapageria rosea	48	28.40	2.51	340	1.61	4.13
Rubus constrictus	60	35.50	3.14	199	0.94	4.09
Holcus lanatus	53	31.36	2.78	241	1.14	3.92
Eucryphia cordifolia	36	21.30	1.89	378	1.79	3.68
Vulpia bromoides	25	14.79	1.31	447	2.12	3.43
Dichondra sericea	27	15.98	1.41	410	1.94	3.36
Acaena ovalifolia	28	16.57	1.47	397	1.88	3.35
Myrceugenia planipes	28	16.57	1.47	369	1.75	3.22
Drimys winteri	31	18.34	1.62	317	1.50	3.13
Nertera granadensis	30	17.75	1.57	288	1.37	2.94
Lotus pedunculatus	45	26.63	2.36	119	0.57	2.92
Prunella vulgaris	50	29.59	2.62	63	0.30	2.92
Centaurium cachanlahuen	41	24.26	2.15	106	0.50	2.65
Lomatia ferruginea	31	18.34	1.62	137	0.65	2.27
Rhaphithammus spinosus	34	20.12	1.78	64	0.30	2.08
Luzuriaga radicans	34	20.12	1.78	50	0.24	2.02
Aristotelia chilensis	28	16.57	1.47	86	0.41	1.87
Boquila trifoliolata	30	17.75	1.57	34	0.16	1.73
Mitraria coccinia	30	17.75	1.57	34	0.16	1.73
Luma apiculata	24	14.20	1.26	71	0.34	1.59
Sarmienta scandens	27	15.98	1.41	35	0.17	1.58
Blechnum cordatum	24	14.20	1.26	51	0.24	1.50
Aira caryophyllea	16	9.47	0.84	139	0.66	1.50
Uncinia phleoides	24	14.20	1.26	24	0.11	1.37
Ugni molinae	19	11.24	1.00	75	0.36	1.35
Cliococca selaginoides	16	9.47	0.84	95	0.45	1.29
Baccharis racemosa	19	11.24	1.00	49	0.23	1.23
Oldenlandia salzmannii	15	8.88	0.79	85	0.40	1.19
Luzuriaga polyphylla	20	11.83	1.05	29	0.14	1.19
Gevuina avellana	17	10.06	0.89	61	0.29	1.18
Gamochaeta americana	19	11.24	1.00	37	0.18	1.17
Hymenophyllum caudiculatum	20	11.83	1.05	20	0.09	1.14
Hymenophyllum sp.	19	11.24	1.00	19	0.09	1.09
Carex fuscula	19	11.24	0.99	19	0.09	1.08

	Frequency			Cover		Importance
Species	Abs.	[%]	Rel.	Abs.	Rel.	value
Amomyrtus luma	15	8.88	0.79	60	0.28	1.07
Leptinella scariosa	15	8.88	0.79	60	0.28	1.07
Cissus striata	18	10.65	0.94	26	0.12	1.07
Ranunculus repens	12	7.10	0.63	86	0.41	1.04
Rumex acetosella	17	10.06	0.89	21	0.10	0.99
Lophosoria quadripinnata	12	7.10	0.63	44	0.21	0.84
Anthoxanthum odoratum	13	7.69	0.68	29	0.14	0.82
Trifolium repens	14	8.28	0.73	14	0.07	0.80
Lotus subpinnatus	13	7.69	0.68	23	0.11	0.79
Rhamnus diffusus	13	7.69	0.68	21	0.10	0.78
Polypogon chilensis	8	4.73	0.42	73	0.35	0.77
Galium hypocarpium	13	7.69	0.68	17	0.08	0.76
Hypochaeris radicata	12	7.10	0.63	25	0.12	0.75
Hymenoglossum cruentum	13	7.69	0.68	13	0.06	0.74
Azara lanceolata	11	6.51	0.58	11	0.05	0.63
Megalastrum spectabile	10	5.92	0.52	14	0.07	0.59
Ovidia pillopillo	10	5.92	0.52	14	0.07	0.59
Blechnum hastatum	10	5.92	0.52	10	0.05	0.57
Rigodium brachypodium	9	5.33	0.47	18	0.09	0.56
Laureliopsis philippiana	8	4.73	0.42	29	0.14	0.56
Juncus microcephalus	7	4.14	0.37	40	0.19	0.56
Cirsium vulgare	9	5.33	0.47	13	0.06	0.53
Hymenophyllum cuneatum	9	5.33	0.47	9	0.04	0.51
Weymouthia mollis	9	5.33	0.47	9	0.04	0.51
Gaultheria mucronata	8	4.73	0.42	19	0.09	0.51
Dioscorea auriculata	8	4.73	0.42	8	0.04	0.46
Hydrocotyle poepigii	8	4.73	0.42	8	0.04	0.46
Podocarpus nubigenus	7	4.14	0.37	11	0.05	0.42
Anemone hepaticifolia	6	3.55	0.31	22	0.10	0.42
Fuchsia magellanica	6	3.55	0.31	19	0.09	0.40
Myrceugenia exsucca	5	2.96	0.26	23	0.11	0.37
Fascicularia bicolor	6	3.55	0.31	10	0.05	0.36
Lobelia bridgessi	6	3.55	0.31	10	0.05	0.36
Plantago lanceolata	6	3.55	0.31	6	0.03	0.34
Raukaua valdiviensis	6	3.55	0.31	6	0.03	0.34
Myrceugenia chrysocarpa	3	1.78	0.16	32	0.15	0.31
Sophora microphylla	3	1.78	0.16	31	0.15	0.30
Embothrium coccineum	5	2.96	0.26	5	0.02	0.29
Blechnum asperum	4	2.37	0.21	13	0.06	0.27
Libertia chilensis	4	2.37	0.21	13	0.06	0.27
Berberis darwinii	4	2.37	0.21	12	0.06	0.27
Acrisione denticulata	4	2.37	0.21	4	0.02	0.23
Brachystele unilateralis	4	2.37	0.21	4	0.02	0.23
Buddleja globosa	4	2.37	0.21	4	0.02	0.23
Chevreulia sarmentosa	4	2.37	0.21	4	0.02	0.23
Hydrangea serratofolia	4	2.37	0.21	4	0.02	0.23
Muehlenbeckia hastulata	4	2.37	0.21	4	0.02	0.23

	Frequency			Cover		Importance
Species	Abs.	[%]	Rel.	Abs.	Rel.	value
Oxalis sp	4	2.37	0.21	4	0.02	0.23
Gunnera trinctoria	3	1.78	0.16	12	0.06	0.21
Crinodendron hookerianum	3	1.78	0.16	3	0.01	0.17
Osmorhiza chilensis	3	1.78	0.16	3	0.01	0.17
Baccharis sagittalis	1	0.59	0.05	20	0.09	0.15
Paspalum dasypleurum	2	1.18	0.10	6	0.03	0.13
Cuscuta chilensis	2	1.18	0.10	2	0.01	0.11
Dactylis glomerata	2	1.18	0.10	2	0.01	0.11
Digitalis purpurea	2	1.18	0.10	2	0.01	0.11
Genista monspessulana	2	1.18	0.10	2	0.01	0.11
Hydrocotyle indecora	2	1.18	0.10	2	0.01	0.11
Persea lingue	2	1.18	0.10	2	0.01	0.11
Rigodium implexum	2	1.18	0.10	2	0.01	0.11
Saxegothaea conspicua	2	1.18	0.10	2	0.01	0.11
Gratiola peruviana	1	0.59	0.05	10	0.05	0.10
Alstroemeria aurea	1	0.59	0.05	1	0.00	0.06
Aspelium sp	1	0.59	0.05	1	0.00	0.06
Baccharis concava	1	0.59	0.05	1	0.00	0.06
Berberis microphylla	1	0.59	0.05	1	0.00	0.06
Blechnum penna-marina	1	0.59	0.05	1	0.00	0.06
Blepharocalyx cruckshanksii	1	0.59	0.05	1	0.00	0.06
Calceolaria integrifolia	1	0.59	0.05	1	0.00	0.06
Corynabutilon vitifolium	1	0.59	0.05	1	0.00	0.06
Cyperus sp	1	0.59	0.05	1	0.00	0.06
Daucus carota	1	0.59	0.05	1	0.00	0.06
Francoa appendiculata	1	0.59	0.05	1	0.00	0.06
Gavilea odoratissima	1	0.59	0.05	1	0.00	0.06
Geranium core-core	1	0.59	0.05	1	0.00	0.06
Griselinia jodinifolia	1	0.59	0.05	1	0.00	0.06
Leptostigma arnottianum	1	0.59	0.05	1	0.00	0.06
Loasa sp.	1	0.59	0.05	1	0.00	0.06
Lomatia hirsuta	1	0.59	0.05	1	0.00	0.06
Modiola caroliniana	1	0.59	0.05	1	0.00	0.06
Nassella poeppegiana	1	0.59	0.05	1	0.00	0.06
Nothoscordum striatellum	1	0.59	0.05	1	0.00	0.06
Oxalis corniculata	1	0.59	0.05	1	0.00	0.06
Paspalum distichium	1	0.59	0.05	1	0.00	0.06
Piptochaetium montevidense	1	0.59	0.05	1	0.00	0.06
Relchela panicoides	1	0.59	0.05	1	0.00	0.06
Rigodium pseudothuidium	1	0.59	0.05	1	0.00	0.06
Tepualis stipularis	1	0.59	0.05	1	0.00	0.06
Trifolium pratense	1	0.59	0.05	1	0.00	0.06
Weinmannia trichosperma	1	0.59	0.05	1	0.00	0.06
Sisyrinchium chilense	1	0.59	0.05	1	0.00	0.06

Table C.2: Importance values in the *Olivillo* forest.

Olivillo forest	Frequency			Cover		Importance
Species	Abs.	[%]	Rel.	Abs.	Rel.	value
Aextoxicon punctatum	41	100.00	5.23	3055	47.13	52.36
Lapageria rosea	41	100.00	5.23	333	5.14	10.37
Luzuriaga radicans	34	82.93	4.34	50	0.77	5.11
Amomyrtus meli	33	80.49	4.21	577	8.90	13.11
Eucryphia cordifolia	32	78.05	4.08	365	5.63	9.71
Chusquea quila	31	75.61	3.95	130	2.01	5.96
Lomatia ferruginea	30	73.17	3.83	136	2.10	5.92
Rhaphithammus spinosus	30	73.17	3.83	60	0.93	4.75
Mitraria coccinia	30	73.17	3.83	34	0.52	4.35
Drimys winteri	28	68.29	3.57	310	4.78	8.35
Myrceugenia planipes	27	65.85	3.44	368	5.68	9.12
Sarmienta scandens	27	65.85	3.44	35	0.54	3.98
Nertera granadensis	26	63.41	3.32	280	4.32	7.64
Greigia sphalaceta	22	53.66	2.81	43	0.66	3.47
Uncinia phleoides	22	53.66	2.81	22	0.34	3.15
Luma apiculata	20	48.78	2.55	67	1.03	3.58
Luzuriaga polyphylla	20	48.78	2.55	29	0.45	3.00
Hymenophyllum caudiculatum	20	48.78	2.55	20	0.31	2.86
Hymenophyllum sp.	19	46.34	2.42	19	0.29	2.72
Gevuina avellana	17	41.46	2.17	61	0.94	3.11
Blechnum cordatum	16	39.02	2.04	20	0.31	2.35
Boquila trifoliolata	16	39.02	2.04	16	0.25	2.29
Cissus striata	15	36.59	1.91	23	0.35	2.27
Amomyrtus luma	13	31.71	1.66	58	0.89	2.55
Rhamnus diffusus	13	31.71	1.66	21	0.32	1.98
Hymenoglossum cruentum	13	31.71	1.66	13	0.20	1.86
Megalastrum spectabile	10	24.39	1.28	14	0.22	1.49
Lophosoria quadripinnata	9	21.95	1.15	41	0.63	1.78
Hymenophyllum cuneatum	9	21.95	1.15	9	0.14	1.29
Weymouthia mollis	9	21.95	1.15	9	0.14	1.29
Laureliopsis philippiana	8	19.51	1.02	29	0.45	1.47
Dioscorea auriculata	8	19.51	1.02	8	0.12	1.14
Hydrocotyle poepigii	8	19.51	1.02	8	0.12	1.14
Podocarpus nubigenus	7	17.07	0.89	11	0.17	1.06
Azara lanceolata	7	17.07	0.89	7	0.11	1.00
Anemone hepaticifolia	6	14.63	0.77	22	0.34	1.10
Fascicularia bicolor	6	14.63	0.77	10	0.15	0.92
Raukaua valdiviensis	6	14.63	0.77	6	0.09	0.86
Blechnum asperum	4	9.76	0.51	13	0.20	0.71
Carex fuscula	4	9.76	0.51	4	0.06	0.57
Hydrangea serratofolia	4	9.76	0.51	4	0.06	0.57
Myrceugenia chrysocarpa	3	7.32	0.38	32	0.49	0.88
Aristotelia chilensis	3	7.32	0.38	27	0.42	0.80
Myrceugenia exsucca	3	7.32	0.38	21	0.32	0.71

Olivillo forest	Frequency			Cover		Importance
Species	Abs.	[%]	Rel.	Abs.	Rel.	value
Crinodendron hookerianum	3	7.32	0.38	3	0.05	0.43
Osmorhiza chilensis	3	7.32	0.38	3	0.05	0.43
Sophora microphylla	2	4.88	0.26	30	0.46	0.72
Blechnum hastatum	2	4.88	0.26	2	0.03	0.29
Hydrocotyle indecora	2	4.88	0.26	2	0.03	0.29
Persea lingue	2	4.88	0.26	2	0.03	0.29
Rigodium implexum	2	4.88	0.26	2	0.03	0.29
Saxegothaea conspicua	2	4.88	0.26	2	0.03	0.29
Acaena ovalifolia	1	2.44	0.13	1	0.02	0.14
Acrisione denticulata	1	2.44	0.13	1	0.02	0.14
Aspelium sp	1	2.44	0.13	1	0.02	0.14
Blechnum penna-marina	1	2.44	0.13	1	0.02	0.14
Blepharocalyx cruckshanksii	1	2.44	0.13	1	0.02	0.14
Embothrium coccineum	1	2.44	0.13	1	0.02	0.14
Eryngium paniculatum	1	2.44	0.13	1	0.02	0.14
Griselinia jodinifolia	1	2.44	0.13	1	0.02	0.14
Leptinella scariosa	1	2.44	0.13	1	0.02	0.14
Muehlenbeckia hastulata	1	2.44	0.13	1	0.02	0.14
Ovidia pillopillo	1	2.44	0.13	1	0.02	0.14
Oxalis sp	1	2.44	0.13	1	0.02	0.14
Rigodium brachypodium	1	2.44	0.13	1	0.02	0.14
Rigodium pseudothuidium	1	2.44	0.13	1	0.02	0.14
Ulex europeaus	1	2.44	0.13	1	0.02	0.14
Weinmannia trichosperma	1	2.44	0.13	1	0.02	0.14

Table C.3: Importance values in the *Espinillo* shrub.

Espinillo shrub	Frequency			Cover		Importance
Species	Abs.	[%]	Rel.	Abs.	Rel.	value
Ulex europeaus	19	100.00	17.76	1780	90.40	108.16
Rubus constrictus	17	89.47	15.89	76	3.86	19.75
Aristotelia chilensis	9	47.37	8.41	22	1.12	9.53
Holcus lanatus	6	31.58	5.61	6	0.30	5.91
Cirsium vulgare	5	26.32	4.67	9	0.46	5.13
Lobelia bridgessi	4	21.05	3.74	8	0.41	4.14
Boquila trifoliolata	4	21.05	3.74	4	0.20	3.94
Embothrium coccineum	4	21.05	3.74	4	0.20	3.94
Lotus pedunculatus	4	21.05	3.74	4	0.20	3.94
Baccharis racemosa	3	15.79	2.80	7	0.36	3.16
Centella asiatica	2	10.53	1.87	11	0.56	2.43
Eryngium paniculatum	2	10.53	1.87	6	0.30	2.17
Hypochaeris radicata	2	10.53	1.87	6	0.30	2.17
Buddleja globosa	2	10.53	1.87	2	0.10	1.97
Chevreulia sarmentosa	2	10.53	1.87	2	0.10	1.97
Chusquea quila	2	10.53	1.87	2	0.10	1.97
Digitalis purpurea	2	10.53	1.87	2	0.10	1.97
Gunnera trinctoria	2	10.53	1.87	2	0.10	1.97
Muehlenbeckia hastulata	2	10.53	1.87	2	0.10	1.97
Polypogon chilensis	2	10.53	1.87	2	0.10	1.97
Ranunculus repens	2	10.53	1.87	2	0.10	1.97
Acaena ovalifolia	1	5.26	0.93	1	0.05	0.99
Acrisione denticulata	1	5.26	0.93	1	0.05	0.99
Azara lanceolata	1	5.26	0.93	1	0.05	0.99
Baccharis concava	1	5.26	0.93	1	0.05	0.99
Centaurium cachanlahuen	1	5.26	0.93	1	0.05	0.99
Gaultheria mucronata	1	5.26	0.93	1	0.05	0.99
Gavilea odoratissima	1	5.26	0.93	1	0.05	0.99
Leontodon saxatilis	1	5.26	0.93	1	0.05	0.99
Lotus subpinnatus	1	5.26	0.93	1	0.05	0.99
Prunella vulgaris	1	5.26	0.93	1	0.05	0.99

Table C.4: Importance values in the *Quila* shrub.

Quila shrub	Frequency			Cover		Importance
Species	Abs.	[%]	Rel.	Abs.	Rel.	value
Chusquea quila	19	100.00	19.00	1740	93.40	112.40
Rubus constrictus	11	57.89	11.00	15	0.81	11.81
Aristotelia chilensis	7	36.84	7.00	28	1.50	8.50
Fuchsia magellanica	5	26.32	5.00	9	0.48	5.48
Boquila trifoliolata	5	26.32	5.00	5	0.27	5.27
Lapageria rosea	5	26.32	5.00	5	0.27	5.27
Eucryphia cordifolia	4	21.05	4.00	13	0.70	4.70
Aextoxicon punctatum	4	21.05	4.00	4	0.21	4.21
Drimys winteri	3	15.79	3.00	7	0.38	3.38
Azara lanceolata	3	15.79	3.00	3	0.16	3.16
Baccharis racemosa	3	15.79	3.00	3	0.16	3.16
Blechnum hastatum	3	15.79	3.00	3	0.16	3.16
Lophosoria quadripinnata	3	15.79	3.00	3	0.16	3.16
Acrisione denticulata	2	10.53	2.00	2	0.11	2.11
Blechnum cordatum	2	10.53	2.00	2	0.11	2.11
Buddleja globosa	2	10.53	2.00	2	0.11	2.11
Cissus striata	2	10.53	2.00	2	0.11	2.11
Lobelia bridgessi	2	10.53	2.00	2	0.11	2.11
Luma apiculata	2	10.53	2.00	2	0.11	2.11
Amomyrtus luma	1	5.26	1.00	1	0.05	1.05
Corynabutilon vitifolium	1	5.26	1.00	1	0.05	1.05
Francoa appendiculata	1	5.26	1.00	1	0.05	1.05
Greigia sphalaceta	1	5.26	1.00	1	0.05	1.05
Loasa sp.	1	5.26	1.00	1	0.05	1.05
Lotus pedunculatus	1	5.26	1.00	1	0.05	1.05
Myrceugenia exsucca	1	5.26	1.00	1	0.05	1.05
Ovidia pillopillo	1	5.26	1.00	1	0.05	1.05
Oxalis sp	1	5.26	1.00	1	0.05	1.05
Prunella vulgaris	1	5.26	1.00	1	0.05	1.05
Rhaphithammus spinosus	1	5.26	1.00	1	0.05	1.05
Ulex europeaus	1	5.26	1.00	1	0.05	1.05
Uncinia phleoides	1	5.26	1.00	1	0.05	1.05

Table C.5: Importance values in the *Chupón* grassland.

Chupón grassland	Frequency			Cover		Importance
Species	Abs.	[%]	Rel.	Abs.	Rel.	value
Greigia sphalaceta	18	100.00	15.13	1600	89.34	104.46
Rubus constrictus	13	72.22	10.92	56	3.13	14.05
Baccharis racemosa	7	38.89	5.88	11	0.61	6.50
Ugni molinae	6	33.33	5.04	14	0.78	5.82
Aristotelia chilensis	6	33.33	5.04	6	0.34	5.38
Chusquea quila	5	27.78	4.20	10	0.56	4.76
Boquila trifoliolata	5	27.78	4.20	9	0.50	4.70
Prunella vulgaris	5	27.78	4.20	7	0.39	4.59
Blechnum cordatum	4	22.22	3.36	4	0.22	3.58
Galium hypocarpium	4	22.22	3.36	4	0.22	3.58
Lotus pedunculatus	4	22.22	3.36	4	0.22	3.58
Agrostis capillaris	3	16.67	2.52	12	0.67	3.19
Berberis darwinii	3	16.67	2.52	11	0.61	3.14
Ovidia pillopillo	3	16.67	2.52	7	0.39	2.91
Eryngium paniculatum	3	16.67	2.52	5	0.28	2.80
Blechnum hastatum	3	16.67	2.52	3	0.17	2.69
Rhaphithammus spinosus	3	16.67	2.52	3	0.17	2.69
Gaultheria mucronata	2	11.11	1.68	3	0.17	1.85
Centella asiatica	2	11.11	1.68	2	0.11	1.79
Holcus lanatus	2	11.11	1.68	2	0.11	1.79
Lapageria rosea	2	11.11	1.68	2	0.11	1.79
Leontodon saxatilis	2	11.11	1.68	2	0.11	1.79
Acaena ovalifolia	1	5.56	0.84	1	0.06	0.90
Aextoxicon punctatum	1	5.56	0.84	1	0.06	0.90
Alstroemeria aurea	1	5.56	0.84	1	0.06	0.90
Centaurium cachanlahuen	1	5.56	0.84	1	0.06	0.90
Cissus striata	1	5.56	0.84	1	0.06	0.90
Cliococca selaginoides	1	5.56	0.84	1	0.06	0.90
Gamochaeta americana	1	5.56	0.84	1	0.06	0.90
Leptinella scariosa	1	5.56	0.84	1	0.06	0.90
Libertia chilensis	1	5.56	0.84	1	0.06	0.90
Lomatia ferruginea	1	5.56	0.84	1	0.06	0.90
Lomatia hirsuta	1	5.56	0.84	1	0.06	0.90
Luma apiculata	1	5.56	0.84	1	0.06	0.90
Muehlenbeckia hastulata	1	5.56	0.84	1	0.06	0.90
Nassella poeppegiana	1	5.56	0.84	1	0.06	0.90

Table C.6: Importance values in the *Cardoncillo* grassland.

Cardoncillo grassland	Frequency			Cover		Importance
Species	Abs.	[%]	Rel.	Abs.	Rel.	value
Eryngium paniculatum	13	100.00	9.35	1035	58.61	67.96
Agrostis capillaris	13	100.00	9.35	123	6.96	16.32
Centella asiatica	13	100.00	9.35	59	3.34	12.69
Cliococca selaginoides	7	53.85	5.04	68	3.85	8.89
Lotus pedunculatus	10	76.92	7.19	20	1.24	8.44
Rubus constrictus	9	69.23	6.47	34	1.93	8.40
Ugni molinae	6	46.15	4.32	54	3.06	7.37
Centaurium cachanlahuen	6	46.15	4.32	30	1.70	6.02
Prunella vulgaris	7	53.85	5.04	9	0.51	5.55
Holcus lanatus	6	46.15	4.32	15	0.85	5.17
Baccharis racemosa	5	38.46	3.60	27	1.53	5.13
Leontodon saxatilis	5	38.46	3.60	13	0.74	4.33
Galium hypocarpium	5	38.46	3.60	9	0.51	4.11
Acaena ovalifolia	3	23.08	2.16	21	1.19	3.35
Gaultheria mucronata	3	23.08	2.16	13	0.74	2.89
Libertia chilensis	3	23.08	2.16	12	0.68	2.84
Oldenlandia salzmannii	1	7.69	0.72	20	1.13	1.85
Hypochaeris radicata	2	15.38	1.44	7	0.40	1.84
Juncus imbricatus	2	15.38	1.44	3	0.17	1.61
Lotus subpinnatus	2	15.38	1.44	3	0.17	1.61
Anthoxanthum odoratum	2	15.38	1.44	2	0.11	1.55
Aristotelia chilensis	2	15.38	1.44	2	0.11	1.55
Ovidia pillopillo	2	15.38	1.44	2	0.11	1.55
Rumex acetosella	2	15.38	1.44	2	0.11	1.55
Trifolium repens	2	15.38	1.44	2	0.11	1.55
Fuchsia magellanica	1	7.69	0.72	10	0.57	1.29
Ranunculus repens	1	7.69	0.72	10	0.57	1.29
Blechnum hastatum	1	7.69	0.72	1	0.06	0.78
Calceolaria integrifolia	1	7.69	0.72	1	0.06	0.78
Carex fuscula	1	7.69	0.72	1	0.06	0.78
Gamochaeta americana	1	7.69	0.72	1	0.06	0.78
Genista monspessulana	1	7.69	0.72	1	0.06	0.78
Geranium core-core	1	7.69	0.72	1	0.06	0.78

Table C.7: Importance values in the *Junco húmedo* grassland.

Junco húmedo grassland	Frequency			Cover		Importance
Species	Abs.	[%]	Rel.	Abs.	Rel.	value
Juncus procerus	15	100.00	9.80	1010	54.30	64.10
Centella asiatica	15	100.00	9.80	207	11.13	20.93
Leontodon saxatilis	7	46.67	4.58	122	6.56	11.13
Agrostis capillaris	10	66.67	6.54	70	3.76	10.30
Holcus lanatus	11	73.33	7.19	55	2.96	10.15
Ranunculus repens	7	46.67	4.58	53	2.85	7.42
Juncus imbricatus	7	46.67	4.58	39	2.10	6.67
Rubus constrictus	8	53.33	5.23	12	0.65	5.87
Oldenlandia salzmannii	5	33.33	3.27	38	2.04	5.31
Leptinella scariosa	5	33.33	3.27	32	1.72	4.99
Prunella vulgaris	6	40.00	3.92	15	0.81	4.73
Polypogon chilensis	3	20.00	1.96	36	1.94	3.90
Juncus microcephalus	3	20.00	1.96	30	1.61	3.57
Lotus pedunculatus	5	33.33	3.27	5	0.27	3.54
Nertera granadensis	4	26.67	2.61	8	0.43	3.04
Blechnum cordatum	2	13.33	1.31	25	1.34	2.65
Rumex acetosella	3	20.00	1.96	7	0.38	2.34
Centaurium cachanlahuen	3	20.00	1.96	3	0.16	2.12
Hypochaeris radicata	3	20.00	1.96	3	0.16	2.12
Chusquea quila	1	6.67	0.65	20	1.08	1.73
Paspalum dasypleurum	2	13.33	1.31	6	0.32	1.63
Anthoxanthum utriculatum	1	6.67	0.65	15	0.81	1.46
Acaena ovalifolia	2	13.33	1.31	2	0.11	1.41
Carex fuscula	2	13.33	1.31	2	0.11	1.41
Cirsium vulgare	2	13.33	1.31	2	0.11	1.41
Galium hypocarpium	2	13.33	1.31	2	0.11	1.41
Gratiola peruviana	1	6.67	0.65	10	0.54	1.19
Gunnera trinctoria	1	6.67	0.65	10	0.54	1.19
Anthoxanthum odoratum	1	6.67	0.65	5	0.27	0.92
Aextoxicon punctatum	1	6.67	0.65	1	0.05	0.71
Aristotelia chilensis	1	6.67	0.65	1	0.05	0.71
Baccharis racemosa	1	6.67	0.65	1	0.05	0.71
Chevreulia sarmentosa	1	6.67	0.65	1	0.05	0.71
Cyperus sp	1	6.67	0.65	1	0.05	0.71
Dichondra sericea	1	6.67	0.65	1	0.05	0.71
Genista monspessulana	1	6.67	0.65	1	0.05	0.71
Luma apiculata	1	6.67	0.65	1	0.05	0.71
Myrceugenia exsucca	1	6.67	0.65	1	0.05	0.71
Myrceugenia planipes	1	6.67	0.65	1	0.05	0.71
Ovidia pillopillo	1	6.67	0.65	1	0.05	0.71
Oxalis corniculata	1	6.67	0.65	1	0.05	0.71
Sophora microphylla	1	6.67	0.65	1	0.05	0.71
Tepualis stipularis	1	6.67	0.65	1	0.05	0.71
Trifolium repens	1	6.67	0.65	1	0.05	0.71
Ugni molinae	1	6.67	0.65	1	0.05	0.71

Table C.8: Importance values in the *Paja ratonera* grassland.

Paja ratonera grassland	Frequency			Cover		Importance
Species	Abs.	[%]	Rel.	Abs.	Rel.	value
Anthoxanthum utriculatum	11	100.00	8.94	800	58.06	67.00
Centella asiatica	11	100.00	8.94	156	11.32	20.26
Lotus pedunculatus	10	90.91	8.13	61	4.43	12.56
Holcus lanatus	7	63.64	5.69	53	3.85	9.54
Agrostis capillaris	9	81.82	7.32	30	2.18	9.49
Leontodon saxatilis	6	54.55	4.88	47	3.41	8.29
Prunella vulgaris	9	81.82	7.32	9	0.65	7.97
Juncus procerus	6	54.55	4.88	33	2.39	7.27
Oldenlandia salzmannii	6	54.55	4.88	24	1.74	6.62
Centaurium cachanlahuen	7	63.64	5.69	11	0.80	6.49
Polypogon chilensis	3	27.27	2.44	35	2.54	4.98
Juncus microcephalus	4	36.36	3.25	10	0.73	3.98
Leptinella scariosa	3	27.27	2.44	17	1.23	3.67
Ranunculus repens	2	18.18	1.63	21	1.52	3.15
Acaena ovalifolia	3	27.27	2.44	4	0.29	2.73
Cliococca selaginoides	2	18.18	1.63	11	0.80	2.42
Baccharis sagittalis	1	9.09	0.81	20	1.45	2.26
Juncus imbricatus	2	18.18	1.63	7	0.51	2.13
Aira caryophyllea	2	18.18	1.63	6	0.44	2.06
Rubus constrictus	2	18.18	1.63	6	0.44	2.06
Anthoxanthum odoratum	2	18.18	1.63	2	0.15	1.77
Galium hypocarpium	2	18.18	1.63	2	0.15	1.77
Lotus subpinnatus	2	18.18	1.63	2	0.15	1.77
Ovidia pillopillo	2	18.18	1.63	2	0.15	1.77
Vulpia bromoides	2	18.18	1.63	2	0.15	1.77
Amomyrtus luma	1	9.09	0.81	1	0.07	0.89
Berberis darwinii	1	9.09	0.81	1	0.07	0.89
Blechnum hastatum	1	9.09	0.81	1	0.07	0.89
Carex fuscula	1	9.09	0.81	1	0.07	0.89
Nothoscordum striatellum	1	9.09	0.81	1	0.07	0.89
Oxalis sp	1	9.09	0.81	1	0.07	0.89
Trifolium repens	1	9.09	0.81	1	0.07	0.89

Table C.9: Importance values in the *Centella* grassland.

Centella grassland	Frequency			Cover		Importance
Species	Abs.	[%]	Rel.	Abs.	Rel.	value
Centella asiatica	3	100.00	8.82	160	41.34	50.17
Agrostis capillaris	3	100.00	8.82	100	25.84	34.66
Leontodon saxatilis	2	66.67	5.88	60	15.50	21.39
Holcus lanatus	3	100.00	8.82	22	5.68	14.51
Lotus pedunculatus	3	100.00	8.82	16	4.13	12.96
Oldenlandia salzmannii	3	100.00	8.82	3	0.78	9.60
Rigodium brachypodium	2	66.67	5.88	11	2.84	8.72
Aira caryophyllea	2	66.67	5.88	2	0.52	6.40
Brachystele unilateralis	2	66.67	5.88	2	0.52	6.40
Centaurium cachanlahuen	2	66.67	5.88	2	0.52	6.40
Carex fuscula	2	66.67	5.88	2	0.52	6.40
Ugni molinae	2	66.67	5.88	2	0.52	6.40
Vulpia bromoides	2	66.67	5.88	2	0.52	6.40
Acaena ovalifolia	1	33.33	2.94	1	0.26	3.20
Juncus imbricatus	1	33.33	2.94	1	0.26	3.20
Prunella vulgaris	1	33.33	2.94	1	0.26	3.20

Table C.10: Importance values in the *Chépica cadillo* grassland.

Chépica cadillo grassland	Frequency			Cover		Importance
Species	Abs.	[%]	Rel.	Abs.	Rel.	value
Agrostis capillaris	11	100.00	7.97	545	39.12	47.10
Acaena ovalifolia	11	100.00	7.97	325	23.33	31.30
Dichondra sericea	9	81.82	6.52	117	8.40	14.92
Leontodon saxatilis	8	72.73	5.80	111	7.97	13.77
Holcus lanatus	8	72.73	5.80	78	5.60	11.40
Centaurium cachanlahuen	8	72.73	5.80	26	1.87	7.66
Prunella vulgaris	9	81.82	6.52	9	0.65	7.17
Aira caryophyllea	7	63.64	5.07	24	1.72	6.80
Gamochaeta americana	7	63.64	5.07	21	1.51	6.58
Juncus imbricatus	7	63.64	5.07	19	1.36	6.44
Vulpia bromoides	5	45.45	3.62	36	2.58	6.21
Centella asiatica	6	54.55	4.35	19	1.36	5.71
Anthoxanthum odoratum	6	54.55	4.35	18	1.29	5.64
Lotus subpinnatus	4	36.36	2.90	13	0.93	3.83
Cliococca selaginoides	4	36.36	2.90	4	0.29	3.19
Lotus pedunculatus	4	36.36	2.90	4	0.29	3.19
Rumex acetosella	4	36.36	2.90	4	0.29	3.19
Trifolium repens	4	36.36	2.90	4	0.29	3.19
Carex fuscula	3	27.27	2.17	3	0.22	2.39
Rigodium brachypodium	3	27.27	2.17	3	0.22	2.39
Leptinella scariosa	2	18.18	1.45	2	0.14	1.59
Berberis microphylla	1	9.09	0.72	1	0.07	0.80
Brachystele unilateralis	1	9.09	0.72	1	0.07	0.80
Chevreulia sarmentosa	1	9.09	0.72	1	0.07	0.80
Hypochaeris radicata	1	9.09	0.72	1	0.07	0.80
Leptostigma arnottianum	1	9.09	0.72	1	0.07	0.80
Paspalum distichium	1	9.09	0.72	1	0.07	0.80
Ugni molinae	1	9.09	0.72	1	0.07	0.80
Ulex europeaus	1	9.09	0.72	1	0.07	0.80

Table C.11: Importance values in the *Junco duro* grassland.

Junco duro grassland	Frequency			Cover		Importance
Species	Abs.	[%]	Rel.	Abs.	Rel.	value
Agrostis capillaris	12.0	100.0	8.5	245.0	17.0	25.5
Juncus imbricatus	12.0	100.0	8.5	600.0	41.6	50.1
Leontodon saxatilis	11.0	91.7	7.7	152.0	10.5	18.3
Dichondra sericea	10.0	83.3	7.0	225.0	15.6	22.7
Prunella vulgaris	10.0	83.3	7.0	10.0	0.7	7.7
Vulpia bromoides	9.0	75.0	6.3	66.0	4.6	10.9
Holcus lanatus	8.0	66.7	5.6	8.0	0.6	6.2
Gamochaeta americana	7.0	58.3	4.9	11.0	0.8	5.7
Centaurium cachanlahuen	6.0	50.0	4.2	6.0	0.4	4.6
Rumex acetosella	6.0	50.0	4.2	6.0	0.4	4.6
Trifolium repens	6.0	50.0	4.2	6.0	0.4	4.6
Plantago lanceolata	5.0	41.7	3.5	5.0	0.3	3.9
Carex fuscula	4.0	33.3	2.8	4.0	0.3	3.1
Juncus procerus	4.0	33.3	2.8	8.0	0.6	3.4
Acaena ovalifolia	3.0	25.0	2.1	30.0	2.1	4.2
Aira caryophyllea	3.0	25.0	2.1	7.0	0.5	2.6
Hypochaeris radicata	3.0	25.0	2.1	7.0	0.5	2.6
Lotus subpinnatus	3.0	25.0	2.1	3.0	0.2	2.3
Anthoxanthum odoratum	2.0	16.7	1.4	2.0	0.1	1.5
Cirsium vulgare	2.0	16.7	1.4	2.0	0.1	1.5
Dactylis glomerata	2.0	16.7	1.4	2.0	0.1	1.5
Lotus pedunculatus	2.0	16.7	1.4	2.0	0.1	1.5
Rigodium brachypodium	2.0	16.7	1.4	2.0	0.1	1.5
Centella asiatica	1.0	8.3	0.7	10.0	0.7	1.4
Cliococca selaginoides	1.0	8.3	0.7	10.0	0.7	1.4
Daucus carota	1.0	8.3	0.7	1.0	0.1	0.8
Eryngium paniculatum	1.0	8.3	0.7	1.0	0.1	0.8
Gaultheria mucronata	1.0	8.3	0.7	1.0	0.1	0.8
Leptinella scariosa	1.0	8.3	0.7	5.0	0.3	1.1
Modiola caroliniana	1.0	8.3	0.7	1.0	0.1	0.8
Relchela panicoides	1.0	8.3	0.7	1.0	0.1	0.8
Trifolium pratense	1.0	8.3	0.7	1.0	0.1	0.8
Uncinia phleoides	1.0	8.3	0.7	1.0	0.1	0.8

Table C.12: Importance values in the *Aira* grassland.

Aira grassland	Frequency			Cover		Importance
Species	Abs.	[%]	Rel.	Abs.	Rel.	value
Aira caryophyllea	2	100.00	8.00	100	50.51	58.51
Agrostis capillaris	2	100.00	8.00	40	20.20	28.20
Vulpia bromoides	2	100.00	8.00	21	10.61	18.61
Dichondra sericea	2	100.00	8.00	20	10.10	18.10
Carex fuscula	2	100.00	8.00	2	1.01	9.01
Centaurium cachanlahuen	2	100.00	8.00	2	1.01	9.01
Leontodon saxatilis	2	100.00	8.00	2	1.01	9.01
Rumex acetosella	2	100.00	8.00	2	1.01	9.01
Acaena ovalifolia	1	50.00	4.00	1	0.51	4.51
Gaultheria mucronata	1	50.00	4.00	1	0.51	4.51
Hypochaeris radicata	1	50.00	4.00	1	0.51	4.51
Juncus imbricatus	1	50.00	4.00	1	0.51	4.51
Lotus pedunculatus	1	50.00	4.00	1	0.51	4.51
Piptochaetium montevidense	1	50.00	4.00	1	0.51	4.51
Plantago lanceolata	1	50.00	4.00	1	0.51	4.51
Prunella vulgaris	1	50.00	4.00	1	0.51	4.51
Ugni molinae	1	50.00	4.00	1	0.51	4.51

Table C.13: Importance values in the *Cepilla* grassland.

Cepilla grassland	Frequency			Cover		Importance
Species	Abs.	[%]	Rel.	Abs.	Rel.	value
Vulpia bromoides	5	100.00	10.87	320	56.54	67.41
Agrostis capillaris	5	100.00	10.87	55	9.72	20.59
Leontodon saxatilis	4	80.00	8.70	60	10.60	19.30
Dichondra sericea	5	100.00	10.87	47	8.30	19.17
Centaurium cachanlahuen	5	100.00	10.87	24	4.24	15.11
Centella asiatica	1	20.00	2.17	30	5.30	7.47
Gamochaeta americana	3	60.00	6.52	3	0.53	7.05
Cuscuta chilensis	2	40.00	4.35	2	0.35	4.70
Holcus lanatus	2	40.00	4.35	2	0.35	4.70
Leptinella scariosa	2	40.00	4.35	2	0.35	4.70
Ugni molinae	2	40.00	4.35	2	0.35	4.70
Acaena ovalifolia	1	20.00	2.17	10	1.77	3.94
Brachystele unilateralis	1	20.00	2.17	1	0.18	2.35
Cliococca selaginoides	1	20.00	2.17	1	0.18	2.35
Juncus imbricatus	1	20.00	2.17	1	0.18	2.35
Juncus procerus	1	20.00	2.17	1	0.18	2.35
Lotus pedunculatus	1	20.00	2.17	1	0.18	2.35
Lotus subpinnatus	1	20.00	2.17	1	0.18	2.35
Oxalis sp	1	20.00	2.17	1	0.18	2.35
Rigodium brachypodium	1	20.00	2.17	1	0.18	2.35
Sisyrinchium chilense	1	20.00	2.17	1	0.18	2.35

Appendix D

Vegetation table

This Appendix reports the vegetation tables of the research area. Lf. stands for life forms, defined as in Table 4.2. The values in the tables are calculated according to the Braun-Blanquet coverage scale (see Table 4.5).

- Table D.1: Initial table;
- Table D.2: Species in frequency-class order;
- Table D.3: Species in syntaxonomic affinity;
- Table D.4: Synoptic table.

Table D.1: Initial plant sociological table. Species in alphabetical order. S.: Status (see Table 4.1); Lf.: Lifeform (see Table 4.2); Fr.: Frequency. Information about the header data in Appendix E.

Relevé Nr.				1111111111111111111111111111111111111111111111111111111111111111111111
				1111111111222222222233333333334444444444555555555566666666667777777777888888888899999999990000000000111111111122222222223333333333444444444455555555556666666666
				1234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123456789
Species	**S.**	**Lf.**	**Fr.**	
Acaena ovalifolia	[E(Ch/Arg)]	[H]	[28]	......r..r..............22.+.++.....................22.232332332322....2....++...1.+...........................+...........+.
Acrisione denticulata	[E(Ch/Arg)]	[Mi P]	[4]	...................+...........................r...+..+..................................
Aextoxicon punctatum	[E(Ch/Arg)]	[Mes P]	[47]	54455555545444454554444545545444544444444.....................................+..+r..r....r.....................r........
Agrostis capillaris	[nat]	[H]	[68]	....2221222222222+222..+...+++2232222222222334444322444222222++2..+++22222.........................+..+....2...333
Aira caryophyllea	[a]	[T]	[16]	....+....+..2++...+2+2.2.........+...2..34......................................++
Alstroemeria aurea	[E(Ch)]	[G]	[1]	....+........
Amomyrtus luma	[E(Ch/Arg)]	[Mes P]	[15]	.+2...2..........++...++2.2..+.+...+..2...+...........+..................................
Amomyrtus meli	[E(Ch)]	[Mes P]	[33]	.222.2232+33.+3.32.2323..23222322.2222222..
Anemone hepaticifolia	[E(Ch)]	[T]	[6]	.....................+...2222....+...
Anthoxanthum odoratum	[i]	[H]	[13]	....++...............2............++........2++.2.+2...........++..
Anthoxanthum utriculatum	[E(Ch/Arg)]	[H]	[12]	....2..................................54544444454..
Aristotelia chilensis	[E(Ch/Arg)]	[Mi P]	[28]	2.+.....................................r+..r.r.2+.++.+2.........r.....+........+..2+2.......++....22...++r....+..+...+....
Asplenium sp.	[N]	[E]	[1]	................+..
Azara lanceolata	[E(Ch/Arg)]	[Mi P]	[11]	......++........++.+..............+r.......................r..+++................................
Baccharis concava	[N]	[N P]	[1]	....+..
Baccharis racemosa	[E(Ch/Arg)]	[N P]	[19]	....+..........2......+....22+.+.2.+..+...........+.+.....++..++.....+..+2....
Baccharis sagittalis	[N]	[N P]	[1]	....2...
Berberis darwinii	[E(Ch/Arg)]	[N P]	[4]	....+..2+2...
Berberis microphylla	[E(Ch/Arg)]	[N P]	[1]	....+..
Blechnum asperum	[E(Ch)]	[H]	[4]	.......+++........2..
Blechnum chilense	[N]	[H]	[24]	..++++.......+..+....+.+..+.++..++2...+.+.......................................22...+.....+........+.+.++...........
Blechnum hastatum	[E(Ch/Arg)]	[H]	[10]	+..................+..+...+.......+......+.........+++...+...............
Blechnum penna-marina	[C]	[H]	[1]	.........+...
Blepharocalyx cruckshanksii	[E(Ch)]	[Mes P]	[1]	.....................+...
Boquila trifoliolata	[E(Ch/Arg)]	[L]	[30]	+.....+..++.+.......+++++...+++++.+........+.+.++...+.++++...........+++.......+2........
Brachystele unilateralis	[N]	[G]	[4]	....+..........+...+.+
Buddleja globosa	[E(Ch/Arg)]	[Mi P]	[4]	....r..+..+..r.......................
Calceolaria integrifolia	[N]	[T]	[1]	....+..
Carex fuscula	[N]	[H]	[19]	.++...................................+.+.....................+...........+........+....+.+..++......++...+.........+..........++.....................................+.+
Centaurium cachanlahuen	[N]	[T]	[41]	....+..................+.1.+.22+...++..+.........+++....+.++.2++..++2+++++2++.++++..+2.++....................+................++.
Centella asiatica	[N]	[H]	[54]	....2+..............++++++222222+222222323222+2+...........2...22++++.....3.2222+322222......................+......+.........443
Chevreulia sarmentosa	[N]	[H]	[4]	....+..+....................+...........................+..
Chusquea quila	[E(Ch)]	[N P]	[58]	.+22++..++..+32..22.22+++++.+++2++2.++++2..............++.......................2..5555555555555555445........+..++2...1...
Cirsium vulgare	[nat]	[T]	[9]	....+++.+2..........................+.....+............+...+...
Cissus striata	[E(Ch/Arg)]	[L]	[18]	...2........++.....+.2+++++....++..+++...+.................+...........+.........
Cliococca selaginoides	[N]	[Ch]	[16]	....12..+.2222............................2..++..++....+...........+2.....................................+.....
Corynabutilon vitifolium	[E(Ch)]	[N P]	[1]	....+...............................
Crinodendron hookerianum	[E(Ch)]	[N P]	[3]	.......................+.+.......+...
Cuscuta chilensis	[N]	[T]	[2]	....++..
Cyperus sp.	[N]	[H]	[1]	....+..
Dactylis glomerata	[a]	[H]	[2]	....+.+...
Daucus carota	[a]	[T]	[1]	....+...
Dichondra sericea	[N]	[H]	[27]	....+....222333222.322..+2+22222+2+2...........22..
Digitalis purpurea	[a]	[T]	[2]	....++...
Dioscorea auriculata	[E(Ch)]	[G]	[8]	+.++..............+....+.++.............+..
Drimys winteri	[E(Ch)]	[Mi P]	[31]	..22.2+23223.+2++2+.222.22222222.2.....2...2r.+..................................
Embothrium coccineum	[E(Ch/Arg)]	[Mi P]	[5]	..r......................................+...r..++...
Eryngium paniculatum	[N]	[H]	[20]	r..+2.....5555455455445.........................r..+........1.1....
Eucryphia cordifolia	[E(Ch/Arg)]	[Mes P]	[36]	22.2222+++.22++2222.222.2..22..323.222222...+++......2.........................
Fascicularia bicolor	[E(Ch)]	[E]	[6]	+.+2+..............+...................+...
Francoa appendiculata	[E(Ch)]	[H]	[1]	....+.............................
Fuchsia magellanica	[E(Ch/Arg)]	[N P]	[6]	....2...++.......+2...+........................
Galium hypocarpium	[N]	[Ch]	[13]	....++......2.+.+....+...+.....................................++............................+....++.+............
Gamochaeta americana	[N]	[H]	[19]	....+..................+.++.+.+2+.+.++.+++..2..+++.................................+...................
Gaultheria mucronata	[E(Ch/Arg)]	[N P]	[8]	....+...................2.........1+...........................+...........................+..................................1+.....
Gavilea odoratissima	[E(Ch/Arg)]	[G]	[1]	....+..
Genista monspessulana	[a]	[N P]	[2]	....+...+..
Geranium core-core	[N]	[T]	[1]	....+..
Gevuina avellana	[E(Ch/Arg)]	[Mi P]	[17]	......+.2..++.+..+.+..+...+222+.+2.+2..
Gratiola peruviana	[N]	[Ch]	[1]	....2...
Greigia sphacelata	[E(Ch)]	[H]	[41]	..2.r.+2++.+r2.++++..+...+.+..+r+..r..+.2..r.............5555555555545555455...
Griselinia jodinifolia	[E(Ch)]	[N P]	[1]	................+..
Gunnera tinctoria	[E(Ch)]	[H]	[3]	....+.......+...............................2..
Holcus lanatus	[a]	[H]	[53]	....+..+++.++............++..2.+...++.22+2++.2.2++2..+++++++..+....+32++222++....+++2.2.22.......................+......+.........2++
Hydrangea serratifolia	[E(Ch/Arg)]	[L]	[4]	.+.....+...........+................+..
Hydrocotyle indecora	[E(Ch/Arg)]	[H]	[2]	................++...
Hydrocotyle poeppigii	[E(Ch)]	[H]	[8]	..+.............+..+++.+...+...........+...
Hymenoglossum cruentum	[E(Ch/Arg)]	[E]	[13]	.++.+...........++..+.........+..+.+++.++..
Hymenophyllum caudiculatum	[E(Ch/Arg)]	[E]	[20]	.++.+++++......+....+.....+.+..+++++++++...
Hymenophyllum sp.	[E(Ch/Arg)]	[E]	[19]	.++.++.....+.+.+.+..+.....+.++.++.++++.+...
Hymenophyllum cuneatum	[E(Ch/Arg)]	[E]	[9]	...++..+....+.................+.++...++..
Hypochaeris radicata	[a]	[H]	[12]	....+.2..............21..+...........+..+.....++......2.......+..................+...
Juncus imbricatus	[N]	[H]	[33]	....1.+..........2++..2.2.+.+244324444344+.2..+++.22..+..2.......1.+......................................r..
Juncus microcephalus	[N]	[H]	[7]	....2..2.2................................+.+.21..
Juncus procerus	[N]	[H]	[26]	....434444444545554....2+..++...............+.2+...+.+.22..
Lapageria rosea	[E(Ch)]	[L]	[48]	222222+++++22++22222222222222222222222222..+.+++........+.............++.......

continue...

Species	**S.**	**Lf.**	**Fr.**	**Relevé Nr.**
				1111111111111111111111111111111111111111111111111111111111111111111111
				1111111111222222222233333333334444444444555555555566666666667777777777888888888899999999990000000000111111111122222222223333333333444444444455555555556666666666
				1234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123456789
Laureliopsis philippiana	[E(Ch/Arg)]	[Mes P]	[8]	..r..............2.2....+.+.......2r....2..
Leontodon saxatilis	[a]	[H]	[48]	....+..........+..2+.2+...33322++........++22222223.32+322222...22.222.2++2.2...++....................++...............3.2
Leptinella scariosa	[E(Ch/Arg)]	[H]	[15]	.......................+...22+.2......+...........2...+.+........++.+......2..+..........................+...............
Leptostigma arnottianum	[E(Ch/Arg)]	[G]	[1]	....+..
Libertia chilensis	[E(Ch/Arg)]	[H]	[4]	....2+.........+..r.....
Loasa sp.	[N]	[T]	[1]	....+......................................
Lobelia bridgesii	[E(Ch)]	[Ch]	[6]	....++......+2..++.........................
Lomatia ferruginea	[E(Ch/Arg)]	[N P]	[31]	.++...++++2.+.2.+++..+++22+2++22.2.+++++2...r....................
Lomatia hirsuta	[N]	[Mi P]	[1]	....r.....
Lophosoria quadripinnata	[N]	[H]	[12]	.....+..2......+2...++.....+....2.+..++..+...............................
Lotus pedunculatus	[i]	[H]	[45]	....+.+.........++.......++++++++++..........+++.++.......+..+....++.++....+...22++.+++32++............+...........+.+.....+....+2+2
Lotus subpinnatus	[E(Ch)]	[T]	[13]	....+.....................1+...........................+++..+.+...2.+...+......++..
Luma apiculata	[E(Ch/Arg)]	[Mi P]	[24]	+.2+2+...2.....+......+...++.++++.22.+222...r..++..................r.............
Luzuriaga polyphylla	[E(Ch)]	[E]	[20]	+.+++.+.+.++.++...+..++...++.2.++..+....+..
Luzuriaga radicans	[E(Ch/Arg)]	[E]	[34]	+.+++2++++.++.+++++++2++..+++2++++++.2.++..
Megalastrum spectabile	[E(Ch/Arg)]	[B]	[10]	......+++.++.........+..++..2..........+...
Mitraria coccinea	[E(Ch/Arg)]	[E]	[30]	++++..++++..++.+++++++.+.+++++++++2..+..+..
Modiola caroliniana	[a]	[H]	[1]	....+...
Muehlenbeckia hastulata	[N]	[L]	[4]	...........+..................................++...+.............
Myrceugenia chrysocarpa	[E(Ch/Arg)]	[Mi P]	[3]	3.+.....................................+..
Myrceugenia exsucca	[E(Ch/Arg)]	[Mi P]	[5]	......................22..............+...................................+..r...........................
Myrceugenia planipes	[E(Ch/Arg)]	[Mi P]	[28]	.2232.2+....232222+.22..+2...222.2222.222....................................+...
Nassella poeppigiana	[N]	[H]	[1]	....+..............
Nertera granadensis	[N]	[H]	[30]	32+3..34232+...++2.+...2++22.2..2+..22+.+................................+....+.....2+...
Nothoscordum striatellum	[N]	[G]	[1]	....+...
Oldenlandia salzmannii	[N]	[H]	[15]	....2.......+2....3..++..............................2.+.+..+2.+.......................................+++
Osmorhiza chilensis	[N]	[H]	[3]	...................+......+....+...
Ovidia pillopillo	[E(Ch/Arg)]	[Mi P]	[10]	..........................+..................................r..........r........r....................................+.+....................+......+.....r...2..........
Oxalis corniculata	[C]	[T]	[1]	....+...
Oxalis sp.	[N]	[T]	[4]	...................+..+...+...........+......................................
Paspalum dasypleurum	[E(Ch/Arg)]	[H]	[2]	....+2...
Paspalum distichum	[i]	[H]	[1]	....+..
Persea lingue	[E(Ch/Arg)]	[Mi P]	[2]	...................+............r..
Piptochaetium montevidense	[N]	[H]	[1]	....+...
Plantago lanceolata	[a]	[H]	[6]	....++.++...+............................+..
Podocarpus nubigenus	[E(Ch/Arg)]	[Mi P]	[7]	........+..+..r........r..+...2..+...
Polypogon chilensis	[N]	[H]	[9]	....+....+..........................+.......22.................................22........2..
Prunella vulgaris	[a]	[Ch]	[50]	....+.................+...++++r1.++2+.+.......+...+++++++++++++++.++.++.....+.++++++.+++..+..................+...++.+.......1.+..
Ranunculus repens	[a]	[H]	[12]	....++.....................2...........+....+2+222.................................+.2...
Raukaua valdiviensis	[E(Ch)]	[L]	[6]	......+.........++....+.........+.....+..
Relchela panicoides	[E(Ch/Arg)]	[H]	[1]	....+..
Rhamnus diffusus	[E(Ch)]	[N P]	[13]	......+++............+2...++.2+.+++r...
Rhaphithamnus spinosus	[N]	[N P]	[34]	2+22..+.++++.++++2++++++++++.+.+.+.+.+..2..+................++........+........
Rigodium brachypodium	[E(Ch)]	[B]	[9]	+..++.....++..+...+...2+
Rigodium implexum	[E(Ch)]	[B]	[2]	.....................................++..
Rigodium pseudothuidium	[E(Ch/Arg)]	[B]	[1]	+..
Rubus constrictus	[a]	[N P]	[60]	....+2222222222+2+++.+.22r..22.+r+.2....+++2...++++.................................2+......2++......+++++++..+..+.+.+.++++++2221...
Rumex acetosella	[a]	[H]	[17]	....+.......r..+.+.......2.....++..++.++..+.++.+.....................++..
Sarmienta scandens	[E(Ch)]	[E]	[27]	++..+++++..++++++++++.+.......+.11++.++++..
Saxegothaea conspicua	[E(Ch/Arg)]	[Mi P]	[2]	.........+....................+..
Sisyrinchium chilense	[N]	[G]	[1]	....+...
Sophora microphylla	[N]	[N P]	[3]	..2.....................................2.......................................r..
Tepualia stipularis	[E(Ch/Arg)]	[Mi P]	[1]	....r..
Trifolium pratense	[a]	[Ch]	[1]	....+...
Trifolium repens	[a]	[H]	[14]	....+.....+.........r..........++++.+.+..+...+++........+...
Ugni molinae	[E(Ch/Arg)]	[N P]	[19]	....2+rr...r...3.........r...........................r...+.+...........+....................+....++........2+2.++
Ulex europaeus	[i]	[N P]	[22]	..................................r......5555555555555555555...r.....................................+...........................
Uncinia phleoides	[N]	[H]	[24]	......++..++.+++.++++++++++.++.+++..+...+....................................
Vulpia bromoides	[a]	[T]	[25]	....22222...+2222.2+.2....244444..++.......2+......................................++
Weinmannia trichosperma	[E(Ch/Arg)]	[Mes P]	[1]	.....+...
Weymouthia mollis	[C]	[B]	[9]	.+...+.......................+.++..++.++...

Table D.2: Phytosociological table with frequency class. Species in frequency classes order. S.: Status (see Table 4.1); Lf.: Lifeform (see Table 4.2); F.C.: Constancy classes (see Table 4.6); Fr.: Frequency. Information about the header data in Appendix E.

Relevé Nr.					111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111 1111111111222222222233333333334444444444555555555566666666667777777777888888888899999999990000000000111111111122222222223333333333444444444455555555556666666666 123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123456789
Species	**S.**	**Lf.**	**Fr.**	**F.C**	
Agrostis capillaris	[nat]	[H]	[68]	[III]	....2221222222222+222..+...+++2232222222222233444432244422222++2..+++22222........................+..+....2...333
Rubus constrictus	[a]	[N P]	[60]	[II]	....+2222222222+2+++.+.22r..22.+r+.2....+++2...++++...............................2+......2++......+++++++..+..+.+.+.+++++2221...
Chusquea quila	[E(Ch)]	[N P]	[58]	[II]	.+22++..++..+32..22.22+++++.+++2++2.++++2..............++.....................2...5555555555555555445........+..++2...1...
Centella asiatica	[N]	[H]	[54]	[II]	....2+.............++++++222222+222222323222+2+...........2..22++++......3.2222+322222.....................+.......+........443
Holcus lanatus	[a]	[H]	[53]	[II]	....+..+++.++.........++...2.+...++.22+2++.2.2++2..+++++++..+....+32++222++.....+++2.2.22......................+......+.........2++
Prunella vulgaris	[a]	[Ch]	[50]	[II]	....+.................+...++++r1.++2+.+.......+...++++++++++++++.++.++.....+.++++++.+++..+..................+...++.+.......1.+..
Lapageria rosea	[E(Ch)]	[L]	[48]	[II]	222222++++++22++2222222222222222222222222...+.+++.........+............++.......
Leontodon saxatilis	[a]	[H]	[48]	[II]	....+..........+..2+.2+...33322++........++22222223.32+322222...22.222.2++2.2...++....................++..............3.2
Aextoxicon punctatum	[E(Ch/Arg)]	[Mes P]	[47]	[II]	5445555555545444454554444545545444544444444...................................+..+r..r....r....................r........
Lotus pedunculatus	[i]	[H]	[45]	[II]	....+.+.........++.......++++++++++..........+++.++.......+..+....++.++....+...22++.+++32++...........+...........+.+......+....+2+2
Greigia sphacelata	[E(Ch)]	[H]	[41]	[II]	..2.r.+2++.+r2.++++..+...+.+..+r+..r..+.2..r.............555555555545555455...
Centaurium cachanlahuen	[N]	[T]	[41]	[II]	....+.................+.1.+.22+....++..+.........+++....+.++.2++..++2+++++2++.++++..+2.++...................+................++.
Eucryphia cordifolia	[E(Ch/Arg)]	[Mes P]	[36]	[II]	22.2222+++.22++2222.222.2..22..323.222222...+++.......2.......................
Rhaphithamnus spinosus	[N]	[N P]	[34]	[II]	2+22..+.++++.++++2++++++++++.+.+.+.+..2...+.................++........+.......
Luzuriaga radicans	[E(Ch/Arg)]	[E]	[34]	[II]	+.+++2++++.++.+++++++2++..+++2++++++.2.++...
Amomyrtus meli	[E(Ch)]	[Mes P]	[33]	[I]	.222.2232+33.+3.32.2323..23222322.2222222..
Juncus imbricatus	[N]	[H]	[33]	[I]	....1.+...........2++..2.2.+.+244324444344+.2..+++.22..+..2.........1.+....................................r..
Lomatia ferruginea	[E(Ch/Arg)]	[N P]	[31]	[I]	.++...++++2.+.2.+++..+++22+2++22.2.+++++2..r...................
Drimys winteri	[E(Ch)]	[Mi P]	[31]	[I]	..22.2+23223.+2++2+.222.22222222.2......2...2r.+..................................
Boquila trifoliolata	[E(Ch/Arg)]	[L]	[30]	[I]	+.....+..++.+.......+++++....+++++.+........+.+.++..+.++++..........+++........+2.......
Mitraria coccinea	[E(Ch/Arg)]	[E]	[30]	[I]	++++..++++..++.+++++++.+.+++++++++2..+..+..
Nertera granadensis	[N]	[H]	[30]	[I]	32+3..34232+...++2.+...2++22.2..2+..22+.+...............................+....+.....2+...
Myrceugenia planipes	[E(Ch/Arg)]	[Mi P]	[28]	[I]	.2232.2+....232222+.22..+2...222.2222.222.................................+...
Aristotelia chilensis	[E(Ch/Arg)]	[Mi P]	[28]	[I]	2.+..................................r+...r.r.2+.++.+2........r.....+........+..2+2.......++....22...++r...+..+...+....
Acaena ovalifolia	[E(Ch/Arg)]	[H]	[28]	[I]	......r...r.............22.+.++...................22.232332332322....2....++...1.+.........................+..........+.
Sarmienta scandens	[E(Ch)]	[E]	[27]	[I]	++..+++++..++++++++++.+.......+.11++.++++..
Dichondra sericea	[E(Ch)]	[E]	[27]	[I]	....+....222333222.322..+2+22222+2+2...........22..
Juncus procerus	[N]	[H]	[26]	[I]	....434444444545554.....2+..++..............+.2+...+.+.22..
Vulpia bromoides	[a]	[T]	[25]	[I]	....22222...+2222.2+.2....244444..++.......2+....................................++
Uncinia phleoides	[N]	[H]	[24]	[I]	......++..++.+++.++++++++++.++.+++...+..+..
Luma apiculata	[E(Ch/Arg)]	[Mi P]	[24]	[I]	+.2+2+...2.....+......+...++.++++.22.+222...r..++...............r............
Blechnum chilense	[N]	[H]	[24]	[I]	..++++.......+..+....+.+..+.++..++2...+.+.....................................22...+.....+........+.+.++...........
Ulex europaeus	[i]	[N P]	[22]	[I]	.................................r......5555555555555555555...r..................................+.........................
Luzuriaga polyphylla	[E(Ch)]	[E]	[20]	[I]	+.+++.+.+.++.++...+..++...++.2.++..+....+..
Eryngium paniculatum	[N]	[H]	[20]	[I]	r..+2......5555455455445......................r...+.......1.1....
Hymenophyllum caudiculatum	[E(Ch/Arg)]	[E]	[20]	[I]	.++.+++++......+.....+......+.+..+++++++++...
Hymenophyllum sp.	[E(Ch/Arg)]	[E]	[19]	[I]	.++.++.....+.+.+.+..+......+.++.++.++++.+..
Gamochaeta americana	[N]	[H]	[19]	[I]	....+...............+.++.+.+2+.+.++.+++..2..+++.............................+................
Carex fuscula	[N]	[H]	[19]	[I]	.++...................................+.+.....................+...........+........+....+.+..++......++..+.........+..........++.....................................+.+
Ugni molinae	[E(Ch/Arg)]	[N P]	[19]	[I]	....2+rr...r....3.........r............................r...+.+...........+..................+....++........2+2.++
Baccharis racemosa	[E(Ch/Arg)]	[N P]	[19]	[I]	....+...........2......+.....22+.+.2.+...+...........+.+.....++..++.....+..+2....
Cissus striata	[E(Ch/Arg)]	[L]	[18]	[I]	...2.......++.....+.2+++++....++...+++...+...............+...............+.......
Gevuina avellana	[E(Ch/Arg)]	[Mi P]	[17]	[I]	......+.2..++.+..+.+..+...+222+.+2.+2...
Rumex acetosella	[a]	[H]	[17]	[I]	....+.......r..+.+.......2.....++..++.++..+.++.+.......................++.....................................
Aira caryophyllea	[a]	[T]	[16]	[I]	....+....+..2++...+2+2.2.......+...2..34...++
Cliococca selaginoides	[N]	[Ch]	[16]	[I]	....12..+.2222...........................2..++..++...+...........+2.......................................+....
Amomyrtus luma	[E(Ch/Arg)]	[Mes P]	[15]	[I]	.+2...2..........++...++2.2..+.+...+..2..+..........+...................................
Leptinella scariosa	[E(Ch/Arg)]	[H]	[15]	[I]	......................+...22+.2......+...........2...+.+.........++.+......2..+........................+..................
Oldenlandia salzmannii	[N]	[H]	[15]	[I]	....2.......+2....3..++..............................2.+..+.+2.+.......................................+++
Trifolium repens	[a]	[H]	[14]	[I]	....+.....+..........r..........++++.+.+..+..+++.........+...
Hymenoglossum cruentum	[E(Ch/Arg)]	[E]	[13]	[I]	.++.+...........++..+.......+..+.+++.++..
Rhamnus diffusus	[E(Ch)]	[N P]	[13]	[I]	......+++............+2...++.2+.+++r..
Anthoxanthum odoratum	[i]	[H]	[13]	[I]	....++..............2............++........2++.2.+2..........++..
Lotus subpinnatus	[E(Ch)]	[T]	[13]	[I]	....+.....................1+.........................+++..+.+...2.+...+.....++...
Galium hypocarpium	[N]	[Ch]	[13]	[I]	....++......2.+.+....+...+.............................++...................................+....++.+...........
Hypochaeris radicata	[a]	[H]	[12]	[I]	....+.2..............21...+........+..+.....++......2.......+...................+.....................................
Lophosoria quadripinnata	[N]	[H]	[12]	[I]	.....+..2......+2...++.....+....2..+...++..+..................................
Anthoxanthum utriculatum	[E(Ch/Arg)]	[H]	[12]	[I]	....2...................................54544444454.....................................
Ranunculus repens	[a]	[H]	[12]	[I]	....++.......................2...........+....+2+222.............................+.2..
Azara lanceolata	[E(Ch/Arg)]	[Mi P]	[11]	[I]	......++........++.+..............+r..........................r...+++..
Ovidia pillopillo	[E(Ch/Arg)]	[Mi P]	[10]	[I]	.........................+...r..........r........r.........................+.+......................+......+.....r..2.........
Blechnum hastatum	[E(Ch/Arg)]	[H]	[10]	[I]	+....................+...+.....................................+.......+........+........+++....+...........
Megalastrum spectabile	[E(Ch/Arg)]	[m]	[10]	[I]	......+++.++..........+..++..2..........+..
Hymenophyllum cuneatum	[E(Ch/Arg)]	[E]	[9]	[I]	...++..+....+..................+.++....++..
Rigodium brachypodium	[E(Ch)]	[m]	[9]	[I]	+...++.....++..+...+...2+
Cirsium vulgare	[nat]	[T]	[9]	[I]	....+++.+2.........................+.......+...............+...+..
Weymouthia mollis	[C]	[m]	[9]	[I]	.+...+........................+.++..++.++...
Hydrocotyle poeppigii	[E(Ch)]	[H]	[8]	[I]	..+...............+..+++.+...+.............+...
Dioscorea auriculata	[E(Ch)]	[G]	[8]	[I]	+.++..............+....+.++.............+...
Laureliopsis philippiana	[E(Ch/Arg)]	[Mes P]	[8]	[I]	..r..............2.2....+.+........2r....2..
Gaultheria mucronata	[E(Ch/Arg)]	[N P]	[8]	[I]	....+..................2.........1+.........................+..........................+..1+....
Polypogon chilensis	[N]	[H]	[9]	[I]	....+....+...........................+.......22.................................22........2...................................
Podocarpus nubigenus	[E(Ch/Arg)]	[Mi P]	[7]	[I]	........+..+..r..........r..+...2..+..
Juncus microcephalus	[N]	[H]	[7]	[I]	....2..2.2.................................+.+.21.......................................

Continue...

Relevé nr					1111111111111111111111111111111111111111111111111111111111111111111111
					1111111111222222222233333333334444444444555555555566666666667777777777888888888899999999990000000000111111111122222222223333333333444444444455555555556666666666
					1234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123456789
Species	**S.**	**Lf.**	**Fr.**	**F.C.**	
Raukaua valdiviensis	[E(Ch)]	[L]	[6]	[I]	......+.........++....+.........+.....+..
Plantago lanceolata	[a]	[H]	[6]	[I]	....++.++...+............................+..
Anemone hepaticifolia	[E(Ch)]	[T]	[6]	[I]	.....................+...2222....+...
Fascicularia bicolor	[E(Ch)]	[E]	[6]	[I]	+.+2+..............+....................+..
Fuchsia magellanica	[E(Ch/Arg)]	[N P]	[6]	[I]	....2..++.......+2...+........................
Lobelia bridgesii	[E(Ch)]	[Ch]	[6]	[I]	....++......+2..++.........................
Embothrium coccineum	[E(Ch/Arg)]	[Mi P]	[5]	[I]	..r......................................+....r...++...
Myrceugenia exsucca	[E(Ch/Arg)]	[Mi P]	[5]	[I]	......................22..............+...................................+..r...........................
Oxalis sp.	[N]	[T]	[4]	[I]	...................+..+...+...........+......................................
Acrisione denticulata	[E(Ch/Arg)]	[Mi P]	[4]	[I]	...................+...........................r...+..+..................................
Blechnum asperum	[E(Ch)]	[H]	[4]	[I]	.......+++........2..
Hydrangea serratifolia	[E(Ch/Arg)]	[L]	[4]	[I]	.+.....+...........+.................+...
Muehlenbeckia hastulata	[N]	[L]	[4]	[I]	...........+..................................++...+.............
Chevreulia sarmentosa	[N]	[H]	[4]	[I]	....+..+....................+..........................+..
Brachystele unilateralis	[N]	[G]	[4]	[I]	....+..........+...+.+
Libertia chilensis	[E(Ch/Arg)]	[H]	[4]	[I]	....2+..........+..r.....
Berberis darwinii	[E(Ch/Arg)]	[N P]	[4]	[I]	....+..2+2...
Buddleja globosa	[E(Ch/Arg)]	[Mi P]	[4]	[I]	....r...+...+..r.......................
Sophora microphylla	[N]	[N P]	[3]	[I]	..2.....................................2.......................................r..
Osmorhiza chilensis	[N]	[H]	[3]	[I]	...................+......+....+...
Myrceugenia chrysocarpa	[E(Ch/Arg)]	[Mi P]	[3]	[I]	3.+.....................................+..
Crinodendron hookerianum	[E(Ch)]	[N P]	[3]	[I]	........................+.+......+...
Gunnera tinctoria	[E(Ch)]	[H]	[3]	[I]	....+........+.............................2..
Persea lingue	[E(Ch/Arg)]	[Mi P]	[2]	[I]	...................+............r..
Saxegothaea conspicua	[E(Ch/Arg)]	[Mi P]	[2]	[I]	.........+....................+..
Hydrocotyle indecora	[E(Ch/Arg)]	[H]	[2]	[I]	.................++..
Rigodium implexum	[E(Ch)]	[m]	[2]	[I]	.....................................++..
Genista monspessulana	[a]	[N P]	[2]	[I]	....+....+..
Dactylis glomerata	[a]	[H]	[2]	[I]	....+.+...
Cuscuta chilensis	[N]	[T]	[2]	[I]	....++..
Paspalum dasypleurum	[E(Ch/Arg)]	[H]	[2]	[I]	....+2...
Digitalis purpurea	[a]	[T]	[2]	[I]	....++...
Blepharocalyx cruckshanksii	[E(Ch)]	[Mes P]	[1]	[I]	.....................+...
Griselinia jodinifolia	[E(Ch)]	[N P]	[1]	[I]	................+..
Asplenium sp.	[N]	[E]	[1]	[I]	................+..
Leptostigma arnottianum	[E(Ch/Arg)]	[G]	[1]	[I]	....+..
Paspalum distichum	[i]	[H]	[1]	[I]	....+..
Berberis microphylla	[E(Ch/Arg)]	[N P]	[1]	[I]	....+..
Rigodium pseudothuidium	[E(Ch/Arg)]	[m]	[1]	[I]	+..
Blechnum penna-marina	[C]	[H]	[1]	[I]	.........+...
Piptochaetium montevidense	[N]	[H]	[1]	[I]	....+...
Weinmannia trichosperma	[E(Ch/Arg)]	[Mes P]	[1]	[I]	.....+...
Nassella poeppigiana	[N]	[H]	[1]	[I]	....+..............
Modiola caroliniana	[a]	[H]	[1]	[I]	....+...
Trifolium pratense	[a]	[Ch]	[1]	[I]	....+...
Daucus carota	[a]	[T]	[1]	[I]	....+...
Alstroemeria aurea	[E(Ch)]	[G]	[1]	[I]	....+........
Calceolaria integrifolia	[N]	[T]	[1]	[I]	....+..
Tepualia stipularis	[E(Ch/Arg)]	[Mi P]	[1]	[I]	....r..
Cyperus sp.	[N]	[H]	[1]	[I]	....+...
Nothoscordum striatellum	[N]	[G]	[1]	[I]	....+...
Geranium core-core	[N]	[T]	[1]	[I]	....+...
Loasa sp.	[N]	[T]	[1]	[I]	....+......................................
Oxalis corniculata	[C]	[T]	[1]	[I]	....+...
Lomatia hirsuta	[N]	[Mi P]	[1]	[I]	....r.....
Gavilea odoratissima	[E(Ch/Arg)]	[G]	[1]	[I]	....+...
Gratiola peruviana	[N]	[Ch]	[1]	[I]	....2..
Baccharis sagittalis	[N]	[N P]	[1]	[I]	....2...
Corynabutilon vitifolium	[E(Ch)]	[N P]	[1]	[I]	....+...............................
Sisyrinchium chilense	[N]	[G]	[1]	[I]	....+...
Relchela panicoides	[E(Ch/Arg)]	[H]	[1]	[I]	....+..
Francoa appendiculata	[E(Ch)]	[H]	[1]	[I]	....+.............................
Baccharis concava	[N]	[N P]	[1]	[I]	....+..

Table D.3: Full phytosociological table. Species order in sintanxonomical affinity. Lf.: Lifeform (see Table 4.2); Fr.: Frequency; Group. Nr.: Group Number (see Table 6.2); D: Diagnostic and Dominant species. Information about the header data in Appendix E.

```
Group Nr.                                   |1                                        |2                  |3                 |4                  |5            |6              |7          |8  |9          |10|11          |12   |
Relevé Nr.                                  |                                         |1111111111111111111|111111111111111111|                   |             |               |11111111111|111|11111111111|11|1           |11111|
                                            |4 2323 13332 323 121  3 2211122 131 42311|3333333443444434344|565665655564555665|4454545445445555655|7667766667666|888888887777877|21122222212|666|00000010100|22|099999999998|11111|
                                            |13732478096092318789148241024565655609731|1658470282104533967|510548671429362309|2725044861395376098|2390126783145|432587616547098|29764071385|978|73846511029|89|048216957309|54362|
Species                           Lf.

1  Dm  Aextoxicon punctatum       [Mes P]   44544554544554445555554444554545444544444|r...r.+.........r..|.r................|...................|.............|.............+.|...........|...|...........|..|............|.....
   Dg  Lapageria rosea            [L]       222222+22222+222+222222222++2222+2+22222+|.+.+++..+..........|.+.......+........|...................|.............|...............|...........|...|...........|..|............|.....
2  Dm  Chusquea quila             [N P]     22++2+.2++..+2++...2.2+++2+.3+++.22+++++.|5555555555555555544|.+....1+..2.....+.|...............+...+|.............|.......2.......|...........|...|...........|..|............|.....
   Dg  Fuchsia magellanica        [N P]     .........................................|+........+2+.+.....|..................|...................|...........2.|...............|...........|...|...........|..|............|.....
3  Dm  Greigia sphacelata         [H]       22.++.++.+r.+r.+2+++......++2.+r+......r.|....r..............|555545555555555554|...................|.............|...............|...........|...|...........|..|............|.....
   Dg  Berberis darwinii          [N P]     .........................................|...................|...+2.2...........|...................|.............|...............|........+..|...|...........|..|............|.....
4  Dm  Ulex europaeus             [N P]     ............................r............|.......+...........|..................|5555555555555555555|.............|...............|...........|...|...r.......|..|............|.....
   Dg  Embothrium coccineum       [Mi P]    .r.......................................|...................|..................|+r+......+.........|.............|...............|...........|...|...........|..|............|.....
   Dg  Lobelia bridgesii          [Ch]      .........................................|...........+..+....|..................|..2..+...++........|.............|...............|...........|...|...........|..|............|.....
5      Eryngium paniculatum       [H]       ...................r.....................|...................|+..1..........1...|......2......+.....|4555455545554|...............|...........|...|...........|..|........r...|.....
6      Juncus procerus            [H]       .........................................|...................|..................|...................|.............|454545544344444|+.22+.2..+.|...|...........|..|.2+...++....|+....
7      Anthoxanthum utriculatum   [H]       .........................................|...................|..................|...................|.............|..2............|45554444444|...|...........|..|............|.....
8      CENTELLA
9      Acaena ovalifolia          [T]       ......r..................................|...................|............+.....|......r............|+.22.........|.........++....|+..1...+...|..+|33233223223|+.|2.2.....2...|...2.
10     Aira caryophyllea          [T]       .........................................|...................|..................|...................|.............|...............|.......+..2|+.+|2.+.+.2+.+2|34|2..+....+...|.....
11     Juncus imbricatus          [H]       .........................................|...................|..................|...................|.1..........+|2.2.+.+....2.++|..21.......|.r.|+2+.+.2+2..|+.|443344444242|.+...
12     Vulpia bromoides           [H]       .........................................|...................|..................|...................|.............|...............|.+...+.....|+.+|.2.+2.22...|2+|2.222.2.+222|44444
NOTHOFAGO-EUCRYPHION
       Luzuriaga radicans         [E]       ++++2+++2.+++++++++++2.++++...++++2++.+.|...................|..................|...................|.............|...............|...........|...|...........|..|............|.....
       Amomyrtus meli             [Mes P]   22322.2222222233332..222.3+3+.2..232222.3|...................|..................|...................|.............|...............|...........|...|...........|..|............|.....
       Eucryphia cordifolia       [Mes P]   2..22322.22.+32.+2222222.2+2+2.22.+22222.|.++..+......2......|..................|...................|.............|...............|...........|...|...........|..|............|.....
       Mitraria coccinea          [E]       +++++++++..+++.+++++++++++.+.+.+2...+.+.|...................|..................|...................|.............|...............|...........|...|...........|..|............|.....
       Hymenophyllum cuneatum     [E]       ...+.+...+.....++....+.........+....+..+.|...................|..................|...................|.............|...............|...........|...|...........|..|............|.....
       Megalastrum spectabile     [B]       ....+.+.....+...+..........+.++.....+2..+|...................|..................|...................|.............|...............|...........|...|...........|..|............|.....
       Lomatia ferruginea         [N P]     2++.+2+++++.+2+2++2+..+++.+..22...2.++++2|...................|...........r......|...................|.............|...............|...........|...|...........|..|............|.....
       Hymenophyllum sp.          [E]       ++.+.+.++++....+..+...++.+.++..++..+..+..|...................|..................|...................|.............|...............|...........|...|...........|..|............|.....
       Hymenoglossum cruentum     [E]       ++..++.+..+....+...+..++.......+....+.+..|...................|..................|...................|.............|...............|...........|...|...........|..|............|.....
       Sarmienta scandens         [E]       +..1.1++.++++.++++.++.++.+.++..++++++..+.|...................|..................|...................|.............|...............|...........|...|...........|..|............|.....
       Gevuina avellana           [Mi P]    ..++.2++2.++2.++..2........+......+..22+.|...................|..................|...................|.............|...............|...........|...|...........|..|............|.....
AEXTOXICONENION PUNCTATI
       Uncinia phleoides          [H]       ..+++++++..+.++.+..+....++.++++.+.+..+..+|.............+.....|..................|...................|.............|...............|...........|...|...........|..|....+.......|.....
       Rhamnus diffusus           [N P]     ..+++++.2.r.+.2++.+..............+.......|...................|..................|...................|.............|...............|...........|...|...........|..|............|.....
       Cissus striata             [L]       ..++2....+.+.++......2+.+...+++.......++.|......+.+..........|.+................|...................|.............|...............|...........|...|...........|..|............|.....
       Hydrocotyle poeppigii      [H]       ++..+......+.....++.....++...............|...................|..................|...................|.............|...............|...........|...|...........|..|............|.....
       Hydrangea serratifolia     [L]       ..........+....+.....++..................|...................|..................|...................|.............|...............|...........|...|...........|..|............|.....
       Raukaua valdiviensis       [L]       ...+..++.+....+..+.......................|...................|..................|...................|.............|...............|...........|...|...........|..|............|.....
       Fascicularia bicolor       [E]       ++.........+.........+2.........+........|...................|..................|...................|.............|...............|...........|...|...........|..|............|.....
LAURELITALIA
       Nertera granadensis        [H]       ++22.+322+.+2...4+2.33222.3+.++.+.....2.2|...................|..................|...................|.............|...2..+...+..+.|...........|...|...........|..|............|.....
       Myrceugenia planipes       [Mi P]    22..2222222..2.2+2.+.3.2.2..3+22222.2.22.|...................|..................|...................|.............|..............+|...........|...|...........|..|............|.....
       Rhaphithamnus spinosus     [N P]     22+.+++2+.+++++..+++22+++++++++.+.+.....+|....+..............|.+......+.....+...|...................|.............|...............|...........|...|...........|..|............|.....
       Drimys winteri             [Mi P]    222.22+22...32222+2+.2...223+22.+.22.2..2|.+..r........2.....|..................|...................|.............|...............|...........|...|...........|..|............|.....
       Hymenophyllum caudiculatum [E]       ++.+.++.+++.+...+.+...++.+.....+++.++.+..|...................|..................|...................|.............|...............|...........|...|...........|..|............|.....
       Luzuriaga polyphylla       [E]       +++++.+.2.+.+++...++++.....++..+..+.....+|...................|..................|...................|.............|...............|...........|...|...........|..|............|.....
       Amomyrtus luma             [Mes P]   .22...2++2+..++....+...++....2...........|..+................|..................|...................|.............|...............|........+..|...|...........|..|............|.....
       Luma apiculata             [Mi P]    22++....+22..+++..+.+++...2....2+2.+2....|.+...+.............|............r.....|...................|.............|...r...........|...........|...|...........|..|............|.....
       Laureliopsis philippiana   [Mes P]   2r+....2..r2................+...2........|...................|..................|...................|.............|...............|...........|...|...........|..|............|.....
       Lophosoria quadripinnata   [H]       ...2+.......2....2+......+.......++.+.....|..+++..............|..................|...................|.............|...............|...........|...|...........|..|............|.....
       Blechnum asperum           [H]       ............+...+..2......+..............|...................|..................|...................|.............|...............|...........|...|...........|..|............|.....
       Myrceugenia chrysocarpa    [Mi P]    ++..................3....................|...................|..................|...................|.............|...............|...........|...|...........|..|............|.....
       Weymouthia mollis          [B]       ...+....+++..+..........+...........++.+..|...................|..................|...................|.............|...............|...........|...|...........|..|............|.....
       Anemone hepaticifolia      [T]       ..2.++............2...........2......2...|...................|..................|...................|.............|...............|...........|...|...........|..|............|.....
ARISTOLIETALIA CHILENSIS
       Rubus constrictus          [N P]     .........................................|+.....2+++++++.++..|++.22+1++.+.+..2++|+22222222222++++.+.|.r+r+222.22..|...++++2....+++|2.......+..|...|...........|..|............|.....
       Aristotelia chilensis      [Mi P]    r+................2......................|+.....2..2++.....22|.+.+.+..+...r.+...|+...2.+rr+...+2+...|+.....r......|.........+.....|...........|...|...........|..|............|.....
       Baccharis racemosa         [N P]     .........................................|......++....+......|+++2+...++........|+............2..+..|2..+..22+....|...........+...|...........|...|...........|..|............|.....
WINTERO-NOTHOFAGETEA
       Dioscorea auriculata       [G]       +++................+++..+.....+..........|...................|..................|...................|.............|...............|...........|...|...........|..|............|.....
       Boquila trifoliolata       [L]       ...++++.+.+..+++....+...+++..+.........++|.+++.+........+....|.++.....+.2...+...|.+.++......+.......|.............|...............|...........|...|...........|..|............|.....
       Blechnum chilense          [H]       ++++++..++.......+...+..+...+..+.2.+.+...|...+........+......|+....+.+....+.....|...................|.............|..2....2.......|...........|...|...........|..|............|.....
       Azara lanceolata           [Mi P]    ......++..r+....++...............+.......|.++..+.............|..................|................r..|.............|...............|...........|...|...........|..|............|.....
       Blechnum hastatum          [H]       ..........+........+.....................|+..+....+..........|+.+........+......|...................|.........+...|...............|........+..|...|...........|..|............|.....
```

Group Nr.		1	2	3	4	5	6	7	8	9	10	11	12
Libertion chilensis													
Cliococca selaginoides	[Ch]	....	....	...+..............	....	21222..+...2.	....	...2......+	...	++++.......	..	2...........	..+..
Libertia chilensis	[H]	....	....	....r.............	....	.....+...+2..	....	....	...	....	..	....	.....
Galium hypocarpium	[Ch]	....	....	+.+..+.......+....	....	..2.++...++..	..+...........+	.+...+.....	...	....	..	....	.....
Juncion proceri													
Oldenlandia salzmannii	[H]	....	....	....	....	........2....	..3+..+.+..2...	.+2.+.++..2	+++	....	..	....	.....
Ranunculus repens	[H]	....	....	....	.....+....+........	......2......	2+.+222.......+	+..2.......	...	....	..	....	.....
Juncus microcephalus	[H]	....	....	....	....	....	.2..2.2........	+..2+.1....	...	....	..	....	.....
Polypogon chilensis	[H]	....	....	....	++.................	....	.22.......+....	..2...2..2.	...	....	..	....	.....
Agrostidion chilensis													
Dichondra sericea	[H]	....	....	....	....	....	...+...........	....	...	+.2.2+22222	22	332222.3232.	+2+22
Gamochaeta americana	[H]	....	....	..+...............	....	+............	....	....	...	+++++.2+...	..	..2+..+++++.	++.+.
Lotus subpinnatus	[T]	....	....	....	.+.................	..1+.........	....	+......+...	...	.+...++...2	..	+.+..+.....+	+....
Carex fuscula	[H]	++.......+.............+.................	....	....	....	.+...........	+.......+......	..+........	++.	++......+..	++	.+..+..+...+	+....
Rigodium brachypodium	[B]	....................+....................	....	....	....	....	....	....	+.2	+...+...+..	..	+.....+.....	.+...
Agrostietalia capillari													
Agrostis capillaris	[H]	....	....	+....+.........2..	....	2222222222212	+..+22+.22+2+..	+2+2.2.++2	333	24243443444	22	322222222223	22222
Centella asiatica **Dg 8**	[H]	....	....	..+..+............	...2....+..........	2+222++22++++	2232+2+22222322	3222222+222	344	+2+2++.....	..	2...........	3....
Centaurium cachanlahuen	[T]	....	....	..+...............	...+...............	.+22+..+....1	........+..++..	+++2.+..+.+	.++	++++..+.+22	++	+..++.+.+.+.	2++++
Lotus pedunculatus	[H]	....	..........+........	++....+.....+.....	+....++.....+......	+++++.+++..++	++.+++.........	+22+++..+23	22+	+.++.+.....	+.	.....++.....	..+..
Anthoxanthum odoratum	[H]	....	....	....	....	.....+...+...	2	....+.+....	...	++2..2.2.+.	..	...++.......	.....
Trifolium repens	[H]	....	....	....	....	+.....+......	..r............	........+..	...	+++.......+	..	+++..+.+.+..	.....
Molinio-Arrhenatheretea													
Holcus lanatus	[H]	....	....	..+....+..........	++.++...+..+.......	+...+2.+++...	2.2+.2+.22.+++2	2+.22+2+...	+2+	+.++232.2.2	..	.+.+++++.++.	..+.+
Leontodon saxatilis	[H]	....	....	..+.....+.........	..+................	.+2+..2+.....	.........3332+2	222.2+.+...	23.	232222.2.+.	++	323222.222++	2.222
Prunella vulgaris	[Ch]	....	+..................	+.+1...+.+........	...+...............	1+++r..++....	.....+..2+++.+.	+++++++++..	.+.	++++.+++++.	+.	++++++++++..	.....
Cirsium vulgare	[T]	....	....	....	...+.+.++..2.......	....	.......+.+.....	....	...	....	..	.++.........	.....
Rumex acetosella	[H]	....	....	....	....	.+..r........	2.......+.+....	....	...	.+.++..+...	++	.++.+..++.+.	.....
Leptinella scariosa	[H]	........................+................	....	.........+........	....	....	.....+..2..22.+	..+.2.+....	...	.+...+.....	..	......2.....	++...
Hypochaeris radicata	[H]	....	....	....	..+...2............	..21.........	.+....+...+....	....	...	..+........	+.	2..+.....+..	.....
Companions													
Podocarpus nubigenus	[Mes P]	..+..+......+..2........r..+......r......	....	....	....	....	....	....	...	....	..	....	.....
Sophora microphylla	[N P]	22.......................................	....	....	....	....	.......r.......	....	...	....	..	....	.....
Osmorhiza chilensis	[H]	..+........+.+...........................	....	....	....	....	....	....	...	....	..	....	.....
Crinodendron hookerianum	[N P]	..+..+.......................+...........	....	....	....	....	....	....	...	....	..	....	.....
Hydrocotyle indecora	[H]	.......+...........+.....................	....	....	....	....	....	....	...	....	..	....	.....
Persea lingue	[Mi P]	...r.......+.............................	....	....	....	....	....	....	...	....	..	....	.....
Saxegothaea conspicua	[Mi P]	...............+..........+..............	....	....	....	....	....	....	...	....	..	....	.....
Rigodium implexum	[B]	.........+............+..................	....	....	....	....	....	....	...	....	..	....	.....
Acrisione denticulata	[Mi P]	...........+.............................	..+.....+..........	....	.......r...........	....	....	....	...	....	..	....	.....
Myrceugenia exsucca	[Mi P]	.........+....2.........2................	.......r...........	....	....	....	.........+.....	....	...	....	..	....	.....
Oxalis sp.	[T]	...........+.............................	+..................	....	....	....	....	.+.........	...	....	..	....	+....
Genista monspessulana	[N P]	....	....	....	....	+............	...........+...	....	...	....	..	....	.....
Ovidia pillopillo	[Mi P]	..+......................................	.......+...........	r..........+.....2	....	.....r...r...	..r............	.+.....+...	...	....	..	....	.....
Gaultheria mucronata	[N P]	....	....	...+1.............	+..................	1....2...+...	....	....	...	....	+.	+...........	.....
Muehlenbeckia hastulata	[L]	...........................+.............	....	.............+....	.+.....+...........	....	....	....	...	....	..	....	.....
Ugni molinae	[N P]	....	....	+..+2.2..+.+......	....	3r...+..r.2r.	..r............	....	+.+	........r..	+.	....	.+.+.
Plantago lanceolata	[H]	....	....	....	....	....	....	....	...	....	.+	+..+.+.+.+..	.....
Brachystele unilateralis	[G]	....	....	....	....	....	....	....	++.	...+.......	..	....	+....
Chevreulia sarmentosa	[H]	....	....	....	..+.........+......	....	........+......	....	...	.+.........	..	....	.....
Buddleja globosa	[Mi P]	....	...............+.r.	....	.r..+..............	....	....	....	...	....	..	....	.....
Gunnera tinctoria	[H]	....	....	....	+...+..............	....	.......2.......	....	...	....	..	....	.....
Dactylis glomerata	[H]	....	....	....	....	....	....	....	...	....	..	.+...+......	.....
Digitalis purpurea	[T]	....	....	....	.....+....+........	....	....	....	...	....	..	....	.....
Paspalum dasypleurum	[H]	....	....	....	....	....	.......2+......	....	...	....	..	....	.....
Cuscuta chilensis	[H]	....	....	....	....	....	....	....	...	....	..	....	++...

Single ocurrence

sp.[Relevé Nr.|Cover|Lf.]

Rigodium pseudothuidium [1|+|B]; *Weinmannia trichosperma* [6|+|Mes P]; *Blechnum penna-marina* [10|+|H]; *Asplenium sp.* [17|+|E]; *Griselinia jodinifolia* [17|+|N P];*Blepharocalyx cruckshanksii* [22|+|Mes P]; *Gavilea odoratissima* [52|+|G]; *Baccharis concava* [55|+|N P]; *Geranium core-core* [68|+|T]; *Calceolaria integrifolia* [71|+|T]; *Cyperus sp.*[74|+|H]; *Oxalis corniculata* [80|+|T]; *Gratiola peruviana* [83|+|Ch]; *Tepualia stipularis* [85|r|Mi P]; *Relchela panicoides* [89|+|H]; *Modiola caroliniana* [94|+|H]; *Daucus carota* [96|+|T]; *Trifolium pratense* [96|+|Ch]; *Berberis microphylla* [107|+|N P]; *Leptostigma arnottianum* [107|+|G]; *Paspalum distichum* [107|+|H]; *Sisyrinchium chilense* [112|+|G]; *Baccharis sagittalis* [118|2|N P]; *Nothoscordum striatellum* [120|+|G]; *Piptochaetium montevidense* [128|+|H]; *Loasa sp.* [131|+|T]; *Corynabutilon vitifolium* [138|+ |N P]; *Francoa appendiculata* [140|+|H]; *Nassella poeppigiana* [155|+|H]; *Alstroemeria aurea* [161|+|G]; *Lomatia hirsuta* [164|r|Mi P].

Table D.4: Synoptic table with frequency classes and cover range. Lf.: Lifeform (see Table 4.2); Fr.: Frequency; Group. Nr.: Group Number (see Table 6.2). Information about the header data in Appendix E.

Group Nr.			**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Nr. of relevés			41	19	18	19	13	15	11	3	11	2	12	5
Dominant species	**Lf.**	**Fr.**												
1 *Aextoxicon punctatum*	[Mes P]	[47]	V$^{4-5}$	II^{r-+}	I^{r}	.	.	V^{+}	.	.	.	.	.	.
2 *Chusquea quila*	[N P]	[58]	IV^{+-3}	V$^{4-5}$	II^{+-2}	I^{+}	.	I^{2}	.	.	.	.	.	.
3 *Greigia sphacelata*	[H]	[41]	III^{+-2}	I^{+}	V$^{4-5}$	.	.	.	.	.	.	.	.	.
4 *Ulex europaeus*	[N P]	[22]	I^{+}	I^{+}	.	V^{5}	.	.	.	.	I^{+}	.	.	.
5 *Eryngium paniculatum*	[H]	[20]	I^{+}	.	I^{+-1}	I^{+-2}	V$^{4-5}$	.	.	.	.	.	I^{+}	.
6 *Juncus procerus*	[H]	[26]	.	.	.	.	.	V$^{3-5}$	III^{+-2}	.	.	.	II^{+-2}	1^{+}
7 *Anthoxanthum utriculatum*	[H]	[12]	.	.	.	.	.	I^{2}	V$^{4-5}$	.	.	.	.	.
8 *Centella asiatica*	[H]	[54]	.	.	I^{+}	I^{+-2}	V^{+-2}	V^{+-3}	V^{+-3}	5$^{3-4}$	III^{+-2}	.	I^{2}	1^{3}
9 *Acaena ovalifolia*	[T]	[28]	I^{r}	.	I^{+}	I^{+}	II^{+-2}	I^{+}	II^{+-1}	2^{+}	V$^{2-3}$	3^{+}	II^{2}	1^{2}
10 *Aira caryophyllea*	[T]	[16]	.	.	.	.	.	.	I^{+-2}	4^{+}	IV^{+-2}	5$^{3-4}$	II^{+-2}	.
11 *Juncus imbricatus*	[H]	[33]	.	.	.	.	I^{+-1}	III^{+-2}	I$^{1-2}$	2^{+}	IV^{+-2}	3^{+}	V$^{2-4}$	1^{+}
12 *Vulpia bromoides*	[H]	[25]	.	.	.	.	.	.	I^{+}	4^{+}	III^{+-2}	5^{+-2}	IV^{+-2}	5^{4}
Nothofago-Eucryphion														
Luzuriaga radicans	[E]	[34]	V^{+-2}	.	.	.	.	.	.	.	.	.	.	.
Amomyrtus meli	[Mes P]	[33]	IV^{+-3}	.	.	.	.	.	.	.	.	.	.	.
Eucryphia cordifolia	[Mes P]	[36]	IV^{+-3}	II^{+-2}	.	.	.	.	.	.	.	.	.	.
Mitraria coccinea	[E]	[30]	IV^{+-2}	.	.	.	.	.	.	.	.	.	.	.
Sarmienta scandens	[E]	[27]	IV^{+-1}	.	.	.	.	.	.	.	.	.	.	.
Lomatia ferruginea	[N P]	[31]	IV^{+-2}	.	I^{+}	.	.	.	.	.	.	.	.	.
Gevuina avellana	[Mi P]	[17]	III^{+-2}	.	.	.	.	.	.	.	.	.	.	.
Hymenophyllum sp.	[E]	[19]	III^{+}	.	.	.	.	.	.	.	.	.	.	.
Megalastrum spectabile	[B]	[10]	II^{+-2}	.	.	.	.	.	.	.	.	.	.	.
Hymenophyllum cuneatum	[E]	[9]	II^{+}	.	.	.	.	.	.	.	.	.	.	.
Hymenoglossum cruentum	[E]	[13]	II^{+}	.	.	.	.	.	.	.	.	.	.	.
Aextoxiconenion punctati														
Lapageria rosea	[L]	[48]	V^{+-2}	II^{+}	I^{+}	.	.	.	.	.	.	.	.	.
Uncinia phleoides	[H]	[24]	III^{+}	I^{+}	.	.	.	.	.	.	.	.	I^{+}	.
Rhamnus diffusus	[N P]	[13]	II^{+-2}	.	.	.	.	.	.	.	.	.	.	.
Cissus striata	[L]	[18]	II^{+-2}	I^{+}	I^{+}	.	.	.	.	.	.	.	.	.
Hydrocotyle poeppigii	[H]	[8]	I^{+}	.	.	.	.	.	.	.	.	.	.	.
Hydrangea serratifolia	[L]	[4]	I^{+}	.	.	.	.	.	.	.	.	.	.	.
Raukaua valdiviensis	[L]	[6]	I^{+}	.	.	.	.	.	.	.	.	.	.	.
Fascicularia bicolor	[E]	[6]	I^{+-2}	.	.	.	.	.	.	.	.	.	.	.
Laurelitalia														
Nertera granadensis	[H]	[30]	IV^{+-4}	.	.	.	.	II^{+-2}	.	.	.	.	.	.
Myrceugenia planipes	[Mi P]	[28]	IV^{+-3}	.	.	.	.	I^{+}	.	.	.	.	.	.
Rhaphithamnus spinosus	[N P]	[34]	IV^{+-2}	I^{+}	I^{+}	.	.	.	.	.	.	.	.	.
Drimys winteri	[Mi P]	[31]	IV^{+-3}	I^{+-2}	.	.	.	.	.	.	.	.	.	.
Hymenophyllum caudiculatum	[E]	[20]	III^{+}	.	.	.	.	.	.	.	.	.	.	.
Luzuriaga polyphylla	[E]	[20]	III^{+-2}	.	.	.	.	.	.	.	.	.	.	.
Luma apiculata	[Mi P]	[24]	III^{+-2}	I^{+}	I^{+}	.	.	I^{+}	.	.	.	.	.	.
Amomyrtus luma	[Mes P]	[15]	II^{+-2}	I^{+}	.	.	.	.	I^{+}	.	.	.	.	.
Lophosoria quadripinnata	[H]	[12]	II^{+-2}	I^{+}	.	.	.	.	.	.	.	.	.	.
Laureliopsis philippiana	[Mes P]	[8]	I^{+-2}	.	.	.	.	.	.	.	.	.	.	.
Blechnum asperum	[H]	[4]	I^{+-2}	.	.	.	.	.	.	.	.	.	.	.
Myrceugenia chrysocarpa	[Mi P]	[3]	I^{+-3}	.	.	.	.	.	.	.	.	.	.	.
Anemone hepaticifolia	[T]	[6]	I^{+-2}	.	.	.	.	.	.	.	.	.	.	.
Berberidion buxifoliae														
Fuchsia magellanica	[N P]	[6]	.	II^{+-2}	.	.	I^{2}	.	.	.	.	.	.	.
Ovidia pillopillo	[Mi P]	[10]	I^{+}	I^{+}	I^{+-2}	.	I^{+}	I^{+}	I^{+}	.	.	.	.	.
Berberis darwinii	[N P]	[4]	.	.	I^{+-2}	.	.	.	I^{+}	.	.	.	.	.
Muehlenbeckia hastulata	[L]	[4]	I^{+}	.	I^{+}	I^{+}	.	.	.	.	.	.	.	.
Gaultherion phyllyreaefoliae														
Lobelia bridgesii	[Ch]	[6]	.	I^{+}	.	II^{+-2}	.	.	.	.	.	.	.	.
Embothrium coccineum	[Mi P]	[5]	I^{+}	.	.	II^{r-+}	.	.	.	.	.	.	.	.
Gaultheria mucronata	[N P]	[8]	.	.	I^{+-1}	I^{+}	II^{+-2}	.	.	.	.	3^{+}	I^{+}	.
Aristolietalia chilensis														
Rubus constrictus	[N P]	[60]	.	III^{+-2}	IV^{+-2}	IV^{+-2}	V^{+-2}	III^{+-2}	I^{+-2}	.	.	.	.	.
Aristotelia chilensis	[Mi P]	[28]	I^{+-2}	II^{+-2}	II^{+-+}	III^{+-2}	I^{+-+}	I^{+}	.	.	.	.	.	.
Baccharis racemosa	[N P]	[19]	.	I^{+}	II^{+-2}	I^{+-2}	II^{+-2}	I^{+}	.	.	.	.	.	.
Wintero-Nothofagetea														
Boquila trifoliolata	[L]	[30]	II^{+}	II^{+}	II^{+-2}	II^{+}	.	.	.	.	.	.	.	.
Blechnum chilense	[H]	[24]	II^{+-2}	I^{+}	II^{+}	.	.	I^{2}	.	.	.	.	.	.
Azara lanceolata	[Mi P]	[11]	I^{+-+}	I^{+}	.	I^{+}	.	.	.	.	.	.	.	.
Blechnum hastatum	[H]	[10]	I^{+}	I^{+}	I^{+}	.	I^{+}	.	I^{+}	.	.	.	.	.
Libertion chilensis														
Cliococca selaginoides	[Ch]	[16]	.	.	I^{+}	.	III^{+-2}	.	I^{+-2}	.	II^{+}	.	I^{2}	1^{+}
Libertia chilensis	[H]	[4]	.	.	I^{+}	.	II^{+-2}	.	.	.	.	.	.	.
Galium hypocarpium	[Ch]	[13]	.	.	II^{+}	.	II^{+-2}	I^{+}	I^{+}	.	.	.	.	.
Juncion proceri														
Oldenlandia salzmannii	[H]	[15]	.	.	.	.	I^{2}	II^{+-3}	III^{+-2}	5^{+}	.	.	.	.
Ranunculus repens	[H]	[12]	.	.	.	I^{+}	I^{2}	III^{+-2}	I^{+-2}	.	.	.	.	.
Juncus microcephalus	[H]	[7]	.	.	.	.	.	II^{2}	II^{+-2}	.	.	.	.	.
Polypogon chilensis	[H]	[8]	.	.	.	I^{+}	.	I^{+-2}	II^{2}	.	.	.	.	.
Agrostidion chilensis														
Dichondra sericea	[H]	[27]	.	.	.	.	.	I^{+}	.	.	V^{+-2}	5^{2}	V$^{2-3}$	5^{+-2}
Gamochaeta americana	[H]	[19]	.	.	I^{+}	.	I^{+}	.	.	.	IV^{+-2}	.	III^{+-2}	3^{+}
Carex fuscula	[H]	[19]	I^{+}	.	.	.	I^{+}	I^{+}	I^{+}	4^{+}	II^{+}	5^{+}	II^{+}	.
Lotus subpinnatus	[T]	[13]	.	.	.	I^{+}	I^{+-1}	.	I^{+}	.	II^{+-2}	.	I^{+}	1^{+}
Agrostietalia capillari														
Agrostis capillaris	[H]	[68]	.	.	I^{+-2}	.	V$^{1-2}$	IV^{+-2}	V^{+-2}	5^{3}	V$^{2-4}$	5^{2}	V$^{2-3}$	5^{2}
Centaurium cachanlahuen	[T]	[41]	.	.	I^{+}	I^{+}	III^{+-2}	I^{+}	IV^{+-2}	4^{+}	IV^{+-2}	5^{+}	III^{+}	5^{+-2}
Lotus pedunculatus	[H]	[45]	.	I^{+}	II^{+}	II^{+}	IV^{+}	II^{+}	V^{+-3}	5^{+-2}	II^{+}	3^{+}	I^{+}	1^{+}
Anthoxanthum odoratum	[H]	[13]	.	.	.	.	I^{+}	I^{2}	I^{+}	.	III^{+-2}	.	I^{+}	.
Trifolium repens	[H]	[14]	.	.	.	.	I^{+}	I^{+}	I^{+}	.	II^{+}	.	III^{+}	.
Molinio-Arrhenatheretea														
Holcus lanatus	[H]	[53]	.	.	I^{+}	II^{+}	III^{+-2}	IV^{+-2}	IV^{+-2}	5^{+-2}	IV^{+-3}	.	IV^{+}	1^{+}
Leontodon saxatilis	[H]	[48]	.	.	I^{+}	I^{+}	II^{+-2}	III^{+-3}	III^{+-2}	4$^{2-3}$	IV^{+-3}	5^{+}	V^{+-3}	4^{2}
Prunella vulgaris	[Ch]	[50]	.	I^{+}	II^{+-1}	I^{+}	III^{+-1}	II^{+-2}	V^{+}	2^{+}	V^{+}	3^{+}	V^{+}	.
Rumex acetosella	[H]	[17]	.	.	.	.	I^{+-+}	I^{+-2}	.	.	II^{+}	5^{+}	III^{+}	.
Leptinella scariosa	[H]	[15]	I^{+}	.	I^{+}	.	.	II^{+-2}	II^{+-2}	.	I^{+}	.	I^{2}	2^{+}
Hypochaeris radicata	[H]	[12]	.	.	.	I^{+-2}	I$^{1-2}$	I^{+}	.	.	I^{+}	3^{+}	II^{+-2}	.
Companions														
Weymouthia mollis	[B]	[9]	II^{+}	.	.	.	.	.	.	.	.	.	.	.
Podocarpus nubigenus	[Mes P]	[7]	I^{+-2}	.	.	.	.	.	.	.	.	.	.	.
Crinodendron hookerianum	[N P]	[3]	I^{+}	.	.	.	.	.	.	.	.	.	.	.
Osmorhiza chilensis	[H]	[3]	I^{+}	.	.	.	.	.	.	.	.	.	.	.
Saxegothaea conspicua	[Mi P]	[2]	I^{+}	.	.	.	.	.	.	.	.	.	.	.
Dioscorea auriculata	[G]	[8]	I^{+}	.	.	.	.	.	.	.	.	.	.	.
Rigodium implexum	[B]	[2]	I^{+}	.	.	.	.	.	.	.	.	.	.	.
Persea lingue	[Mi P]	[2]	I^{r-+}	.	.	.	.	.	.	.	.	.	.	.
Hydrocotyle indecora	[H]	[2]	I^{+}	.	.	.	.	.	.	.	.	.	.	.
Sophora microphylla	[N P]	[3]	I^{2}	.	.	.	.	I^{+}	.	.	.	.	.	.
Rigodium brachypodium	[B]	[9]	I^{+}	.	.	.	.	.	.	4^{+-2}	II^{+}	.	I^{+}	1^{+}
Myrceugenia exsucca	[Mi P]	[5]	I^{+-2}	I^{+}	.	.	.	I^{+}	.	.	.	.	.	.
Ugni molinae	[H]	[19]	.	.	II^{+-2}	.	III^{+-3}	I^{+}	.	4^{+}	I^{+}	3^{+}	.	2^{+}
Cirsium vulgare	[T]	[9]	.	.	.	II^{+-2}	.	I^{+}	.	.	.	.	I^{+}	.
Plantago lanceolata	[H]	[6]	.	.	.	.	.	.	.	.	.	3^{+}	III^{+}	.
Oxalis sp.	[T]	[4]	I^{+}	I^{+}	.	.	.	.	I^{+}	.	.	.	.	1^{+}
Acrisione denticulata	[Mi P]	[4]	I^{+}	I^{+}	.	I^{+}	.	.	.	.	.	.	.	.
Chevreulia sarmentosa	[H]	[4]	.	.	.	I^{+}	.	I^{+}	.	.	I^{+}	.	.	.
Brachystele unilateralis	[G]	[4]	.	.	.	.	.	.	.	4^{+}	I^{+}	.	.	1^{+}
Buddleja globosa	[Mi P]	[4]	.	I^{+-+}	.	I^{+-+}	.	.	.	.	.	.	.	.
Gunnera tinctoria	[H]	[3]	.	.	.	I^{+}	.	I^{2}	.	.	.	.	.	.
Digitalis purpurea	[T]	[2]	.	.	.	I^{+}	.	.	.	.	.	.	.	.
Paspalum dasypleurum	[H]	[2]	.	.	.	.	.	I^{+-2}	.	.	.	.	.	.
Genista monspessulana	[N P]	[2]	.	.	.	.	I^{+}	I^{+}	.	.	.	.	.	.
Dactylis glomerata	[H]	[2]	.	.	.	.	.	.	.	.	.	.	I^{+}	.
Cuscuta chilensis	[H]	[2]	.	.	.	.	.	.	.	.	.	.	.	2^{+}
Single occurrence														
Blechnum penna-marina	[H]	[1]	I^{+}	.	.	.	.	.	.	.	.	.	.	.
Griselinia jodinifolia	[N P]	[1]	I^{+}	.	.	.	.	.	.	.	.	.	.	.
Blepharocalyx cruckshanksii	[Mes P]	[1]	I^{+}	.	.	.	.	.	.	.	.	.	.	.
Rigodium pseudothuidium	[B]	[1]	I^{+}	.	.	.	.	.	.	.	.	.	.	.
Asplenium sp.	[E]	[1]	I^{+}	.	.	.	.	.	.	.	.	.	.	.
Weinmannia trichosperma	[Mes P]	[1]	I^{+}	.	.	.	.	.	.	.	.	.	.	.
Francoa appendiculata	[H]	[1]	.	I^{+}	.	.	.	.	.	.	.	.	.	.
Corynabutilon vitifolium	[N P]	[1]	.	I^{+}	.	.	.	.	.	.	.	.	.	.
Loasa sp.	[T]	[1]	.	I^{+}	.	.	.	.	.	.	.	.	.	.
Nassella poeppigiana	[H]	[1]	.	.	I^{+}	.	.	.	.	.	.	.	.	.
Alstroemeria aurea	[G]	[1]	.	.	I^{+}	.	.	.	.	.	.	.	.	.
Lomatia hirsuta	[Mi P]	[1]	.	.	I^{r}	.	.	.	.	.	.	.	.	.
Baccharis concava	[N P]	[1]	.	.	.	I^{+}	.	.	.	.	.	.	.	.
Gavilea odoratissima	[G]	[1]	.	.	.	I^{+}	.	.	.	.	.	.	.	.
Geranium core-core	[T]	[1]	.	.	.	.	I^{+}	.	.	.	.	.	.	.
Calceolaria integrifolia	[T]	[1]	.	.	.	.	I^{+}	.	.	.	.	.	.	.
Gratiola peruviana	[Ch]	[1]	.	.	.	.	.	I^{2}	.	.	.	.	.	.
Oxalis corniculata	[T]	[1]	.	.	.	.	.	I^{+}	.	.	.	.	.	.
Cyperus sp.	[H]	[1]	.	.	.	.	.	I^{+}	.	.	.	.	.	.
Tepualia stipularis	[Mi P]	[1]	.	.	.	.	.	I^{r}	.	.	.	.	.	.
Baccharis sagittalis	[N P]	[1]	.	.	.	.	.	.	I^{2}	.	.	.	.	.
Nothoscordum striatellum	[G]	[1]	.	.	.	.	.	.	I^{+}	.	.	.	.	.
Paspalum distichum	[H]	[1]	.	.	.	.	.	.	.	.	I^{+}	.	.	.
Berberis microphylla	[N P]	[1]	.	.	.	.	.	.	.	.	I^{+}	.	.	.
Leptostigma arnottianum	[G]	[1]	.	.	.	.	.	.	.	.	I^{+}	.	.	.
Piptochaetium montevidense	[H]	[1]	.	.	.	.	.	.	.	.	.	3^{+}	.	.
Trifolium pratense	[Ch]	[1]	.	.	.	.	.	.	.	.	.	.	I^{+}	.
Relchela panicoides	[H]	[1]	.	.	.	.	.	.	.	.	.	.	I^{+}	.
Modiola caroliniana	[H]	[1]	.	.	.	.	.	.	.	.	.	.	I^{+}	.
Daucus carota	[T]	[1]	.	.	.	.	.	.	.	.	.	.	I^{+}	.
Sisyrinchium chilense	[G]	[1]	.	.	.	.	.	.	.	.	.	.	.	1^{+}

Appendix E

Header data

This appendix reports the header data for each relevé considered for the present search. The following entries in the table are defined as follows:

- Date: relevé colletion date;
- UTM, mS and mE: relevé's geographic coordinates according to the Universal Transverse Mercator scale;
- Aspect: relevé's orientation.

Relevé number	Country Code	Date [D. M. Y]	Locality	UTM	m E	m S	Altitude [m a.s.l]	Aspect	Slope [°]	Relevé area [m^2]	Total cover [%]	Tree cover layer [%]	Shrubs cover layer [%]	Herbs cover layer [%]	Vegetation hight [m]
1	CL	02.03.13	Lagunas Gemelas	18 G	615034	5563420	35	SO	30	350	100	90	10		25
2	CL	07.03.13	Lagunas Gemelas	18 G	615238	5563515	66	NO	10	300	100	85	40	5	20
3	CL	03.02.13	Lagunas Gemelas	18 G	615054	5563353	35	SO	5	350	100	90	15		20
4	CL	03.02.13	Lagunas Gemelas	18 G	615158	5563328	45	SO	5	350	100	80	15		25
5	CL	02.03.13	Lagunas Gemelas	18 G	615208	5563419	48	SO	5	350	100	95	20		25
6	CL	02.04.13	Lagunas Gemelas	18 G	615127	5563401	46	NO	10	350	100	90	15		25
7	CL	12.01.12	Punta Galera	18 H	613128	5572323	97	NO	5	400	100	90	30	10	30
8	CL	12.01.12	Puerto Galera	18 H	613297	5572356	95	NO	8	400	100	90	20		25
9	CL	12.01.12	Puerto Galera	18 H	613405	5572534	90	NO	8	400	100	90	30		30
10	CL	12.01.12	Punta Galera	18 G	613530	5572880	72	n. d.	2	400	100	90	15		30
11	CL	12.01.12	Punta Galera	18 H	614493	5573980	82	n. d.	2	400	100	80	20		30
12	CL	12.01.12	Punta Galera	18 H	614147	5573250	72	O	5	400	100	90	20		30
13	CL	19.01.12	Puerto Galera	18 H	613078	5571708	80	O	5	400	100	80	20		25
14	CL	19.01.12	Puerto Galera	18 H	612887	5572368	63	O	5	400	100	80	20		25
15	CL	19.01.12	Puerto Galera	18 H	613091	5572417	83	O	5	400	100	80	20		25
16	CL	21.01.12	Playa Colun	18 G	613877	5567324	69	SE	10	400	100	80	20		30
17	CL	21.01.12	Playa Colun	18 G	614213	5565346	49	N	5	350	100	80	20		25
18	CL	21.01.12	Playa Colun	18 G	614318	5565202	30	O	5	400	100	75	20		20
19	CL	21.01.12	Playa Colun	18 G	614150	5565348	36	NE	3	400	100	75	20		25
20	CL	01.02.12	Bonifacio	18 H	639041	5605230	121	O	5	400	100	75	30		25
21	CL	03.02.12	Pelche	18 H	613346	5573199	42	O	5	400	100	80	20		20
22	CL	12.02.12	Pelche	18 H	613243	5572859	72	NO	5	400	100	80	20		20
23	CL	12.02.12	Pelche	18 H	613067	5572849	43	n. d.	2	350	100	75	20		30
24	CL	12.02.12	Pelche	18 H	613136	5573036	41	n. d.	2	350	100	75	30		20
25	CL	12.02.12	Pelche	18 H	613265	5572963	66	N	5	350	100	80	15		20
26	CL	12.02.12	Pelche	18 H	613348	5573058	70	n. d.	2	350	100	85	30		25
27	CL	15.02.12	Pelche	18 H	613645	5573735	35	n. d.	2	350	100	80	30		25
28	CL	15.02.12	Playa Pelche	18 H	613674	5573626	49	SO	5	400	100	80	30		30
29	CL	15.02.12	Pelche	18 H	613705	5573770	50	NO	4	350	100	70	20		25
30	CL	15.02.12	Pelche	18 H	613839	5573540	59	N	4	350	100	75	15		25
31	CL	15.02.12	Pelche	18 H	613715	5574048	50	O	10	300	100	80	15		25
32	CL	16.02.12	Pelche	18 H	613590	5574165	60	n. d.	2	350	100	80	10		20
33	CL	16.02.12	Pelche	18 H	613605	5574033	52	SO	15	300	100	85	30		25
34	CL	16.02.12	Caleta Guadi	18 H	613523	5573551	46	SO	5	400	100	85	20		30
35	CL	16.12.12	Hueicolla	18 G	618490	5553523	228	O	30	300	100	85	30		25
36	CL	07.03.13	Punta Galera	18 H	612922	5572123	59	O	4	400	100	85	15		30
37	CL	07.03.13	Punta Galera	18 H	612935	5572070	66	n. d.	2	300	100	90	10		25
38	CL	06.03.13	Punta Galera	18 H	612820	5572034	67	NO	10	300	100	85	10		25
39	CL	07.03.13	Punta Galera	18 G	612215	5570234	88	NO	5	300	100	80	30		25
40	CL	23.03.13	Punta Galera	18 G	612365	5571212	73	N	4	300	100	80	10		25
41	CL	02.03.12	Lagunas Gemelas	18 G	614980	5563409	18	NO	10	400	100	80	10		30
42	CL	12.01.12	Chaihuin	18 H	618619	5575832	43	n. d.	2	200	100		100		2.5

Relevé number	Country Code	Date [D. M. Y]	Locality	UTM	m E	m S	Altitude [m a.s.l]	Aspect	Slope [°]	Relevé area [m²]	Total cover [%]	Tree cover layer [%]	Shrubs cover layer [%]	Herbs cover layer [%]	Vegetation high layer [m]
43	CL	12.01.12	Morro Gonzalo	18 H	631659	5586801	110	n. d.	2	200	100		100		2.5
44	CL	12.01.12	Morro Gonzalo	18 H	631701	5586782	110	n. d.	2	200	100		100		3
45	CL	19.01.12	Corral	18 H	632866	5586661	19	n. d.	2	200	100		100		3
46	CL	19.01.12	Corral	18 H	632847	5586768	13	n. d.	2	200	100		100		3
47	CL	19.01.12	Morro Gonzalo	18 H	632471	5586916	38	O	5	200	100		100		2.5
48	CL	19.01.12	Chaihuin	18 H	619710	5575824	28	S	5	200	100		100		2.5
49	CL	19.01.12	Los Liles	18 H	630417	5584768	41	n. d.	2	200	100		100		2.5
50	CL	19.01.12	Los Liles	18 H	630235	5584103	30	n. d.	2	200	100		100		2.5
51	CL	19.01.12	Chaihuin	18 H	620092	5575957	31	n. d.	2	200	100		100		2.5
52	CL	19.01.12	Chaihuin	18 H	619962	5575947	36	n. d.	2	200	100		100		2.5
53	CL	11.02.10	Calfuco	18 H	638096	5594452	24	NO	5	200	100		100		2.5
54	CL	11.02.10	Calfuco	18 H	637949	5594747	61	NO	5	200	100		100		2.5
55	CL	19.01.12	Chaihuin	18 H	619744	5575881	36	NO	5	200	100		100		3
56	CL	06.03.13	Punta Galera	18 G	610728	5570723	52	O	55	200	100		100		3
57	CL	06.03.13	Punta Galera	18 G	610719	5570759	52	NO	55	200	100		100		2.5
58	CL	06.03.13	Punta Galera	18 G	610546	5570686	35	O	35	200	100		100		2.5
59	CL	06.03.13	Punta Galera	18 G	610550	5570818	35	NO	35	200	100		100		2.5
60	CL	06.03.13	Punta Galera	18 G	610618	5570817	42	NO	40	200	100		100		2.5
61	CL	06.03.13	Punta Galera	18 G	610874	5570757	57	SO	4	100	100			100	1
62	CL	06.03.13	Punta Galera	18 G	610778	5570724	54	SO	4	100	100			100	1
63	CL	26.01.10	Curiñanco	18 H	638004	5597423	34	n. d.	2	100	100			100	1
64	CL	26.01.10	Curiñanco	18 H	637980	5597454	41	n. d.	2	100	100			100	1
65	CL	26.01.10	Curiñanco	18 H	638035	5597854	22	n. d.	2	100	100			100	1
66	CL	11.02.10	Calfuco	18 H	637943	5594062	20	n. d.	2	100	100			100	1
67	CL	26.01.10	Curiñanco	18 H	638015	5598040	25	n. d.	2	100	100			100	1
68	CL	26.01.10	Curiñanco	18 H	637924	5598771	29	n. d.	2	100	100			100	1
69	CL	26.01.10	Curiñanco	18 H	637878	5599223	24	n. d.	2	100	100			100	1
70	CL	26.01.10	Curiñanco	18 H	637965	5599243	25	n. d.	2	100	100			100	1
71	CL	27.01.10	Curiñanco	18 H	637994	5598225	33	n. d.	2	100	100			100	1
72	CL	11.02.10	Calfuco	18 H	637895	5594157	25	n. d.	2	100	100			100	1
73	CL	06.03.13	Punta Galera	18 G	610791	5570773	60	n. d.	2	100	100			100	1
74	CL	12.01.12	Fundo Galera	18 H	613565	5572851	59	n. d.	2	100	100			100	1.2
75	CL	12.01.12	Huiro	18 H	613993	5573222	87	n. d.	2	100	100				1.2
76	CL	19.01.12	Los Liles	18 H	630738	5585521	35	n. d.	2	100	100				1.2
77	CL	19.01.12	Lis Liles	18 H	630671	5585448	28	n. d.	2	100	100				1.2
78	CL	03.02.12	Chaihuin	18 H	621240	5578845	9	n. d.	2	100	100				1.2
79	CL	03.02.12	Chaihuin	18 H	621325	5578814	16	n. d.	2	100	100				1.2
80	CL	03.02.12	Guapi	18 H	626876	5580522	10	n. d.	2	100	100				1.2
81	CL	13.02.10	La mision	18 H	637496	5593469	43	n. d.	2	100	100				1.2
82	CL	12.02.10	Curiñanco	18 H	637298	5602118	17	n. d.	2	100	100				1.2
83	CL	26.01.10	Curiñanco	18 H	637530	5600908	26	n. d.	2	100	100				1.2
84	CL	31.03.12	Playa Pelche	18 H	630668	5585414	23	n. d.	2	100	100				1.2

Relevé number	Country Code	Date [D. M. Y]	Locality	UTM	m E	m S	Altitude [m a.s.l]	Aspect	Slope [°]	Relevé area [m^2]	Total cover [%]	Tree cover layer [%]	Shrubs cover layer [%]	Herbs cover layer [%]	Vegetation high layer [m]
85	CL	03.03.12	Fundo Galera	18 G	613002	5571005	97	n. d.	2	100	100				1.2
86	CL	31.03.12	Huape	18 H	624463	5579320	21	n. d.	2	100	100				1.2
87	CL	31.03.12	Huape	18 H	624285	5579289	17	n. d.	2	100	100				1.2
88	CL	31.03.12	Huape	18 H	624520	5579246	25	n. d.	2	100	100				1.2
89	CL	11.01.12	Chaihuin	18 H	621203	5576571	23	n. d.	2	100	100			100	0.1
90	CL	01.02.12	Bonifacio	18 H	638935	5605062	102	SO	10	100	100				0.1
91	CL	01.02.12	Bonifacio	18 H	639020	5604994	120	SO	5	100	100				0.1
92	CL	01.02.12	San Ignacio	18 H	636849	5588966	26	n. d.	2	100	100				0.1
93	CL	03.02.12	Guapi	18 H	627175	5580778	19	n. d.	2	100	100				0.1
94	CL	25.02.12	Chaihuin	18 H	620675	5578680	24	n. d.	2	100	100				0.1
95	CL	25.02.12	Chaihuin	18 H	620699	5578705	21	n. d.	2	100	100				0.1
96	CL	31.03.12	Guapi	18 H	624752	5579521	16	n. d.	2	100	100				0.1
97	CL	15.02.12	Playa Pelche	18 H	613399	5574159	39	O	6	100	100				0.1
98	CL	15.02.12	Playa Pelche	18 H	613410	5573935	40	n. d.	2	100	100				0.1
99	CL	06.02.13	Puerto Ranquil	18 H	615344	5575898	41	n. d.	2	100	100				0.1
100	CL	26.01.10	Curiñanco	18 H	637698	5601303	25	n. d.	2	100	100				0.1
101	CL	03.02.12	Huape	18 H	626018	5579909	154	N	4	100	100				0.2
102	CL	03.03.12	Huape	18 H	625879	5579855	130	SO	10	100	100				0.2
103	CL	05.02.13	Puerto Ranquil	18 H	615436	5575787	55	n. d.	2	100	100				0.2
104	CL	05.02.13	Puerto Ranquil	18 H	615231	5575986	38	n. d.	2	100	100				0.2
105	CL	06.02.13	Fundo Galera	18 H	612356	5571704	45	n. d.	2	100	100				0.2
106	CL	03.02.12	Curiñanco	18 H	637592	5601462	28	n. d.	2	100	100				0.2
107	CL	03.02.12	Huapi	18 H	627307	5580996	20	n. d.	2	100	100				0.2
108	CL	03.02.12	Curiñanco	18 H	637051	5602190	28	n. d.	2	100	100				0.2
109	CL	27.01.10	Curiñanco	18 H	637919	5599280	24	n. d.	2	100	100				0.2
110	CL	27.01.10	Los Pellines	18 H	638367	5596263	240	NO	5	100	100				0.2
111	CL	27.01.10	Los Pellines	18 H	638304	5596525	212	NO	5	100	100				0.2
112	CL	31.03.12	Curiñanco	18 H	638236	5599257	18	n. d.	2	100	95			100	0.05
113	CL	31.03.12	Curiñanco	18 H	638295	5599243	21	n. d.	2	100	95			100	0.05
114	CL	31.03.12	Puerto Ranquil	18 H	616125	5576007	33	n. d.	2	100	100			100	0.05
115	CL	31.03.12	Puerto Ranquil	18 H	616108	5575967	35	n. d.	2	100	95			100	0.05
116	CL	31.03.12	Puerto Ranquil	18 H	616150	5575958	34	n. d.	2	100	95			100	0.05
117	CL	19.01.12	Los Liles	18 H	629846	5583501	20	n. d.	2	100	100			100	1
118	CL	19.01.12	Los Liles	18 H	625645	5580219	13	n. d.	2	100	100			100	1
119	CL	02.01.12	Los Liles	18 H	630768	5585450	31	n. d.	2	100	100			100	1
120	CL	02.01.12	Curiñanco	18 H	637519	5601693	23	n. d.	2	100	100			100	1
121	CL	02.02.12	Curiñanco	18 H	638847	5599817	338	n. d.	2	100	100			100	1
122	CL	03.02.12	Guapi	18 H	626925	5580536	6	n. d.	2	100	100			100	1
123	CL	03.02.12	Curiñanco	18 H	638359	5599318	24	SO	5	100	100			100	1
124	CL	26.01.10	Curiñanco	18 H	637130	5602183	24	n. d.	2	100	100			100	1
125	CL	26.01.10	Curiñanco	18 H	637765	5601264	28	n. d.	2	100	100			100	1
126	CL	27.01.10	Curiñanco	18 H	637939	5599344	29	n. d.	2	100	100			100	1

Table E.1: Header data with geographical and referential information of each sample plot.

Relevé number	Country Code	Date [D. M. Y]	Locality	UTM	m E	m S	Altitude [m a.s.l]	Aspect	Slope [°]	Relevé area [m^2]	Total cover [%]	Tree cover layer [%]	Shrubs cover layer [%]	Herbs cover layer [%]	Vegetation high layer [m]
127	CL	27.01.10	Curiñanco	18 H	637079	5602226	24	n. d.	2	100	100			100	1
128	CL	12.01.12	Chaihuin	18 H	617704	5575432	49	n. d.	2	100	90			100	0.05
129	CL	01.02.12	Bonifacio	18 H	638914	5605048	92	NO	10	100	90			100	0.05
130	CL	19.01.12	Los Liles	18 H	630473	5584757	39	NO	20	200	100		100		3
131	CL	19.01.12	Los Liles	18 H	630399	5584643	55	NO	20	200	100		100		3
132	CL	19.01.12	Los Liles	18 H	630359	5584667	43	n. d.	2	200	100		100		3
133	CL	19.01.12	Corral	18 H	613092	5572345	70	n. d.	2	200	100		100		3
134	CL	21.01.12	Playa Colun	18 H	613895	5567599	91	n. d.	2	200	100		100		3
135	CL	21.01.12	Playa Colun	18 H	613918	5567649	83	n. d.	2	200	100		100		3
136	CL	21.01.12	Playa Colun	18 H	613893	5567792	92	n. d.	2	200	100		100		3
137	CL	21.01.12	Punta Galera	18 G	610642	5570751	89	SO	5	200	100		100		3
138	CL	21.01.12	Playa Colun	18 G	613762	5567550	65	O	20	200	100		100		3
139	CL	21.01.12	Playa Colun	18 H	613870	5567383	85	O	10	200	100		100		3
140	CL	21.01.12	Playa Colun	18 H	613902	5567523	85	n. d.	2	200	100		100		3
141	CL	30.01.12	La mision	18 H	637096	5591756	43	n. d.	2	200	100		100		3
142	CL	30.01.12	Calfuco	18 H	637695	5593672	41	NO	4	200	100		100		3
143	CL	30.01.12	La mision	18 H	637057	5592741	9	O	10	200	100		100		3
144	CL	30.01.12	La mision	18 H	637065	5592651	6	O	10	200	100		100		3
145	CL	16.03.13	Punta Galera	18 G	610553	5570671	6	SO	4	200	100		100		3
146	CL	27.02.10	Curiñanco	18 H	638121	5598107	63	O	30	200	100		100		2
147	CL	27.02.10	Los Pellines	18 H	637853	5596956	72	NO	50	200	100		100		2
148	CL	10.02.12	La mision	18 H	637121	5592779	28	SO	15	200	100		100		2.5
149	CL	19.01.12	Huape	18 H	625706	5579924	52	NO	35	150	100			100	2.5
150	CL	19.01.12	Huape	18 H	625736	5579941	70	NO	30	150	100			100	2.5
151	CL	19.01.12	Huape	18 H	625766	5579958	76	SO	30	150	100			100	2.5
152	CL	19.01.12	Huape	18 H	625800	5579946	92	NO	30	150	100			100	2.5
153	CL	19.01.12	Huape	18 H	625789	5579933	96	N	30	150	100			100	2.5
154	CL	21.01.12	Huape	18 H	614202	5564959	18	NO	25	150	100			100	2.5
155	CL	01.02.12	Bonifacio	18 H	638578	5604881	82	N	30	150	100			100	2.5
156	CL	03.02.12	Huape	18 H	625995	5579930	147	N	20	150	100			100	2.5
157	CL	03.02.12	Calfuco	18 H	637919	5594432	46	SE	20	150	100			100	2.5
158	CL	03.02.12	Curiñanco	18 H	638596	5597680	18	O	10	150	100			100	2.5
159	CL	03.02.12	Huape	18 H	625811	5580002	52	N	20	150	100			100	2.5
160	CL	06.03.13	Punta Galera	18 H	612219	5571765	40	NO	5	150	100			100	2.5
161	CL	03.02.12	Punta Galera	18 H	612695	5572760	31	n. d.	2	150	100			100	2.5
162	CL	06.03.13	Punta Galera	18 H	610636	5570695	44	SO	15	150	100			100	2.5
163	CL	26.02.10	Curiñanco	18 H	638097	5597977	24	n. d.	2	150	100			100	2.5
164	CL	11.02.10	Curiñanco	18 H	637928	5594838	43	n. d.	2	150	100			100	2.5
165	CL	11.02.10	Curiñanco	18 H	637502	5593666	46	S	10	150	100			100	2.5
166	CL	27.01.10	Curiñanco	18 H	637559	5600466	18	n. d.	2	150	100			100	2.5
167	CL	02.03.13	Lagunas Gemelas	18 H	615240	5562851	13	n. d.	2	100	100			100	0.15
168	CL	01.03.12	Los Liles	18 H	629800	5583532	20	n. d.	2	100	100			100	0.1
169	CL	27.01.10	Curiñanco	18 H	637120	5602216	23	n. d.	2	100	100			100	0.15

References

Aguirre, L., Hervé, F. & Godoy. E. (1972): Distribution of metamorphic facies in Chile, an outline. Kristalinikum 9: 7-19.

Aguayo, M., Pauchard, A., Azócar, G., & Parra, O. (2009): Cambio del uso del suelo en el centro sur de Chile a fines del siglo XX: Entendiendo la dinámica espacial y temporal del paisaje. Revista Chilena de Historia Natural 82(3): 361-374.

Alberdi, M., Ramírez, C. & Steubing, L. (1978): La familia Hymenophyllaceae (Pteridophyta) en el fundo San Martín, Valdivia, Chile. II. Resistencia al desecamiento y sobrevivencia en comunidades antropogénicas. Medio Ambiente 3(2): 3-13.

Alvarez, M., Möseler, B.M., San Martín, C., Ramirez, C. & Amigo, J. (2012): CL-Dataveg- a database of Chilean grassland vegetation. In: Dengler, J., Oldeland, J., Jansen, F., Chytrý, M., Ewald, J., Finckh, M., Glöckler, F., Lopez-Gonzalez, G., Peet, R.K. Schaminée, J.H.J.(Eds.): Vegetation databases for the 21st century. Biodiversity & Ecology 4: 443-443.

Amigo, J. & Ramírez, C. (1998): Bibliographia phytosociologica et scientiae vegetationis Chile (1983-1994): Excerpta Bot. Sect. B 32(1-4): 31-68. (In English) [358 refs.]

Amigo, J. & Ramírez, C. (1998b): A bioclimatic classification of Chile: woodland communities in the temperate zone. Plant Ecology 136: 9-26.

Añazco, N., Moraga, M. & Ramírez, C. (1981): Distribución de comunidades pratenses antropogénicas en un gradiente de inclinación en Valdivia, Chile. Agro Sur 9(1): 14-27.

Andrade, M.A. & Pacheco, R. (2009): Memorias de la mar: Reconstrucción de la memoria colectiva en torno a las actividades marinas desarrolladas en las comunidades de Amargos, San Carlos, Huape, Chaihuín y Huiro durante el siglo XX. 177 p.

Ardiles, R. (1977): Contribución al estudio del bosque nativo perennifolio de la Cordillera de la Costa, en tres niveles altitudinales. Tesis. Universidad Austral de Chile. Valdivia.

Ardiles, V., Cuvertino, J., & Osorio, F. (2008): Briofitas de los bosques templados australes de Chile. Una introducción al mundo de los Musgos, Hepáticas y Antocerotes que habitan los bosques de Chile. Guía de campo. Editorial Corporación Chilena de la Madera (CORMA). Concepción, Chile. 168 p.

Armesto, J., Smith-Ramírez, C., Leon, P. & Kalin Arroyo, M. (1992): Biodiversidad y conservación del bosque templado en Chile. Ambiente y Desarrollo X: 19-24.

Armesto, J., Villagran, C. & Donoso, C. (1994): La historia del Bosque Templado Chileno. Ciencia y Ambiente 10 (1): 66-72.

Armesto, J., Villagran, C. & Kalin Arroyo, M. (1996): Ecología de los Bosques Nativos de Chile. Editorial Univeritaria. Santiago. Chile. 120 p.

Arroyo, M.T.K., Marquet, P., Marticonera, C., Simonetti, J., Cavieres, L., Squeo, F., Rozzi, R. & Massardo, F. (2006): El hotspot chileno de biodiversidad, una prioridad mundial para la conservación. In: CONAMA (Ed.). Biodiversidad de Chile: Patrimonio y Desafíos: xx p . Comisión Nacional del Medio Ambiente. Santiago

Austin, M. (2005): Vegetation and environment: discontinuities and continuities. In: van der Maarel, E. (Ed.) Vegetation ecology: 52-84 p. Blackwell, Oxford, UK.

Backhaus, K., Erichson, B., & Weiber, R. (2003): Multivariate Analysemethoden: eine anwendungsorientierte Einführung. 10 Auflage. Springer-Verlag. 819 p.

Baeza, M., E Barrera, E., Flores, J., Ramírez, C. & Rodríguez, R. (1998): Categorías de conservación de Pteridophyta nativas de Chile. Boletín del Museo Nacional Historia Natural 47: 23-46.

Bartheld, J., Moreno-Gómez, F. N., Soto-Gamboa., M., Silva-Escobar A. A., & Suazo, C. G. (2011): Monitoreo Acústico de Aves y Anfibios en el Bosque Costero Valdiviano. Valdivia, Chile. 78 p.

Belmonte, E., Faúndez, L., Flores, J., Hoffmann, A., Muñoz, M. & Teillier, S. (1998): Categorías de conservación de cactáceas nativas de Chile. Boletín del Museo Nacional Historia Natural 47: 69-89.

Benoit, I. L. (Ed). (1989): Red Book of Chilean Terrestial Flora (Part I). Corporacion Forestal Nacional [CONAF]. Santiago, Chile. 151 p.

Berry, P. & Reid, D. (1993): Mecánica de Suelos. Caicedo, B., Arieta, A. (Trad.). Colombia, ed. McGraw-Hill. 415 p.

Besoain, E. (1985): Los suelos. In: Tosso, J. (Ed.). Suelos volcánicos de Chile: 25-106 p. Instituto de Investigaciones Agropecuarias. Chile.

Besoain, E. (1985b): Mineralogía de arcillas de suelos. UCA, San José, Costa Rica. 1189 p.

Blume, H. P., Brümmer, G. W., Horn, R., Kandeler, E., Kögel-Knabner, I., Kretzschmar, R., Stahr, K., & Wilke, B.-M. (2010): Scheffer y Schachtschabel: Lehrbuch der Bodenkunde. Spektrum Akademischer Verlag, Heidelberg. 569 p.

Bonelli, C. & Schlatter, J. (1995): Caracterización de los suelos rojo arcillosos de la zona Centro-Sur de Chile. Bosque 16(2): 21-37.

Börgel, R. (1983): Geomorfología. Colección Geografía de Chile. Tomo II. Instituto Geográfico Militar. Santiago. Chile 182 p.

Braun-Blanquet, J. (1964): Pflanzensoziologiche-Grundzüge der Vegetationskunde. Springer Verlag. 867 p.

Bustamante, R. O., Simonetti, J., Grez A., & San Martín, J. (2005): Fragmentación y dinámica de regeneración del bosque maulino: diagnóstico actual y perspectivas futuras: 555-564 p. Historia, biodiversidad y ecología de los bosques costeros de Chile.

Cabrera, A. & Willink, A. (1973): Biogeografía de America Latina. Secretaria General de la Organización de Estados Americanos. Washington D.C. 117 p.

Cain, S. (1950): Life-forms and phytoclimate. The Botanical Review 16(1): 1-32.

Cárdenas, R. (1976): Flora y vegetación del fundo San Martín, Valdivia, Chile. Thesis. Facultad de Ciencias. Universidad Austral de Chile.

CECPAN & MMA [Centro de Estudio y Conservación del Patrimonio Natural & Ministerio de Medioambiente] (2012): Ranas de la Cordillera de la Costa Valdiviana. Región de Los Ríos. 24 p.

Cembrano, J. & Lara, L. (2009): The link between volcanism and tectonics in the southern volcanic zone of the Chilean Andes: A review. Tectonophysics 471: 96-113.

Chytrý, M., Tichý L., Holt, J., & Botta-Dukát, Z. (2002): Determination of diagnostic species with statistical fidelity measures. Journal of vegetation science 13(1): 79-90.

CIREN [Centro de Información de Recursos Naturales] (2003): Descripciones de suelos materiales y símbolos. Estudio agrológico X Regioón. Santiago, Chile. 412 p.

Crouzeilles, R., Curran, M., Ferreira, M., Lindenmayer, D., Grelle, C. & Rey Benayas, J. (2016): A global meta analysis on the ecological drivers of forest restoration success. Nature communications 7, 11666.

CONAMA [Comisión Nacional de Medio Ambiente] (2008a): Biodiversidad de Chile. Patrimonio y desafíos. Editorial Ocho Libros. Santiago, Chile. 640 p.

CONAF [Corporación Nacional Forestal], CONAMA [Comisión Nacional del Medio Ambiente], UACh [Universidad Austral de Chile]: (2008b): Catastro de uso del suelo y vegetación. Monitoreo y actualización Región de los Ríos. Período 1998-2006. 16 p.

Daniëls, F. J. (1982): Vegetation of the Angmagssalik District, Southeast Greenland, IV. Shrub, Dwarf Shrub, and Terricolous Lichens (Vol. 10). Commission for Scientific Research in Greenland.

Dec, D. Ivelic-Saez, J., Zuñiga, F., Balocchi, O., Lopez, I., Horn, R. & Dörner, J. (2015): Capacity and intensity parameters of the pore system for the evaluation of the soil physical quality of an andisol under grazing. Agro Sur

43(2): 77-87.

Dengler J., Chytrý M, & Ewald, J. (2008): Phytosociology. In: Jorgensen SE, Fath BD (Eds) Encyclopedia of Ecology Vol. [4]. Elsevier. pp.2767-2779

DS [Decreto Supremo] Decretos generados en el marco del Reglamento de Clasificación de Especies: DS N° 151 de 2007, DS N° 50 de 2008, DS N° 51 de 2008, DS N° 23 de 2009 and DS N° 33 de 2012, by MINSEGPRES.

di Biase, F. & Lillo, F. (1973): Geología Regional, geoquímica del drenaje y minería de la Provincia de Valdivia. Instituto Nacional de Investigación de Recursos Naturales (IREN). 97 p.

di Castri, F. & Hayek, E. (1976): Bioclimatología de Chile. Universidad Católica de Chile. Santiago. Chile. 129 p.

di Castri, F. (1968): Equisse écologique du Chili. In: Debouteville, C. & E. Rapaport (Eds.) Biologie de L'Amerique Australe: 7-52. Tome IV. Paris: Editions du Centre National de la Recherche Scientifique. Paris. France.

Dierschke, H. (1994): Pflanzensoziologie: Grundlagen und Methoden. Verlag Ulmer. Stuttgart. 683 p.

Dimitri, M. (1964): Fitosociología de dos comunidades de Myrceugenella apiculata del Parque Nacional Nahuel Huapi. Anales de Parques Nacionales 10 (1): 73-98.

Dinerstein, E., Olson, D. M., Graham, D. J., Webster, A. L., Primm, S. A., Bookbinder, M. P., Ledec, G., & Young, K. R. (1995): A conservation assessment of the terrestrial ecoregions of Latin America and the Caribbean (No. P01 47). Washington, DC: World Bank.

Donoso, C. (1981): Tipos forestales de los bosques nativos de Chile. Documento de trabajo N° 38. Publicaciones FAO-CONAF-Chile. 70 p.

Donoso, C. (1982): Reseña ecológica de los bosques mediterráneos de Chile. Bosque 4(2): 117-146.

Donoso, C. (1993): Bosques templados de Chile y Argentina. Editorial Universitaria. Santiago de Chile. 484 p.

Donoso, C., Nuñez, M., Donoso, P. & Escobar, B. (2006): *Aextoxicon punctatum* R. et Pav. Olivillo, Tique, Palo muerto. Familia: Aextoxicaceae: 135-147 p. In: Donoso, C, (Ed) Especies arboreas de los Bosques Templados de Chile y Argentina. Ediciones Marisa Cuneo.

Dörner, J. & D. Dec. (2007): La permeabilidad de aire y la conductividad hidráulica en fase saturada como herramienta para la caracterización funcional de los poros del suelo. Revista de la Ciencia del Suelo y Nutrición Vegetal (7): 1-13.

Dörner, J., Dec, D., Peng, X., Horn, R., (2009a): Change of shrinkage behavior of an andisol in southern Chile: Effects of land use and wetting/drying cycles. Soil and Tillage Research 106: 45-53.

Dörner, J., Dec, D., Peng, X., Horn, R., (2009b): Efecto del cambio de uso en la estabilidad de la estructura y la función de los poros de un Andisol (Typic Hapludand) del sur de Chile. Revista de la Ciencia del Suelo y Nutrición Vegetal 9: 190-209.

Dörner, J., Dec, D., Peng, X., Horn, R., (2010): Effect of land use change on the dynamic behaviour of structural properties of an Andisol in southern Chile under saturated and unsaturated hydraulic conditions. Geoderma 159: 189-197.

Dörner, J., Dec, D., Peng, X. & Horn, R. (2009): Efecto del cambio de uso en la estabilidad de la estructura y la funcion de los poros de un andisol (Typic Hapludand) del Sur de Chile. Revista de la Ciencia del Suelo y Nutrición Vegetal 9(3): 190-209.

Dörner, J.; Schröderen, V.; Dec, D. & Horn, R. (2009b): Effect of Land Use on physical properties of a Volcanic Soil in South Chile. ISTRO 18th Tiennial Conference Proceedering. Izmir. Turkey.

Duhart, P., McDonough, M., Muñoz, J., Martin, M., Villeneuve, M. (2001): El Complejo Metamórfico Bahía Mansa en la Cordillera de la Costa del Centro-Sur de Chile ($39°30' - 42°0'$ S): geocronología K-Ar, 40Ar/39Ar y U-Pb e implicancias en la evolución del margen sur-occidental de Gondwana. Revista Geológica de Chile 28 (2): 179-208.

Eijkelkamp Agrarsearch Equipament. (2003): Laboratory permeameters. Operating Instruction. Geisbeek, Netherlands. 14 p.

Ellenberg, H. & Müller-Dombois, D. (1967): A key to Raunkier plant life forms with revised subdivisions. Ber. Geobot. Inst. ETH, stift Ruebel 37:21-55.

Ellies, A. & Contreras, C. (1997): Modificaciones estructurales de un Palehumult sometido a distintos manejos. Agricultura tecnica 51(1): 15-21.

Ellies, A. Ramírez, C. & Mac Donald, R. (1993b): Cambios en la porosidad de un suelos por efecto de su uso. Turrialba 43(1): 72-76.

Ellies, A. Ramírez, C. & Mac Donald, R. (1993c): Variación en la resistencia del suelo por efecto de su uso. Turrialba 43(1): 77-82.

Ellies, A., Grez, R. & Ramírez, C. (1995): Cambios en las propiedades humectantes de suelos sometidos a diferentes manejos. Turrialba (1-2): 42-48.

Ellies, A., Grez, R. & Ramírez, C. (1996): Efecto de la materia organica sobre la capacidad de humectacion y las propiedades estructurales de algunos suelos de la zona Centro-Sur de Chile. Agro Sur 24(1): 48-58.

Ellies, A., Horn, R. & Smith, R. (2000): Effect on management of a volcanic ash soil on structural properties. Int. Agrophysics 14: 377-384.

Ellies, A., Horn, R., Smith, R. (2000): Effect of management of a volcanic ash soil on structural properties. International Agrophysics 14: 377-384.

Ellies, A., Ramirez, C. & Figueroa, H. (1993a): Modificaciones estructurales de un suelo sometido a distintos usos forestales. Bosque 14(2): 25-30.

Errázuriz, A. M., Cereceda, P., Gonzáles, J., Gonzáles, M. & Riosecol, R. (1998): Manual de Geografía de Chile. 3^{a} Edición. Editorial Andrés Bello. Santiago. 433 p.

Eskuche, U. (1968) Fisionomia y sociología de los bosques de *Nothofgus dombeyi* en la región de Nahuel Huapi. Vegetatio 16: 192-204.

Etienne, M. G., & Prado, C. C. (1982): Descripción de la vegetación mediante la cartografía de ocupación de tierras: conceptos y manual de uso práctico.

Farias, A., Sepúlveda, M., Silva-Rodríguez, E., Eguren, A., Gonzáles, D., Jordán, N., Ovando, E., Stauhas, P. —6 Svensson, G. (2014): A new population of Darwin's fox (*Lycalopex fulvipes*) in the valdivian Coastal Range. Revista Chilena de Historia Natural: 87(1): 1-3.

Finot, V. & Ramírez, C. (1998): Fitosociología de la vegetación ruderal de la ciudad de Valdivia (X Región, Chile) 2. Vegetación de senderos. Stud. Bot. 17: 69-86.

Francois, J.P. (2004): Eslabones de una cadena rota: el caso del bosque relicto de Santa Inés: 205-218 p. In: Squeo, F. A., Gutierrez, J. R. & Hernandez, I. R. Historia Natural del Parque Nacional Fray Jorge. Ediciones Universidad de la Serena.

Frey, W. & Lösch, R. (2004): Lehrbuch der Geobotanik. Pflanze und vegetation in Raum und Zeit. 2. Auflage.

Fuentes, N., Pauchard, A., Sánchez, P., Esquivel, J., & Marticorena, A. (2013): A new comprehensive database of alien plant species in Chile based on herbarium records. Biological Invasions 15(4): 847-858.

Fuentes, N., Sánchez, P., Pauchard, A., Urrutia, J., Cavieres, L. & Marticorena, A. (2014): Plantas invasoras del Centro-Sur de Chile: Una guía de campo. Laboratorio de Invasiones Biológicas (LIB), Concepción, Chile.

Gajardo, R. (1994): La Vegetación Natural de Chile. Clasificación y Distribución Geográfica. Editorial Universitaria. Santiago, Chile. 165 p.

Galán de Mera, A. & Vicente, J. (2006): Aproximación al esquema sintaxonómico de la vegetación del Caribe y America del Sur. Anales de Biología 28: 3-27.

Gardner, M. (2013): *Saxegothaea conspicua*. The IUCN Red List of Threatened Species 2013:e.T32053A2809854. http://dx.doi.org/10.2305/IUCN.UK.2013-1.RLTS.T32053A2809854.en

Gobierno Regional de los Ríos [GORE de los Ríos]. (2010): Estudio para el fortalecimiento de la identidad de la región de los Rios. Informe Inédito. Valdivia 100 p.

Godoy, M. (2003): Diagnóstico Social Comunidades Costeras Provincia de Valdivia Comunas de Corral y La Unión. Informe Final. Documento N° 5. Serie de Publicaciones WWF Chile. Programa Ecorregión Valdiviana.

González, M. (1998): *Eucryphia cordifolia*. The IUCN Red List of Threatened Species 1998:e.T33901A9816963. http://dx.doi.org/10.2305/IUCN.UK.1998.RLTS.T33901A9816963.en

González-Bonorino, F. & Aguirre, L. (1970): Metamorphic facies series of the crystalline basement of Chile. Geologische Rundschau 59: 979 - 993.

González-Bonorino, F. (1970): Series metamórficas del basamento cristalino de la Cordillera de la Costa de Chile Central. Publicaciones Departamento de Geología. Universidad de Chile. Santiago. Chile

González-Bonorino, F. (1971): Metamorphism of the crystalline basement of Central Chile. Journal of Petrology 12: 149-175.

Grigera, D., Brion, C., Chiapella, J. & Pillado, M. (1996): Las formas de vida de las plantas como indicadoras de factores ambientales. Medio Ambiente 13:11-29.

Gunkel, H. (1984): Helechos de Chile. Universidad de Chile, Santiago, Chile. 243 p.

Hajek, E. & di Castri, F. (1975): Bioclimatografía de Chile. Editorial Universidad Católica de Chile. Santiago. 107 p.

Hammer, Ø. (2015): PAST: Paleontological Statistics Software Package. Manual Reference. 225 p.

Hammer, Ø, Harper, D.A.T. & Ryan, P.D. (2001): PAST: Paleontological Statistics Software Package for Education and Data Analysis. Palaeontologia Electrónica 4(1): 1 - 9.

Hartge. K. & Horn, R. (1992): Die physikalische Untersuchung von Böden. Ferdinand Enke Verlag. Stuttgart. 3Th Auflage. 177 p.

Hauenstein, E., Ramírez, C., Latsague, M. & Contreras, D. (1988): Origen fitogeográfico y espectro biológico como medida de grado de intervención antrópica en comunidades vegetales. Medio Ambiente 9(1): 140-142.

He, S. (1998): A Checklist of the mosses of Chile. Journal of the Hattori Botanical Laboratory 85: 103-189. http://www.mobot.org/MOBOT/moss/Chile/welcome.shtml

Hechenleitner, P., Gardner, M., Thomas, P., Echeverría, C., Escobar, B., Brownless, P. & Martínez, C. (2005) Plantas Amenazadas del Centro-Sur de Chile. Distribución, Conservación y Propagación. Primera Edición. Universidad Austral de Chile y Real Jardín Botánico de Edimburgo, Valdivia. 188 p.

Hennekens, S. & Schaminée, J. (2001): Turboveg, a comprehensive database management system for vegetation data. Journal of Vegetation Science 12: 589-591.

Hennekens, SM. (1996): TURBOVEG: Software package for input, processing and presentation of phytosociological data. Users guide. University of Lancaster, Lancaster.

Hervé, F., Faundez, V., Calderón, M., Massone, H. J. & Willner, A. (2007): Metamorphic and plutonic basement complexes: 5-19 p. In: Moreno, T. & Gibbons, W.(Eds.): The Geology of Chile. The Geological Society. London.

Heusser, C.J. (1981): Palynology of the Last Interglacial-Glacial Cycle in Midlatitudes of Southern Chile. Quaternary Research 16: 293-321.

Hildebrand, R. (1983) Die Vegetation der Tieflandsgebüsche des südchilenischen Lorbeerwaldsgebiets unter besonderer Berücksichtig der Neophytenproblematik. Phytocoenologia 11(2): 145-223.

Hill, M. O. & Gauch, H.G. (1960): Detrended correspondence analysis: an improved ordination technique. Vegetatio 42: 47-58.

Hoffmann, A. (1991): Flora Silvestre de Chile. Zona Araucana. 2^a Edición. Ediciones Claudio Gay. Santiago, Chile. 81 p.

Horn, R., Fleige, H., (2009): Risk assessment of subsoil compaction for arable soils in Northwest Germany at farm scale. Soil and Tillage Research 102: 201-208.

Horn, R., Kutilek, M., (2009): The intensity-capacity concept - How far is it possible to predict intensity values with capacity parameters. Soil and Tillage Research 103: 1-3.

Hudson, R., (Ed). (1994): Chile: A Country Study. Washington D.C.: GPO for the Library of Congress. http://countrystudies.us/chile/36.htm [accessed 23. April 2011]

Hueck, K. (1966): Die Wälder Südamerikas. Ökologie, Zusammensetzung und wirtschaftliche Bedeutung. Gustav Fischere Verlag. Stuttgart. 442 p.

Hueck, K. & Seibert, P. (1981): Vegetationskarte von Südamerika. Gustav Fischer Verlag, Stuttgart et New York. 2 Auflage. 90 p + 1 Karte

Illies, H. (1960): Geologie der Gegend von Valdivia, Chile. Neues Jahrbuch Geologie und Palaöntologie Abhandlungen 111: 30-110.

Illies, H. (1970): Geología de los alrededores de Valdivia y volcanismo y tectónica en márgenes del Pacífico de Chile Meridional. Instituto de Geología y Geografía, Universidad Austral de Chile. Valdivia 64 p.

Instituto Nacional de Estadistica [INE]. (2005): Chile. Ciudades, Pueblos, Aldeas y Caseríos. Informe. Instituto Nacional de Estadística. Gobierno de Chile. Santiago. Chile. 300 p.

IPNI [The International Plant Names Index]. (2004): Published on the Internet http://www.ipni.org [accessed 1 July 2012]

IREN, CORFO, UACh [Instituto Nacional de Investigación de Recursos Naturales, Corporación de Fomento de la Producción, Universidad Austral de Chile] (1978): Estudio de suelos de la provincial de Valdivia. Santiago, 178 p.

IUCN Species Survival Commission. (2001): IUCN Red List categories and criteria. Gland, Suiza y Cambridge, Reino Unido. 33 p.

Knapp, R (Ed.) (1984): Considerations on Quantitative Parameters and Qualitative Attributes in Vegetation Analysis and Phytosociologycal Relevés, Part III: 77- 100 p. In: Sampling Methods and Taxon Analysis in Vegetation Science. Handbook of Vegetation Science; Part IV. Dr. W. Junk Publischers, The Hague. The Netherlands.

Knapp, R. (1958): Einführung in die Pflanzensoziologie. 1: Arbeitsmethoden der Pflanzensoziologie und Eigenschaften der Pflanzengesllschaften. 2. Auflage. Eugen Ul,mer verlag. Stuttgart. 112 p.

Lapointe, F. J. & Legendre, P. (1994): A classification of Pure Matt Scotch Whiskies. Appl. Statist. 43: 237-257.

Lara A., Donoso, C. & Aravena, J. C. (1996) La conservación del bosque nativo en Chile: Problemas y desafíos. In: Armesto JJ, C Villagrán & M.K. Arroyo (Eds): Ecología de los bosques nativos de Chile: 335-362 p. Editorial Universitaria, Santiago, Chile.

Lara, A., Solari, M. E., Prieto, M. D. R. & Peña, M. P. (2012): Reconstrucción de la cobertura de la vegetación y uso del suelo hacia 1550 y sus cambios a 2007 en la ecorregión de los bosques valdivianos lluviosos de Chile (35° - 43° 30' S). Bosque 33(1): 13-23.

Larraín J. (2005): Musgos de la Cordillera de la Costa de Valdivia, Osorno y Llanquihue: consideraciones ecológicas y lista de especies: 159-177 p. In: Smith-Ramírez C., Armesto, J. & Valdovinos C, (Eds.): Historia, biodiversidad y Ecología de los Bosques Costeros de Chile. Editorial Universitaria. Santiago, Chile.

Larraín, J. (2009): Musgos de Chile. http://www.musgosdechile.cl [accessed November 2012]

Le Quesne, C., Villagrán, C. & Villa, R. (1999): Historia de los bosques relictos de *Olivillo* (*Aextoxicon punctatum*) y Mirtáceas de la Isla Mocha, Chile, durante el Holoceno tardío. Revista Chilena de Historia Natural 72(1): 31-47.

Leyer, I. & Wesche, K. (2007): Multivariate Statistik in der Ökologie: Eine Einführung. Springer-Verlag.

Lobos, G., Vidal, M., Correa, C., Labra, A., Diaz-Paez, H., Charrier, A., Rabanal, F., Diaz, S. & Tala, C. (2013): Anfibios de Chile, un desafío para la conservación. Ministerio del Medio Ambiente, Fundación Facultad de Ciencias Veterinarias y Pecuarias de la Universidad de Chile y Red Chilena de Herpetología. Santiago. 104 p.

Luebert, F. & Pliscoff, P. (2005): Sobre los límites del bosque valdiviano. Chloris Chilensis Año 8 N° 1. http://www.chlorischile.cl

Luebert, F. & Pliscoff, P. (2006): Sinopsis bioclimática y vegetacional de Chile. Santiago de Chile: Editorial Universitaria, Chile. 316 p

Luzio, W., Sadzawka, A., Besoain, E. & Lara, P. (2003): Influencia de los materiales volcánicos en la génesis de suelos Rojos Arcillosos. R. C. Suelo Nutr. Veg. 3(1): 37-52.

Luzio, W., Seguel, O. & Casanova, M. (2009): Suelos de la Zona Húmeda (Desde 43° LS hasta 50° LS). P., 263-289. In: Luzio (Ed), Suelos de Chile: 195-261 p. Universidad de Chile.

Mann, G. (1960): Regiones biogeográficas de Chile. Investigaciones Zoológicas Chilenas 6: 15-49.

Marticorena C. & Rodríguez, R. (Eds). (1995): Flora de Chile. Volumen 1. Ediciones Universidad de Concepción. Concepción. 351 p.

Marticorena C. & Rodríguez, R. (Eds). (2003): Flora de Chile. Volumen 2(2). Ediciones Universidad de Concepción, Concepción. 93 p.

Marticorena C. & Rodríguez, R. (Eds). (2005): Flora de Chile. Volumen 2(3). Ediciones Universidad de Concepción. Concepción. 128 p.

Marticorena C. & Rodríguez, R. (Eds.) (2001): Flora de Chile. Volumen 2(1). Ediciones Universidad de Concepción. Concepción. 99 p.

Marticorena, A., Alarcon, D., Abello, L. & Atala, C. (2010): Plantas trepadoras, epifitas y parasitas nativas de Chile. Guía de Campo. Editorial Corporación Chilena de la Madera (CORMA). Concepción, Chile. 291 p.

Marticorena, C. & M. Quezada. (1985): Catálogo de la flora vascular de Chile. Gayana Botánica 42: 1-157.

Martínez, A. & Yañez, V. (2005): Plan estratégico de desarrollo turístico participativo para el litoral de la costa de Valdivia. Thesis. Escuela de administración de empresas de turismo. Universidad Austral de Chile. 196 p

Massone, H. J., Medenbach, O., Willner, A., Muñoz, V. & Hervé, F. (1998): Zussmanite in the latepaleozoic metamorphic complex of Southern Chile. Mineralogical Magazine 62(6): 869-876.

Matthei, O. (1995): Manual de las malezas que crecen en Chile. Alfabeta Impresores, Santiago, Chile. 545 p.

Mella, M.; Duhart, P.; McDonough, M; Antinao, J.; Elgueta, S. & Crignola, P. (2012): Geología del Área Valdivia-Corral, Región de Los Ríos. Servicio Nacional de Geología y Minería, Carta Geológica de Chile, Serie Geología Básica 137: 49 p., Mapa escala 1:100.000. Santiago.

Ministerio de Medioambiente [MMA] (2013): Historia de la Clasificación de especies según estado de conservación. Gobierno de Chile. Available from http://www.mma.gob.cl/clasificacionespecies/

Miyawaki, A. (2004): Restoration of living environment based on vegetation ecology: Theory and practice. Ecological Research 19(1): 83-90.

Miyawaki, A., Fujiwara, K. & Ozawa, M. (1993): Native forest by native trees.-Restoration of indigenous forest ecosystem. Bulletin of the Institute of Environmental Science and Technology 19: 73-107.

Miyawaki, A. & Golley, F. (1993): Forest reconstruction as ecological engineering. Ecological Engineering, Volume 2(4):333-345.

Mizota, C. & van Reeuwijik, L. (1989): Clay mineralogy and chemistry of soils formed in volcanic material in diverse climatic region. Soil Monograph 2. ISRIC. Wageningen. 194 p.

Montaldo, P. (1975): Sinecología de las praderas antropogénicas en la provincia de Valdivia, Chile. Agro Sur 3(1): 16-24.

Mora, A. (1986): Estudios fitosociológicos en el bosque de Olivillo (*Lapagerio-Aextoxiconetum*) de la Décima Región de Chile. Tesis, Escuela de Ingeniería Forestal, Universidad Austral de Chile, Valdivia. 85 p.

Moraga, M., Figueroa, H. & Ramírez, C. (1985): Alteración antrópica de los suelos rojo arcillosos en la cordillera de la costa valdiviana, Chile. Agro Sur 13(1): 51-64.

Moreira-Muñoz, A. (2011): Plant Geography of Chile. Springer, Dordrecht. 343 p.

Morrone, J. (2001): Biogeografía de America Latina y el Caribe. M&T- Manuales y Tesis SEA. Volumen III. Zaragoza. España. 148 p.

Mucina, L., Bültmann, H., Dierßen, K., Theurillat, J.-P., Raus, T., Čarni, A., Šumberová, K., Willner, W., Dengler, J., García, R. G., Chytrý, M., Hájek, M., Di Pietro, R., Iakushenko, D., Pallas, J., Daniëls, F. J.A., Bergmeier, E., Santos Guerra, A., Ermakov, N., Valachovič, M., Schaminée, J. H. J., Lysenko, T., Didukh, Y. P., Pignatti, S., Rodwell, J. S., Capelo, J., Weber, H. E., Solomeshch, A., Dimopoulos, P., Aguiar, C., Hennekens, S. M. & Tichý, L. (2016): Vegetation of Europe: Hierarchical Floristic Classification System of Vascular Plant, Bryophyte, Lichen, and Algal Communities. Appl. Veg. Sci. 19: 3-264. doi:10.1111/avsc.12257.

Mucina, L., Schaminée, J. H. J. & Rodwell, J. S. (2000): Common Data Standards for Recording Relevés in Field Survey for Vegetation Classification. J. Veg. Sci. 11:769-772.

Müller, F. (2009): An Updated Checklist of the Mosses of Chile. Archive for Bryology 58: 1-124.

Müller-Dombois, D. & Ellenberg, H. (2002): Aims and Methods of Vegetation Ecology. Blackburn Press. New York. 547 p.

Muñoz, J. (2009). El espinillo (*Ulex europaeus* L. 1753): un invasor biológico en el sur de Chile: estado de su conocimiento y alternativas de control. Gestión Ambiental 17: 23-44.

Muñoz Cristi, J. (1973): Geología de Chile. Prepaleozoico-Paleozoico y Mesozoico. Editorial Andrés Bello. Santiago de Chile. 209 p.

Muñoz, M, Nuñez, H. & Yañez, J. (1997): Libro rojo de los sitios proritarios para la conservación de la biodiversidad en Chile. Ciencia y Ambiente 13(2): 90-99.

Murtagh, F. & Legendre, P. (2014): Ward's Hierarchical Agglomerative Clustering Method: Which Algorithms Implement Ward's Criterion? Journal of Classification 31: 274-295.

Myers, N., Mittermeier, R. A., Mittermeier, C. G., Da Fonseca, G. A., & Kent, J. (2000): Biodiversity hotspots for conservation priorities. Nature 403(6772): 853-858.

Niemeyer, H. & Cereceda, P. (1983): Hidrografía. Colección Geografía de Chile. Tomo VIII. Instituto Geográfico Militar. Santiago. 310 p.

Nuñez, L. (1987): Área mínima y su aplicación en asociaciones vegetales del centro sur de Chile. Thesis. Escuela de Ciencias, Universidad Austral de Chile. Valdivia, Chile. 61 p.

Núñez-Ávila, MC & Armesto, J. (2006): Relict Islands of the Temperate Rainforest Tree *Aextoxicon punctatum* (Aextoxicaceae) in Semi-arid Chile: Genetic Diversity and Biogeographic History. Australian Journal of Botany 54: 733-743. https://doi.org/10.1071/BT06022

Oberdorfer, E. (1960): Pflanzensoziologische Studien in Chile. Ein Vergleich mit Europa. Flora *et* Vegetatio Mundi 2: 1-208.

Oberdorfer, E. (1966): Grünland Gesellchaften und Grünlandprobleme in Chile im Rahmen der chilenischen Vegetationsgliederung: 212- 222 p. In: Tüxen, R. (Ed): Antropogene Vegetation. Springer, Dordrecht.

Oficina Tecnica de Borde Costero [OTBC]. (2009): Macrozonificación del Borde Costero. Informe de Diagnóstico. Gobierno Regional de los Ríos. 161 p

Oksanen, J., Kindt, R., Legendre, p., O'Hara, B., Simpson, G.L., Solymos, P., Stevens, M.H. & Wagner, H. (2009): Vegan: Community ecology package.

Otero, L. (2006): La huella del fuego: Historia de los bosques nativos y cambios en el paisaje del sur de Chile. Pehuen Editores. Santiago, Chile. 168 p.

Peel, M. C., Finlayson, B. L. & Mcmahon, T.A. (2007): Updated World Map of the Updated World Map of the Köppen-Geiger Climate Classification. Hydrology and Earth System Sciences Discussions, European Geosciences Union 11(5): 1633-1644.

Pérez, C., & Villagrán, C. (1994): Influencia del clima en el cambio florístico, vegetacional y edáfico de los bosques de "Olivillo"(*Aextoxicon punctatum* R. et Pav.) de la Cordillera de la Costa de Chile: implicancias biogeográficas. Revista Chilena de Historia Natural 67: 77-90.

Pisano, E. (1954): La vegetación de las distintas zonas geográficas chilenas. Revista Geográfica de Chile 11: 95-106.

Pisano, E. (1956): Esquema de clasificación de las comunidades vegetales de Chile. Agronomía (Chile) 2: 30-33.

Pott, R. (1988): Entstehung von Vegetationstypen und Pflanzengesellschaften unter dem Einfluß des Menschen. Düsseldorfer Geobot. Kollq. 5: 27-54.

Pott, R. (1995): The Origin of Grassland Plant Species and Grassland Communities in Central Europe. Fitosociologia 29: 7-32.

Pott, R. (1998): Vegetation Analysis: 55-89 p. In: Ambasht R.S. (Ed): Modern Trends in Ecology and Environment. Backhuys Publ. Leiden.

Prado, D. (1998): *Aextoxicon punctatum*. The IUCN Red List of Threatened Species 1998:e.T34616A9878587. http://dx.doi.org/10.2305/IUCN.UK.1998.RLTS.T34616A9878587.en

Quintanilla, V. (1974): Les formations végétales du Chili tempéré au 1/1000000. Essai écologique et phytogéographyque. Documents de Cartographie Ecologique 14: 33-80.

Quintanilla, V. (1979): L'etagement altitudinal de la vegetation au Chili Central: Les profils phytogeographyques. Biogeographica 16: 49-68.

Quintanilla, V. (1983): Biogeografía. Colección Geografía de Chile. Tomo III. Instituto Geografico Militar. Santiago de Chile. 225 p.

Quiroz, C., Pauchard, A., Marticorena, A., & Cavieres, L. A. (2009) Manual de plantas invasoras del Centro-Sur de Chile. Concepción, Chile: Laboratorio de Invasiones Biológicas. 45 p.

Ramírez, C. (1979): Bibliographia phytosociologica et scientiae vegetationis: Chile. Excerpta Bot. Sect. B 19(1): 63-90. (In German, English and Spanish) [306 refs.]

Ramírez, C. (1980a): Bibliographia phytosociologica et scientiae vegetationis: Chile: Pars II. Excerpta Bot. Sect. B 20(1): 61-64. (In German and English) [36 refs.]

Ramírez, C. (1980b): Bibliographia phytosociologica et scientiae vegetationis: Chile, Pars III. Excerpta Bot. Sect. B 20(4): 305-319. (In German and English) [150 refs.]

Ramírez, C. (1981): Bibliographia phytosociologica et scientiaevegetationis: Chile, Pars IV. Excerpta Bot. Sect. B 21(4): 249-263. (In German and English) [164 refs.]

Ramírez, C., Amigo, J., & San Martín, C. (2003). Vegetación pratense litoral y dinámica vegetacional antropogénica en Valdivia, Chile. Agro sur 31(2): 24-37.

Ramírez, C. & Figueroa, F. (1985). Delimitación ecosociológica del bosque valdiviano (Chile) mediante análisis estadístico multivariado. Studia Oecologica 6: 105-124.

Ramírez, C., Coliqueo, G., Figueroa, H. y D. Contreras. (1985): Estudio fitosociológico estadístico de las praderas antropogénicas de la Cordillera Pelada, Chile. Agrosur 13 (2): 114-130.

Ramírez, C. Ellies, A., Mac Donald, R. & Seguel, O. (2003): Cambios en la flora y la materia orgánica desde bosques nativos a praderas antropogénicas en suelos volcánicos de la IX Regiíon de Chile. Revista de Ciencia del Suelo y Nutrición Vegetal 2(2): 1-12.

Ramírez, C., Finot, V., San Martín,C. & Ellies, A. (1991): El valor indicador ecológico de las malezas del centro sur de Chile. Agro Sur 19 (2): 94-116.

Ramírez, C., Mac Donald, R. & San Martín, C. (1996a): Riesgos ambientales de la transformacion de los suelos en la Región de Los Lagos. Ambiente y Desarrollo 12(1): 82-88.

Ramírez, C., Moraga, M. & Figueroa, H. (1983): Cambios antrópicos florísticos y edáficos del secano costero húmedo en Valdivia. Primer encuentro científico sobre el medio ambiente chileno. La Serena. Chile. Versiones Abreviadas 1: 11-15.

Ramírez, C., Moraga, M. & Figueroa, H. (1984): La similitud florística como medida de degradación antrópica del bosque valdiviano. Agro Sur 12(2): 127-139.

Ramírez, C. & San Martín, C. (2005): Asociaciones vegetales de la cordillera de la costa en la región de Los Lagos: 206-224 p. In: Smith-Ramírez, C., Armesto, J. & Valdovinos, C. (Eds). Historia, biodiversidad y ecología de los bosques costeros de Chile.

Ramírez, C., San Martín,C. & Contreras, D. (1998): Diversidad florística y vegetacional pratense en vegas, colinas y serranías al poniente de Temuco, Chile. Ciencia e Investigación Agraria 25: 27-50.

Ramírez, C. San Martín, C., Ellies, A. & Mac Donald, R. (1997): Cambios florísticos, fitosociológicos y edáficos provocados por la exclusión de pastoreo en una pradera valdiviana, Chile. Agro Sur 25(2): 180-195.

Ramírez, C., San Martín, C., Ellies, A., Mac Donald, R. & Figueroa, H. (1993a): Cambios florísticos y radiculares en un suelo forestal sometidos a diferentes manejos. Sociedad Chilena de Ciencia del Suelo. Boletín 10: 11-31.

Ramírez, C., San Martín, C. & Figueroa, H. (2000): Clasificación y ordenación multivariada en un complejo vegetacional de marisma (Valdivia, Chile). Revista Geográfica de Valparaíso 31: 211-223.

Ramírez, C., San Martín, C. Finot, V. & Ellies, A. (1995): Diferenciación de manejos agropecuarios en un suelo trumao (Andisol) usando indicadores ecologícos. Ciencia e Investigación Agraria 22(1/2): 3-14.

Ramírez, C., San Martín, C., Finot, V. & Ríos, D. (1992a): Evaluación de praderas usando indicadores ecológicos. Agro Sur 20(2): 85-100.

Ramírez, C., San Martín, C., Flores, L. & Ojeda, P. (1993b): Phytososiological Study of the Chépica Cadillo Prairies in the Coastal Mountain Range of South-Central Chile. Agro Sur 21(1): 26-39.

Ramírez, C., San Martín,C. & Mac Donald, R. (1992b): El paisaje vegetal como indicador de cambios ambientales. Ambiente y Desarrollo 8 (4): 67-71.

Ramírez, C., San Martín, C., Novoa, C., Villagra, J. & Amigo, J. (2009): Uso de tablas fitosociológicas para detectar especies vegetales con problemas de conservación. Agro Sur 37(2): 91-102.

Ramírez, C., San Martín, C. & Ruiz, J. (1999): Estudio sinecológico de la vegetación del litoral pacífico de Valdivia, Chile. Revista Geográfica de Valparaíso 30: 51-63.

Ramírez, C., San Martín, C. & Vázquez, R. (1996b): La vegetación potencial leñosa de la Cordillera Pelada (Valdivia, Chile). Revista geográfica de Valparaíso 26-27: 233-250.

Ramírez, C. Steubing, L. & Alberdi, M. (1976): La familia Hymenophyllaceae (Pteridophyta) en el fundo San Martín, Valdivia, Chile. I Taxonomía y ecología. Medio Ambiente 2(19): 21-28.

Ramírez, C., San Martín, C. & Guner, C. (2005): Cambios florísticos y vegetacionales con diferentes manejos pecuarios en un suelos Andeptic Palehumults (La Unión, X Región, Chile). Agro Sur 33(2): 13-28.

Ravenna, P., Teillier, S., Macaya, J., Rodríguez, R. & Zöllner, O. (1998): Categorías de conservación de las plantas bulbosas nativas de Chile Boletín del Museo Nacional Historia Natural 47: 47-68.

Reiche, K. (1934): Geografía Botánica de Chile. Vol I (Traducción de G. Looser). Imprenta Universitaria. Santiago. Chile. 423 p.

Reiche, K. (1938): Geografía Botánica de Chile. Vol. II (Traducción de G. Looser). Imprenta Universitaria. Santiago. Chile. 158 p.

Reiche, K. 1907. Grundzüge der Pflanzenverbreitung in Chile. In Seies (Vol. 8). W. Engelmann.

Riedemann, P. & Aldunate, G. (2006): Flora nativa de valor ornamental. Identificación & propagación. Chile: Zona Sur y Austral.

Rivas-Martínez, S. (1995): Clasificación bioclimática de la tierra. Folia Bot. Matritensis 16: 1-25.

Rivas-Martínez, S., Rivas-Saenz, S. & Penas, A. (2011): Worldwide bioclimatic classification system. Global Geobotany 1: 1-640 (4 Maps).

Rivas-Martínez, S. (1987): Memoria del mapa de series de vegetación de España. ICONA, Serie Técnica. Servicio de publicaciones del Ministerio de Agricultura, Pesca y Alimentación. España. 268 p + 30 maps.

Rivas-Martínez, S. (2005): Avances en Geobotánica. Discurso de apertura de curso académico de la Real Academia Nacional de Farmacia.

Rivas-Martínez, S., Navarro, G., Penas, A. & Costa M. (2011): Biogeographic maps of South America. A preliminary survey. International Journal of Geobotanical Research 1: 21-40 (1 Map)

Riveros, C. & Ramírez, C. (1978): Fitocenosis epífitas de la asociación *Lapagerio-Aextoxiconetum* en el Fundo San Martín (Valdivia, Chile). Acta científica venezolana 29: 163-169.

Rodríguez, R. (1995): Pteridophyta: 119-307 p. In: Marticorena, C. & Rodríguez, R. (Eds.): Flora de Chile. Volumen. 1. Concepción. Chile

Rodríguez, R., Alarcón, D. & Espejo, J. (2009): Helechos nativos del Centro-Sur de Chile. Guía de campo. Editorial Corporación Chilena de la Madera (CORMA). Concepción, Chile. 212 p.

Rodríguez, R., Matthei, O. & Quezada, M. (1983): Flora Arbórea de Chile. Ediciones Universidad De Concepción. Concepción-Chile. 408 p.

Roskov Y., Kunze T., Orrell T., Abucay L., Paglinawan L., Culham A., Bailly N., Kirk P., Bourgoin T., Baillargeon G., Decock W., De Wever A. & Didžiulis V. (Eds). (2014): Species 2000 & ITIS Catalogue of Life 2014 Annual Checklist. DVD. Species 2000. Naturalis, Leiden, The Netherlands.

Sadzawka, A., Carrasco, M. A., Grez, R., Mora, M. L., Flores, H. & Neaman, A. (2006): Métodos de análisis recomendados para los suelos de Chile. Revisión 2006. Ministerio de Agricultura, Instituto de Investigaciones Agropecuarias (INIA). Serie Actas INIA N^{a} 34, Santiago, Chile. 164 p.

Sadzawka, A., Peralta, M., Ibarra, M., Peralta, J. & Fuentes, J. (1995): Caracteristicas quimicas de los suelos forestales chilenos. Bosque 16 (9): 9-28.

Sáez, N. (1992): La degradación del bosque nativo costero en la Decima Región de Los Lagos. Lider 1:45-49

Salazar, O., Casanova, M. & Luzio, W. (2005): Correlación entre World Reference Base y Soil Taxonomy para los suelos de la X Región de Los Lagos de Chile. R. C. Suelo Nutr. Veg. 5(2): 35-45

San Martín, C. Medina, R., Ojeda, P. & Ramírez, C. (1993) La biodiversidad vegetacional del Santuario de la Naturaleza “Río Cruces” (Valdivia, Chile). Acta Botánica Malacitana 18: 259-279.

San Martín, C. Villagra, J. & Novoa, C. (2009): Comparación de manejos pratenses en el Centro Sur de Chile utilizando valores bioindicadores de Ellenberg. Gayana Botaánica 66(2): 158-170.

San Martín, C., Contreras, D., San Martín, J. & Ramírez, C. (1992): Vegetación de Marismas del centro sur de Chile. Revista Chilena de Historia Natural 65: 327-342.

San Martín, C., Ramírez, C. & Verdugo, M. (1998): Sinecología de las praderas húmedas de junquillo en el Centro-Sur de Chile. Anales de la Sociedad Chilena de Ciencias Geográficas 1: 87-94.

San Martín, J., Espinosa, A., Zanetti, S., Hauenstein, E., N Ojeda, N. & Arriagada, C. (2008): Composición y estructura de la vegetación epífita vascular en un bosque primario de Olivillo (*Aextoxicon punctatum* R. et P.) en el sur de Chile. Ecología Austral 18: 1-11.

Sandoval, M., Dörner, J., Seguel, O., Cuevas, J. & Rivera, D. (2012): Métodos de análisis físicos de suelos. Universidad de Concepción. Publicaciones Departamento de Suelos y Recursos Naturales, Chillán, Chile. Publicación N° 5. 80 p.

Sanhueza, R. & Gil, C. (2004): Bibliografía de la Cordillera Costera, X Región, Chile. Gestión Ambiental 10: 97-106.

Saravia, D. & Uribe, F. (1991): Estudios sinecológicos estadísticos en el estrato herbáceo de un bosque de Olivillo en Valdivia, Chile. Thesis. Escuela de Estadística. Universidad Austral de Chile, Valdivia. 211 p.

Schlatter, J., Grez, R. & Gerding, V. (2003): Manual para el reconocimiento de suelos. 3^a Edición. Universidad Austral de Chile. Valdivia, Chile. 114 p + 9 appendix.

Schmithüsen, J. (1956): Die räumliche Ordnung der chilenischen Vegetation. Bonner Geographische Abhandlungen 17: 1-86.

Schwen, A., Bodner, G., Scholl, P., Buchan, G. D., Loiskandl, W., (2011): Temporal dynamics of Soil Hydraulic Propierties and the Water-conducting Porosity under Different Tillage. Soil and Tillage Research 113: 89-98.

Seguel, O., Ellies, A., Mac Donald, R. & Ramírez, C. (2002a): Propiedades mecánicas en suelos sometidos a distintos usos. Revista de la Ciencia del Suelo y Nutrición Vegetal 2(2): 56-61.

Seguel, O., Ellies, A., Mac Donald, R. & Ramírez, C. (2002b): Capacidad de soporte y resistencia al corte en suelos sometidos a distintos usos. Boletin de la sociedad Chilena de la Ciencia del Suelo 18: 47-50.

Sempe, J. (1981): Las asociaciones vegetales nativas y antropogénicas del Islote Rupanco, Osorno, Chile. Thesis. Escuela de Biología. y Química. Facultad de Letras y Educación. Universidad Austral de Chile, Valdivia. 56 p.

SERNAGEOMIN [Servicio Nacional de Geología y Minería]. (2003): Mapa Geológico de Chile: versión digital. Publicación Geológica Digital, No. 4 (CD-ROM, versión 1.0). Santiago. Chile.

Smith-Ramírez, C., Armesto, J. & Valdovinos, C. (2005a): Historia, biodiversidad y ecología de los bosques costeros de Chile. Editorial Universitaria. Santiago. Chile. 708 p.

Smith-Ramírez, C., Armesto, J., Rodriguez, J., Gutierrez, A. Christie, D. & Nuñez, M. (2005b): *Aextoxicon punctatum*, el Tique u olivillo. In: Smith-Ramírez, C., Armesto, J. & Valdovinos, C. (Eds): Historia, Biodiversidad y Ecología de los Bosques Costeros de Chile. Editorial Universitaria, Santiago. 278-283 p.

Smith-Ramírez, C., Pliscoff, P., Tellier, S. & Barrera, E. (2005c): Patrones de riqueza y distribución de la flora vascular en la cordillera de la costa de Valdivia, Osorno y Llanquihue, Chile. In: Smith-Ramírez, C., Armesto, J. & Valdovinos, C. (Eds) Historia, Biodiversidad y Ecología de los Bosques Costeros de Chile. Editorial Universitaria, Santiago. 253-277 p.

Smith-Ramírez, C. & Armesto, J. (2002): Importancia biológica de los bosques costeros de la Décima Región: El impacto de la carretera costera sur. Ambiente y Desarrollo 15(1): 6-14.

Smith-Ramírez, C. (2004): The Chilean Coastal Range: a Vanishing Center of Biodiversity and Endemism in South American Temperate Rainforests. Biodiversity and Conservation 13: 373-393.

Soil Moisture (2010): Operating Instructions, 2826D08 Tension Infiltrometer-8 cm base. USA

Squeo, F.A., Gutierrez, J. R. & Hernandez, I.R. (2004): Historia Natural del Parque Nacional Fray Jorge. Ediciones Universidad de la Serena.

Steffen, W. (2005): Antecedentes limnológicos de las Cuencas Hidrográficas costeras de los ríos Chaihuín y Colún, X Región. Informe final para TNC & WWF. Valdivia, Chile. 20 p.

Steubing, L. Godoy, R. & Alberdi, M. (2002): Métodos de ecología vegetal. Editorial Universitaria. Santiago de Chile, Chile. 345 p.

Stevens, P. F. (2001 onwards). Angiosperm Phylogeny Website. Version 12, July 2012 [and more or less continuously updated since]. http://www.mobot.org/MOBOT/research/APweb/. [accessed 1 July 2012]

Subiabre, A. & Rojas, C. (1994): Geografía Física de la Región de los Lagos. Dirección de Investigación y Desarrollo. Universidad Austral de Chile. Valdivia, Chile. 117 p.

Szekely, G.J. & Rizzo, M.L. (2005): Hierarchical Clustering Via Joint Between-Within Distances: Extending Ward's Minimum Variance Method. Journal of Classification 22(2): 151-183.

Ter Braak, C.J.F. (1987a). CANOCO-a FORTRAN program for community ordination by [partial][detrended][canonical] correspondence analysis, principal components analysis and redundancy analysis. Agricultural Mathematics Group, Wageningen, The Netherlands.

Ter Braak, C.J.F (1987b): The analysis of vegetation-environment relationships by canonical correspondence analysis. Vegetatio 69: 69-77.

The Plant List (2013): Version 1.1. Published on the Internet; http://www.theplantlist.org [accessed 1 January 2012]

Theurillat, J.P. & Moravec, J. (1996): Index of New Names of Syntaxa Published in 1993. Folia Geobotanica, 31(4): 473-516.

Tichý, L. (2002): JUICE, software for vegetation classification. Journal of Vegetation Science 13: 451-453. doi:10.1111/j.1654-1103.2002.tb02069.x

Tichý, L. and Chytrý, M. (2006): Statistical Determination of Diagnostic Species for Site Groups of Unequal Size. Journal of Vegetation Science 17: 809-818. doi:10.1111/j.1654-1103.2006.tb02504.x

Tomaselli, R. (1981): The longitudinal Zoning of Vegetation in the Southern Sector of the Andes. Studi Trentini di Scienze Naturali, Acta Biologica 58: 471-484.

Troncoso, R., Cisternas, M. E., Alfaro, G. & Vukasovic, M. (1994): Antecedentes sobre volcanismo terciario, Cordillera de la Costa, X Región, Chile. Actas 7° Congreso Geológico Chileno. Universidad de Concepción: 205-209.

Tüxen, R. (1975): Dauer-Pionergesellschaften als Grezenfall der Initialgesellfachten. In: Tüxen, R. (Ed), Sukzessionsforschung 1: 13-30.

Udvardy, M. (1975): A Classification of the Biogeographical provinces of the World. Morges (Switzerland): International Union of Conservation of Nature and Natural Resources. IUCN Occasional Paper (18).

USDA, NRCS: (2013): The PLANTS Database. National Plant Data Team, Greensboro, NC 27401-4901 USA. Home Page: http://plants.usda.gov, [accessed 1 August 2013]

van der Maarel, E. (2005): Vegetation ecology - an overview. In: van der Maarel, E. (Ed.) Vegetation ecology, Blackwell. Oxford, UK. 1-51 p.

Veblen, T. & Schlegel, F. (1982): Reseña ecológica de los bosques del sur de Chile. Bosque 4(2): 73-115.

Villagrán, C. (1980): Vegetationsgeschichtliche und pflanzensoziologische Untersuchungen im Vicente Pérez Rosales National Park (Chile). Dissertationes Botanicae 54: 1-148.

Villagrán, C. & Armesto, J. (2005): Fitogeografía histórica de la Cordillera de la Costa de Chile: 99-116 p. In: Smith-Ramírez, C., Armesto, J., Valdovinos, C. (Eds): Historia, biodiversidad y ecología de los bosques costeros de Chile.

Villagrán, C., Armesto, J., Hinojosa, F., Cuvertino, J., Pérez, F. L., & Medina, C. (2004): El enigmático origen del bosque relicto de Fray Jorge. In: Historia Natural del Parque Nacional Bosque Fray Jorge, Ediciones Universidad de La Serena, La Serena, Chile.

Villagrán, C., & Hinojosa, L. F. (1997): Historia de los bosques del sur de Sudamérica, II: Análisis fitogeográfico. Revista Chilena de Historia Natural 70(2): 1-267.

Villagrán, C., Soto, C. & Serey, I. (1974): Estudio preliminar de la vegetación del Parque Nacional Vicente Pérez Rosales. Anales del Museo de Historia Natural de Valparaíso 7: 125-151.

Ward, J. H., Jr. (1963): Hierarchical Grouping to Optimize an Objective Function. Journal of the American Statistical Association 58: 236-244.

WCSP (2013): World Checklist of Selected Plant Families. Facilitated by the Royal Botanic Gardens, Kew. Published on the Internet; http://apps.kew.org/wcsp/ Retrieved

Weber, H., Moravec & Theurillat, J. (2000): International Code of Phytososiological Nomenclature. 3rd Edition. Journal of Vegetation Science 11: 739-768.

Wright, C. (1965): The Volcanic Ash Soils of Chile. Report to the Government of Chile. FAO. Rome. Report $N°$ 2017 CHI/TE/LA. 201 p. + Maps.

Yudelevich, M., Brown, C., Elgueta, H., & Calderon, S. (1967): Clasificación preliminar del bosque nativo de Chile. Informe Técnico N° 27. Instituto Forestal. Santiago, Chile. 16 p.

Zizka, G., M. Schmidt, Schulte, P. Novoa, R. Pinto & König. (2009): Chilean Bromeliaceae: Diversity, Distribution and Evaluation of Conservation Status. Biodivers. & Conservation 18: 2449-2471.

Zuloaga, F. O., Morrone, O. & M. J. Belgrano (Eds.). (2008): Catálogo de las Plantas Vasculares del Cono Sur (Argentina, Sur de Brasil, Chile, Paraguay y Uruguay). Monographs of the Missouri Botanical Garden 107. Saint Louis, USA. 3348 p.

Online Flora Catalog: http://www.darwin.edu.ar/Proyectos/FloraArgentina/fa.htm accessed in November 2012

Acknowledgements

I am very grateful to:

- Prof. Dr. Richard Pott for opening the doors of the Institute of Geobotany of the Leibniz University Hannover and allowing me to conduct the work presented in this thesis;
- Prof. Dr. Frederikus J. A. Daniëls for his help with the review of the analysis and the manuscript, and to Prof. Dr. Dietbert Thannheisser for his support and ideas;
- Becas Chile and the Deutscher Akademischer Austauschdienst (DAAD) for financing my stay in Germany, and the Graduierte Akademie of the Leibniz University Hannover for the scholarship "Research Stay Aboard 2012", which enabled the part of the investigation activity conducted in Chile;
- Prof. Dr. Carlos Ramírez and M.Sc. Cristina San Martín for encouraging me to carry out the present research project and to his family for hosting me in Valdivia (Chile) during the field work;
- Prof. Dr. Dante Pinochet and Prof. Dr. Jose Dörner of the Soil Institute of the Austral University of Chile for their guidance and support;
- Prof. Dr. Georg Guggenberger and Prof. Dr. Jörg Bachmann of the Soil Institute of the Leibniz University Hannover for their advice and help;
- Dr. Stephan M. Hennekens for kindly enabling the use of TURBOVEG database;
- The owners of the fields where I collected the data presented in this thesis for giving me access to their property: Mrs. Elsa Oyarzún, Mrs. Mariza and Rosa Baeza, Mr. José Barrientos, Mr. Pascal Quinao, Mr. Sergio Leal and the Antillancas family in Huiro and Chaihuín, Mr. Rodrigo Buzeta and Mr Oscar Brahmm of Fundo Galera and all persons of the communities of the Valdivian Coastal Range.

The list of persons I would like to thank for their help is still very long. A special mention to:

- M.Sc. Mauricio Barria and Patricio Novoa for their precious help during the field work;
- Mr. Juan Leiva for providing the cartography;
- Dr. Susane Woche, Dr. Ansgar Hoppe, Dr. Giulio Mazzolo, Ashley Curtis, Laura Pedron, M.Sc. Alischa Staebner and M.Sc. Anna Hißmann for revising the text and providing feedback.

And to my family, parents, siblings and friends for their invaluable support.

Thanks everyone!

Curriculum vitae

Persönliche Angaben

NAME	Carla Alejandra Novoa Sepúlveda
GEBURTSDATUM	11. September 1983 in Talca, Chile
AKADEMISCHE GRAD	Lic. (Chile)
BERUFSZEICHNUNG	Profesora de Biología y Ciencias Naturales [Lehrerin für Biologie und Naturwissenschaften]
STAATSANGEHÖRIGKEIT	chilenisch
EMAIL:	novoa@geobotanik.uni-hannover.de novoa.spulveda@gmail.com

Akademische Ausbildung

2010 - 2019	Promotion in Biologie Institut für Geobotanik, Leibniz Universität Hannover
2003 - 2008	Licenciada en Educación [Lizenziatin der Erziehungswissenschaften] Universidad de Playa Ancha, Valparaíso, Chile Thesis: "Estudio de la variación estacional de la comunidad de bacterias y microalgas en el humedal de Campiche, V Región " Betreuer: M.Sc. Rodrigo VILLASEÑOR
1998 - 2001	Colegio Preciosa Sangre [Gymnasium] Purranque, Región de Los Lagos, Chile

Publikationen

Ramírez, C., Sandoval, V., San Martín, C., Álvarez, M., Pérez, Y. & Novoa, C. (2012): El paisaje rural antropogénico de Aisén, Chile: Estructura y dinámica de la vegetación. *Gayana Bot.* 69(2): 219-231.

Álvarez, M., San Martín, C., Novoa, C., Toledo, G. & Ramírez, C. (2009): Diversidad florística, vegetacional y de hábitas en el archipiélago de Los Chonos (Región de Aisén, Chile. *Anales Instituto de la Patagonia* 38(1): 35-56.

Ramírez, C., San Martín, C., Novoa, C., Villagra, J. & Amigo, J. (2009): Uso de tablas fitosociológicas para detectar especies vegetales con problemas de conservación. *Agro Sur*

37(2): 91-102.

San Martín, C., Villagra, J. & Novoa, C. (2009): Comparación de manejos pratenses del centro-sur de Chile utilizando valores bioindicadores de Ellenberg. *Gayana Bot.* 66(2): 158-170.

Konferenzen

2018 | Novoa, C.. Análisis fitosociológico de la región del bosque de Olivillo (*Lapagerio roseae - Aextoxiconetum punctati* Oberdorfer, 1960) en la cordillera de la costa valdiviana, Chile.
XXVI Jornadas Internacionales de Fitosociología y III Congreso de la Sociedad Española de Geobotánica: "Geobotánica en América Latina: presente y retos del futuro". Universidad Nacional Autónoma de México, UNAM , Ciudad de México . 17.- 18. November

2013 | Novoa, C., Dörner, J., Ramírez, C. & Pott, R. Massive ausbreitung von Espinillo-Gebüsch (*Rubo-Ulicetum*, Hildebrand 1983) als folge intensiver Landnutzung im valdivianischen Küstengebiet, Chile
6. Lateinamerika Symposium: "Landscape Ecology and Biogeography", Zoological Research Museum A. Koenig (ZFMK), Bonn. 17.- 18. November

2012 | Novoa, C., Dörner, J., Ramírez, C. & Pott, R. Das invasive Espinillo (Stechginster) Gebüsch (*Rubo-Ulicetum*, Hildebrand 1983) und dadurch verursachte Landnutzungsänderungen im Valdivianischen Küstengebiet, Chile
Arbeitskreistagung der Ak "Global Change" der Tüxen-Gesellschaft. 14. - 16. September

2011 | Novoa, C., Ramírez, C. & Pott, R. Voruntersuchung von Vegetationsdynamik des Olivillo-Waldes im valdivianischen Küstengebirge, Chile
4. Lateinamerika Symposium: "Monitoring and Securing Biodiversity", Zoological Research Museum A. Koenig (ZFMK), Bonn. 17.- 18. Dezember

2009 | San Martín, C., Villagra, J., Novoa, C. & Ramírez, C. Flora de Macrófitos palustres y acuáticos de la Región de Aysén, Chile
Congreso Sociedad Chilena de Limnología. Coyhaique. 26. - 30. Oktober

San Martín, C., Villagra, J & Novoa, C.. Comparación de manejos pratenses del Centro-Sur de Chile con los valores Bioindicadores de Ellenberg
XXX Congreso Nacional y XV Congreso Internacional de Geografía "Geografía, Desarrollo Sustentable y Medio Ambiente: Desafíos locales para demandas globales" Sociedad Chilena de Ciencias Geográficas y Universidad Autónoma de Chile, Talca. 13. - 16. Oktober

2008 | Novoa, C. & Villaseñor, R. Estudio de la variación estacional de la Comunidad de Bacterias y Microalgas perifíticas en el Humedal de Campiche, V Región, Valparaíso, Chile
XX Reunión anual, Sociedad de Botánica de Chile. "Biodiversidad, desde los genes a los ecosistemas". Olmué, Chile. 25. - 28. September