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Data Paper

Exploring the vegetation of the coastal road in Puerto Cisnes, southern Chile: a vascular plant inventory

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Abstract

Background

In areas of low disturbance, such as the Aysén Region of Chile, the presence of roads can inadvertently facilitate the spread of invasive species. To address this issue, it is imperative to maintain up-to-date biological inventories, as they serve as a primary source of information for the conservation of species and ecosystems. However, the maintenance of systematic inventories of vascular plants in Chile is virtually non-existent, especially outside protected wilderness areas. The data we have come from an inventory of vascular plant species along a stretch of coastal road in Puerto Cisnes (Aysén Region), characterised by a cut slope in the rock. The site is located between mountain ranges, in a region known for its protected wilderness areas and low levels of anthropogenic alteration. The study adopted an observational sampling design, using the road as a transect. For each species identified, the growth substrate, habit and dispersal mode were recorded. A total of 70 species (36 herbs, 23 shrubs and 11 trees) belonging to 42 families were found. The most represented families were Hymenophyllaceae (nine species) and Myrtaceae (four species). We recorded nine introduced species belonging to seven botanical families

(*Cirsium vulgare* (Savi) Ten., *Crocosmia crocosmiiflora* (Lemoine ex Burb. & Dean) N.E.Br., *Cytisus scoparius* (L.) Link, *Digitalis purpurea* L., *Lotus pedunculatus* Cav., *Plantago lanceolata* L., *Polygonum campanulatum* Hook. f., *Prunella vulgaris* L., *Rubus constrictus* Lefèvre & P.J.Müll). Of these nine species, seven are invasive, while the remaining two species have not been assessed for invasive potential (i.e. *Crocosmia crocosmiiflora* and *Polygonum campanulatum*). In particular, *Crocosmia crocosmiiflora* and *Rubus constrictus* are new regional records. The majority of species were found growing on the ground (44 species), while a significant proportion were found exclusively on rocky slopes (17 species). According to their seed dispersal mechanism, the most common syndromes were anemochory (32 species) and ornithochory (20 species). Other mechanisms such as mammalochory, ballochory or myrmecochory were less common (less than four species).

New information

This study provides valuable data on the vascular flora of Puerto Cisnes, Chile, a modest human settlement in a minimally altered landscape. The region, dominated by native forests and a burgeoning salmon farming industry, has few inventories, so the database presented here adds significantly to local botanical knowledge. The main novelty of this research is that it is the first inventory carried out on a road in a slightly altered area surrounded by protected wilderness areas (such as Magdalena Island National Park and Queulat National Park). The study systematically categorises species according to substrate, habitat and dispersal mode, dimensions that are rarely combined in a single database.

The inventory identifies 70 species (36 herbs, 23 shrubs and 11 trees) in 42 families. The most represented families were Hymenophyllaceae (with nine species) and Myrtaceae (with four species). Additionally, we recorded, two introduced species (*Crocosmia crocosmiiflora* and *Rubus constrictus*) at least 100 km south of their known distribution.

Keywords

invasive species, filmy ferns, vascular plants, rupicolous plants, fjords

Introduction

Inventories are indispensable for understanding the spatial and temporal distribution of species. Such baseline information can serve multiple purposes, such as the generation of species distribution models (Weigelt et al. 2019), ecosystem restoration (Rai 2022) and the management and control of invasive exotic species (Fuentes et al. 2010). In Chile, as in many other Latin American countries, species monitoring is virtually non-existent (Möller and Muñóz-Pedreros 2014, Fuentes et al. 2010, Moussy et al. 2021), leaving little information to track the movement of species or their populations within a region. Certain groups, such as invasive plants, can significantly impact ecosystems, nutrient cycling,

water production and fire regimes (Weidlich et al. 2020). These species colonise open areas, such as roadsides or railway lines (Deeley and Petrovskaya 2022), but systematic monitoring of these types of sites is lacking (Weigelt et al. 2019).

Inventories conducted on roads facilitate the study of species movements and their dispersal to other sites, enabling the prevention and management of potential biological invasions (e.g. Pauchard and Alaback 2004, Fuentes et al. 2013, Deeley and Petrovskaya 2022). Inventories are, therefore, needed to identify which new species are establishing in a given area and to act as an early warning system to prevent potential impacts. The identification and control of invasive species can contribute to the 14th and 15th goals of the Sustainable Development Goals (United Nations 2015) and, in particular, to the post-2020 global biodiversity framework (CBD 2021).

The Aysén Region of Chile has a limited number of inventories (e.g. Tomé et al. (2007), Teillier and Marticorena (2002), Quintanilla et al. (2008), Rodríguez et al. (2008), Promis et al. (2013), Sánchez-Jardón et al. (2013), Ramírez et al. (2014)); therefore, the database presented in this work contributes to the local understanding of the flora. The main novelty of this study is that it is the first inventory carried out on a road in a slightly modified area surrounded by protected wilderness areas (i.e. Magdalena Island National Park and Queulat National Park). The study includes the systematic categorisation of species based on substrate, habitat and dispersal mode, aspects rarely reported in a single database (but see Pincheira-Ulbrich et al. (2021)).

The inventory presents a total of 70 species (36 herbs [Fig. 5], 23 shrubs [Fig. 6] and 11 trees [Fig. 7]) belonging to 42 families (Table 1, Suppl. material 1). We recorded nine introduced species belonging to seven botanical families. Of these nine species, seven are invasive (*Cirsium vulgare* (Savi) Ten., *Cytisus scoparius* (L.) Link, *Digitalis purpurea* L., *Lotus pedunculatus* Cav., *Plantago lanceolata* L., *Prunella vulgaris* L., *Rubus constrictus* P.J. Müll. & Lefèvre), while the remaining two species (i.e. *Crocosmia crocosmiiflora* and *Polygonum campanulatum*) have not been assessed for invasive potential (Fuentes et al. 2013, Fuentes et al. 2020). The most represented families were Hymenophyllaceae (nine species, Fig. 4) and Myrtaceae (four species, e.g. Fig. 7a, e). Two new records of introduced species (*Crocosmia crocosmiiflora* and *Rubus constrictus*, Fig. 3) were recorded at least 100 km south of their known distribution (Fuentes et al. 2013, Rodriguez et al. 2018, Fuentes et al. 2020).

Project description

Study area description: Puerto Cisnes is a small coastal town in the Aysén Region of Chile (44°43'46.33"S, 72°40'51.85"W). It is located in a small bay of the Puyuhuapi Channel, adjacent to the mouth of the Cisnes River (Fig. 1), opposite the Magdalena Island National Park and a few kilometres from the Queulat National Park. The landscape is diverse and includes native forests, channels and mountain ranges. The town has a population of about 7,000 and the salmon industry is the main economic activity, with tourism a secondary activity.

Table 1.

Vascular plants along a coastal road in Puerto Cisnes, Aysén Region, Chile. Species: Scientific name of a species. Habit: Climbing shrub, herb, liana, shrub and tree. Site where species were observed: Transect 1, Transect 2, Isolated rock, Transect 3. Seed dispersal syndrome: anemochorous, ornithochorous, mammalochory, ballochory, myrmecochory according to Armesto and Rozzi (1989), Wilson et al. (1996) and Salvande et al. (2011). Geographical origin: native, endemic and introduced according to Rodriguez et al. (2018). *: Invasive species according to Fuentes et al. (2013) and Fuentes et al. (2020). 1: presence, 0: absence

Species	Habit	Transect 1	Transect 2	Isolated rock	Transect 3	Seed dispersal syndrome	Geographic origin
Acaena ovalifolia Ruiz & Pav.	Herb	1	1	0	0	Epizoochory	Native
Acrisione cymosa (J. Remy) B. Nord.	Shrub	0	1	0	0	Anemochory	Endemic
Adiantum chilense Kaulf.	Herb	1	1	0	0	Anemochory	Native
Amomyrtus luma (Molina) D. Legrand & Kausel	Tree	1	1	0	1	Ornithochory	Native
Aristotelia chilensis (Molina) Stuntz	Tree	0	1	0	0	Ornithochory	Native
Asplenium dareoides Desv.	Herb	1	0	0	1	Anemochory	Native
Asplenium trilobum Cav.	Herb	0	1	1	1	Anemochory	Native
Asteranthera ovata (Cav.) Hanst.	Shrub	1	1	0	0	Ornithochory	Native
Azara lanceolata Hook.f.	Shrub	1	1	0	1	Ornithochory	Native
Berberis darwinii Hook.	Shrub	1	1	0	0	Ornithochory	Native
Berberis microphylla G. Forst.	Shrub	0	1	0	0	Ornithochory	Native
Blechnum chilense (Kaulf.) Mett.	Herb	1	1	1	0	Anemochory	Native
Blechnum penna-marina (Poir.) Kuhn	Herb	0	1	0	1	Anemochory	Native
Caldcluvia paniculata (Cav.) D. Don	Tree	1	1	1	0	Anemochory	Native
Campsidium valdivianum (Phil.) Skottsb.	Shrub	1	1	0	0	Anemochory	Native

Species	Habit	Transect 1	Transect 2	Isolated rock	Transect 3	Seed dispersal syndrome	Geographic origin
Diplolepis pachyphylla (Decne.) Hechem & C. Ezcurra	Herb	0	0	0	1	Anemochory	Native
Chusquea culeou E. Desv.	Herb	0	0	0	1	Anemochory	Native
Cirsium vulgare (Savi) Ten.	Herb	0	0	0	1	Anemochory	Introduced*
Crocosmia crocosmiiflora (Lemoine ex Burb. & Dean) N.E.Br.	Herb	0	1	0	0	Hydrochory/ zoochory	Introduced
Cytisus scoparius (L.) Link	Shrub	0	1	0	0	Ballochory/ myrmecochory	Introduced*
Digitalis purpurea L.	Herb	0	1	0	0	Multiple	Introduced*
Drimys winteri J.R. Forst. & G. Forst.	Tree	1	0	0	1	Ornithochory	Endemic
Dysopsis glechomoides (A. Rich.) Müll. Arg.	Herb	0	1	0	0	Ballochory/ myrmecochory	Endemic
Embothrium coccineum J.R. Forst. & G. Forst.	Tree	0	1	0	0	Anemochory	Native
Ercilla syncarpellata Nowicke	Shrub	0	1	0	0	Ornithochory	Endemic
Fascicularia bicolor (Ruiz & Pav.) Mez	Herb	0	1	0	0	Ornithochory	Endemic
Fuchsia magellanica Lam.	Shrub	1	1	0	0	Ornithochory	Native
Galium hypocarpium (L.) Endl. ex Griseb.	Herb	1	1	0	1	Mammalochory/ saurochory	Native
Gaultheria phillyreifolia (Pers.) Sleumer	Shrub	0	1	0	0	Ornithochory/ saurochory	Native
Griselinia racemosa (Phil.) Taub.	Shrub	1	1	1	0	Ornithochory	Native
Gunnera magellanica Lam.	Herb	0	1	0	0	Mammalochory	Native
Gunnera tinctoria (Molina) Mirb.	Herb	0	1	0	0	Mammalochory	Native

Species	Habit	Transect 1	Transect 2	Isolated rock	Transect 3	Seed dispersal syndrome	Geographic origin
Hydrangea serratifolia (Hook. & Arn.) F. Phil.	Shrub	1	1	0	0	Multiple	Native
Hymenoglossum cruentum (Cav.) C. Presl	Herb	1	0	0	0	Anemochory	Native
Hymenophyllum cuneatum Kunze	Herb	1	0	1	0	Anemochory	Endemic
Hymenophyllum dentatum Cav.	Herb	1	1	1	1	Anemochory	Native
Hymenophyllum falklandicum Baker	Herb	0	0	1	0	Anemochory	Native
Hymenophyllum krauseanum Phil.	Herb	1	1	0	0	Anemochory	Native
Hymenophyllum pectinatum Cav.	Herb	1	1	0	0	Anemochory	Native
Hymenophyllum peltatum (Poir.) Desv.	Herb	1	0	1	1	Anemochory	Native
Hymenophyllum plicatum Kaulf.	Herb	1	1	1	0	Anemochory	Native
Laureliopsis philippiana (Looser) Schodde	Tree	1	1	1	1	Anemochory	Native
Leptinella scariosa Cass.	Herb	0	1	0	0	Anemochory	Native
Lomatia ferruginea (Cav.) R. Br.	Tree	1	1	0	0	Anemochory	Native
Lophosoria quadripinnata (J.F. Gmel.) C. Chr.	Herb	1	1	1	0	Anemochory	Native
Lotus pedunculatus Cav.	Herb	0	1	0	0	Anemochory	Introduced*
Luma apiculata (DC.) Burret	Tree	0	1	0	1	Ornithochory	Native
Luzuriaga polyphylla (Hook.) J.F. Macbr.	Subshrub	1	1	0	1	Ornithochory	Endemic
Luzuriaga radicans Ruiz & Pav.	Subshrub	0	1	0	0	Ornithochory	Native
Megalastrum spectabile (Kaulf.) A.R. Sm. & R.C. Moran	Herb	0	1	0	0	Anemochory	Native

Species	Habit	Transect 1	Transect 2	Isolated rock	Transect 3	Seed dispersal syndrome	Geographic origin
Mitraria coccinea Cav.	Shrub	1	1	0	0	Ornithochory	Native
Myrceugenia planipes (Hook. & Arn.) O. Berg	Tree	0	0	0	1	Ornithochory	Native
Nertera granadensis (Mutis ex L.f.) Druce	Herb	1	1	0	0	Ornithochory/ saurochory	Native
Philesia magellanica J.F. Gmel.	Subshrub	0	1	0	0	Ornithochory	Native
Plantago australis Lam.	Herb	0	1	0	0	Hydrochory	Endemic
Plantago lanceolata L.	Herb	0	1	0	0	Hydrochory	Introduced*
Polygonum campanulatum Hook. f.	Herb	1	0	0	0	Hydrochory/ zoochory	Introduced
Prunella vulgaris L.	Herb	0	1	0	0	Myrmecochory	Introduced*
Ranunculus repens L.	Herb	0	1	0	0	Hydrochory	Native
Rhaphithamnus spinosus (Juss.) Moldenke	Shrub	0	0	0	1	Ornithochory	Native
Raukaua laetevirens (Gay) Frodin	Shrub	0	1	0	1	Ornithochory	Native
Ribes magellanicum Poir.	Shrub	1	1	0	0	Ornithochory	Native
Rubus constrictus Lefèvre & P.J.Müll	Shrub	0	1	0	0	Endozoochory	Introduced*
Sarmienta scandens (J.D. Brandis ex Molina) Pers.	Shrub	0	1	0	0	Anemochory	Endemic
Serpyllopsis caespitosa (Gaudich.) C. Chr.	Herb	1	0	1	1	Anemochory	Native
Sophora cassioides (Phil.) Sparre	Tree	0	0	0	1	Hydrochory	Endemic
Sticherus squamulosus (Desv.) Nakai	Herb	0	1	0	0	Anemochory	Endemic
Synammia feuillei (Bertero) Copel.	Herb	0	0	0	1	Anemochory	Native
Tepualia stipularis (Hook. & Arn.) Griseb.	Shrub	1	1	0	0	Anemochory	Native
Weinmannia trichosperma Cav.	Tree	0	1	0	0	Anemochory	Native

Figure 1. doi

Study area in Puerto Cisnes. T1: transect 1, corresponding to a small transect in the north. T2: transect 2, corresponding to most of the road. Yellow circle, corresponding isolated rock in the middle of transect 2. T3: transect 3, corresponding to the beach in the south.

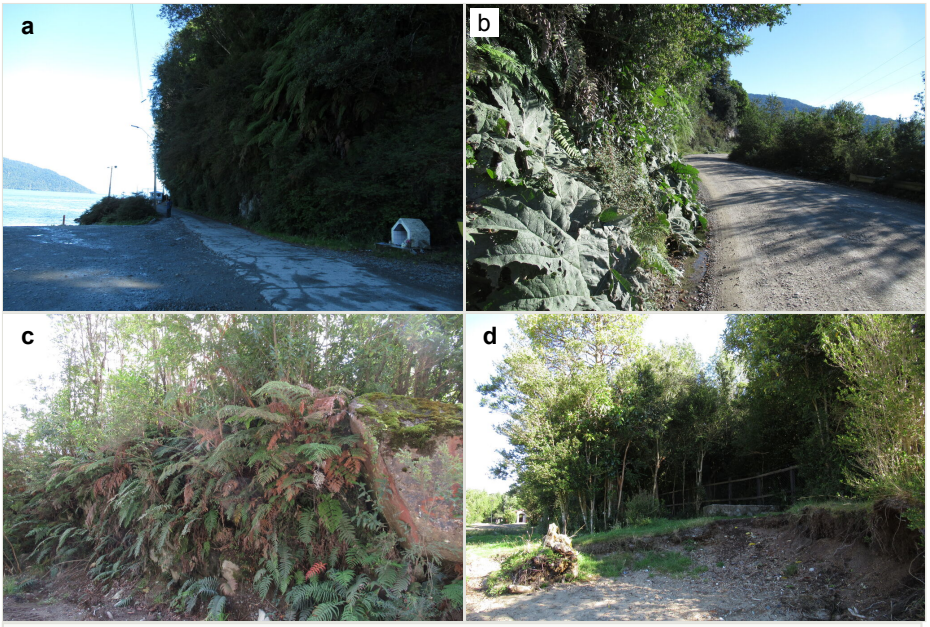

Figure 2.

Study sites.

a: Transect 1; doi
b: Transect 2; doi
c: Isolated rock; doi
d: Transect 3. doi

Figure 3.

A sample of introduced plants.

a: *Cirsium vulgare*; doi
b: *Crocosmia crocosmiiflora*; doi
c: *Digitalis purpurea*; doi
d: *Prunella vulgaris*; doi
e: *Polygonum campanulatum*; doi
f: *Rubus constrictus*. doi

Design description: Data collection took place between 24 and 26 February 2017. Sampling followed an observational protocol using the road as a transect with a continuous walk-through approach being employed (Brower et al. 1997). An inventory of species occurrences was conducted along a transect of approximately 2.45 km, covering both sides of the road and the rock face forming the fjord escarpment. In the near-vertical cut areas adjacent to the road, species growing within the first few metres, easily accessible from the road, were recorded. Whilst safety constraints prevented direct sampling from higher areas, an attempt was made to identify all species visible from the base of the cut.

Each species was recorded at the time of first detection, regardless of subsequent occurrences within the transect. The primary aim of this strategy was to capture the broadest possible diversity of species within the constraints of the study area (Diekmann et al. 2007). The width of the transect was dictated by the physical constraints of the site, namely the road and the adjacent rock face (Diekmann et al. 2007, Speak et al. 2018). On the beach, the average transect width was 10 m.

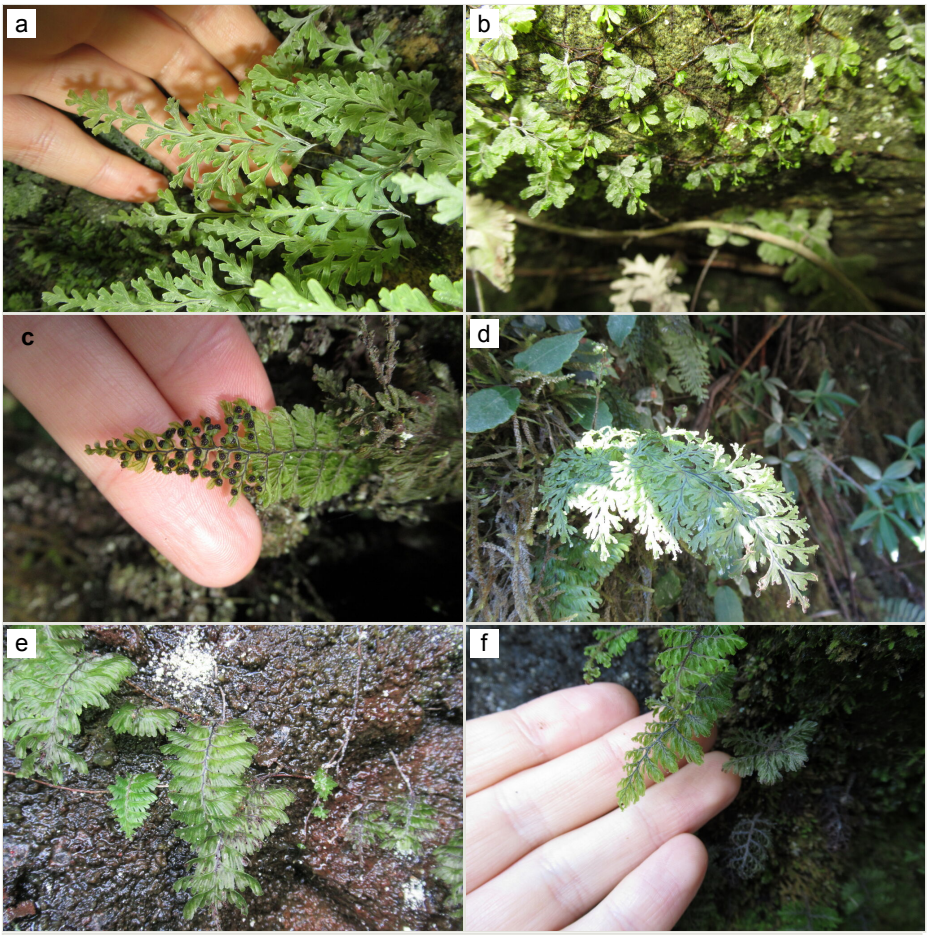

Figure 4.

A sample of filmy ferns (Hymenophyllaceae) diversity.

a: *Hymenophyllum cuneatum*; doi
b: *Hymenophyllum falklandicum*; doi
c: *Hymenophyllum dentatum*; doi
d: *Hymenophyllum krauseanum*; doi
e: *Hymenophyllum pectinatum*; doi
f: *Hymenophyllum plicatum*. doi

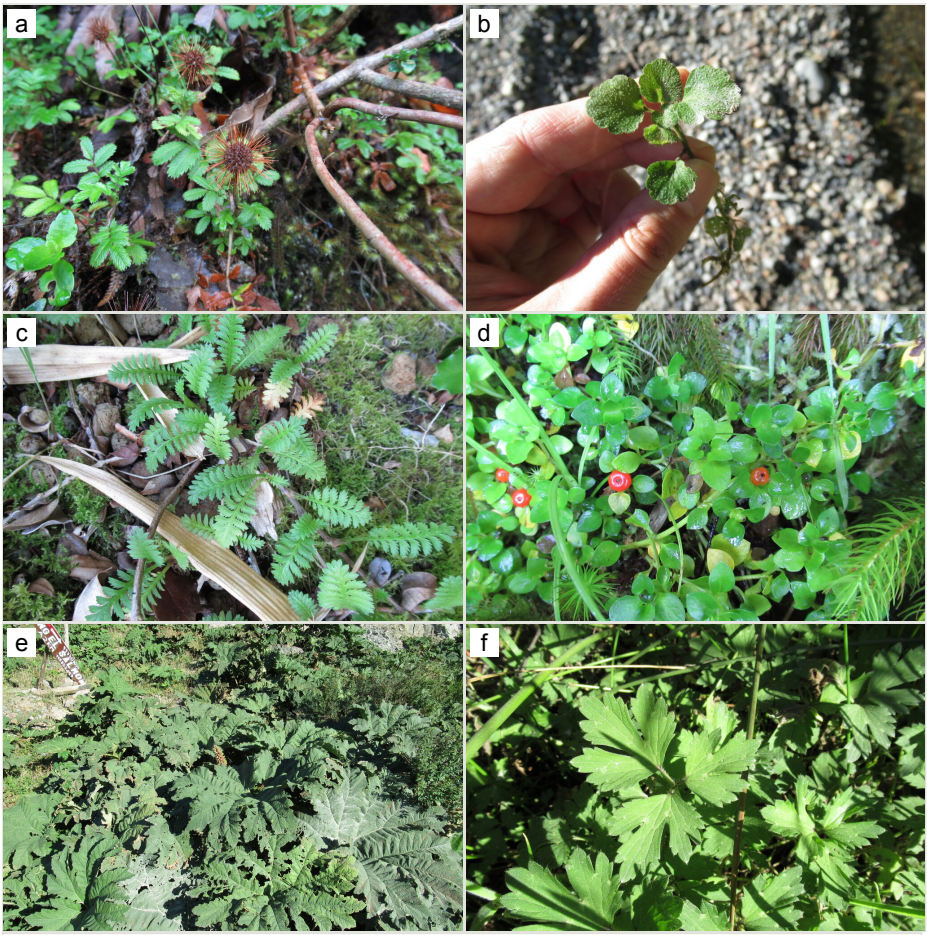

Figure 5.

A sample of herbs diversity.

a: *Acaena ovalifolia*; doi
b: *Dysopsis glechomoides*; doi
c: *Leptinella scariosa*; doi
d: *Nertera granadensis*; doi
e: *Gunnera tinctoria*; doi
f: *Ranunculus repens*. doi

The data were organised according to four sampling locations: Transect 1, corresponding to a small transect in the north; Transect 2, corresponding to most of the road; Isolated Rock, corresponding to a point in the middle of Transect 2; and Transect 3, corresponding to the beach in the south (Fig. 2). The urban area was excluded from the study. After data collection, the information was formatted according to the Darwin Core Standard for Biodiversity Data (https://dwc.tdwg.org/). The refinement of this criterion by Groom et al. (2019) enhances its suitability for the study and management of invasive species by

providing a more detailed representation of the native status, establishment level and site occupancy means of the organism.

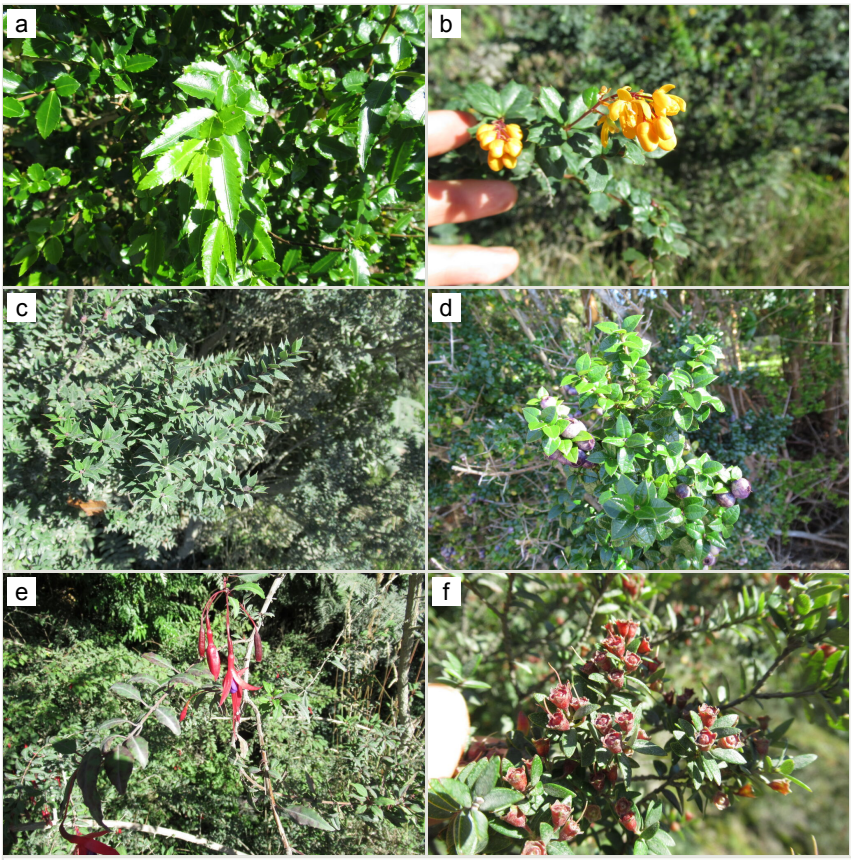

Figure 6.

A sample of shrub diversity.

a: *Azara lanceolata*; doi
b: *Berberis darwinii*; doi
c: *Gaultheria phillyreifolia*; doi
d: *Raphithamnus spinosus*; doi
e: *Fuchsia magellanica*; doi
f: *Tepualia stipularis*. doi

Sampling methods

Sampling description: Field notes, photographs and some difficult-to-identify specimens taken along the transects were examined in the laboratory. Three types of data were described: (i) taxonomic identity, according to Marticorena and Rodríguez (Marticorena and Rodríguez 1995, Marticorena and Rodríguez 2001, Marticorena and Rodríguez 2003, Marticorena and Rodríguez 2005, Marticorena and Rodríguez 2011), (ii) microhabitat

substrate (soil, rock escarpment, tree) as observed in the field, (iii) growth form (climber, epiphyte, liana, terricolous), according to Rodriguez et al. (2018), (vi) habit (herb, shrub, subshrub and tree), according to Rodriguez et al. (2018), (vi) dispersal syndrome (anemochorous, ornithochorous, mammalochory, ballochory, myrmecochory), according to Armesto and Rozzi (1989), Wilson et al. (1996), Salvande et al. (2011) and (vi) geographic origin (native, endemic, introduced) according to Rodriguez et al. (2018) and Fuentes et al. (2020). Taxonomic nomenclature followed Rodriguez et al. (2018) and the International Plant Names Index (IPNI 2022).

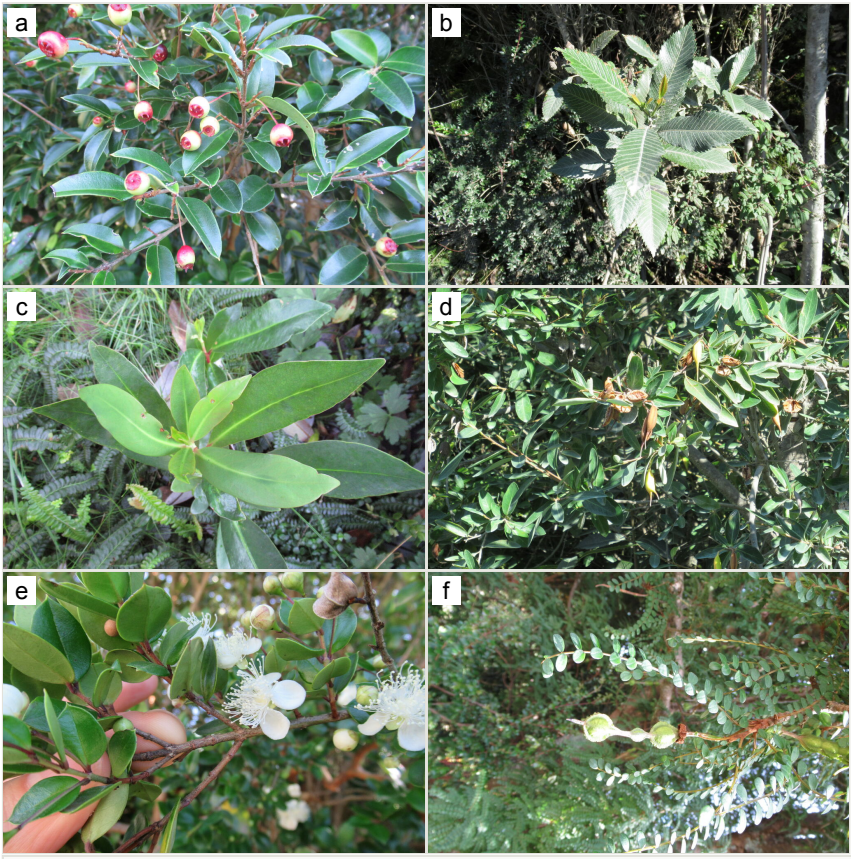

Figure 7.

A sample of trees diversity.

a: *Amomyrtus luma*; doi
b: *Caldcluvia paniculata*; doi
c: *Drimys winteri*; doi
d: *Embothrium coccineum*; doi
e: *Luma apiculata*; doi
f: *Sophora cassioides*. doi

Geographic coverage

Description: Locality of Puerto Cisnes in Chile, situated in a small bay of the Puyuhuapi Channel, next to the mouth of the Cisnes River.

Coordinates: -44.7454° and -44.7242° Latitude; -72.6989° and -72.6877° Longitude.

Usage licence

Usage licence: Creative Commons Public Domain Waiver (CC-Zero)

Data resources

Data package title: Vascular plants along a coastal road in Puerto Cisnes, Aysén Region, Chile.

Number of data sets: 1

Data set name: Vascular plants along a coastal road in Puerto Cisnes, Aysén Region, Chile.

Description: The dataset lists 70 vascular plant species found in three transects made along a rural road in Puerto Cisnes, Chile (Suppl. material 1).

Column label	Column description
occurrenceID	A unique identifier for each occurrence.
scientificName	The scientific name of taxon.
scientificNameAuthorship	The authorship information for the scientific name.
kingdom	The full scientific name of the kingdom in which the taxon is classified.
class	The full scientific name of the class in which the taxon is classified.
order	The full scientific name of the order in which the taxon is classified.
family	The full scientific name of the family in which the taxon is classified.
habitat	Habitat type where species was observed (i.e. Road in an evergreen forest, Beach path).
locationRemarks	Comments or notes about the location (i.e. Growing on rock, growth in the soil, tree bark or a combination of these).
country	The name of the country where the organism was found.
municipality	Village around which sampling was carried out.
stateProvince	The administrative region where sampling took place.

eventRemarks	Name of the street where the transect was located.
locality	The specific mention of the sampling unit in which the organism was found (Transects 1, 2, 3 or isolated rock).
samplingProtocol	Name of the protocol used during sampling.
decimalLatitude	The latitude of the centre of each locality.
decimalLongitude	The longitude of the centre of each locality.
dynamicProperties	A list of additional measurements for the record. Seed dispersal syndrome, Growth form, Habit.
establishmentMeans	Statement about whether a organism has been introduced to a given place and time through the direct or indirect activity of modern humans (i.e. native, introduced).
degreeOfEstablishment	The degree to which a organism survives, reproduces and expands its range at the given place and time (i.e. native, invasive, casual, established).
geodeticDatum	The geographic coordinates given in decimal latitude and decimal longitude are based on a specific ellipsoid, geodetic datum or spatial reference system (SRS) (i.e. WGS84).
coordinateUncertaintyInMetres	Measurement uncertainty in metres.
eventDate	The date when the organism was registered.
recordedBy	Name of the observer.
recordedByID	Unique identifier of the species identifier in ORCID.

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Supplementary material

Suppl. material 1: Vascular plants along a coastal road in Puerto Cisnes, Aysén Region, Chile doi

Authors: Jimmy Pincheira-Ulbrich
Data type: occurrences
Brief description: Vascular plants along a coastal road in Puerto Cisnes, Aysén Region, Chile.
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