Paisajes en transformación: biodiversidad y dinámica ecológica en los Andes de Chile central

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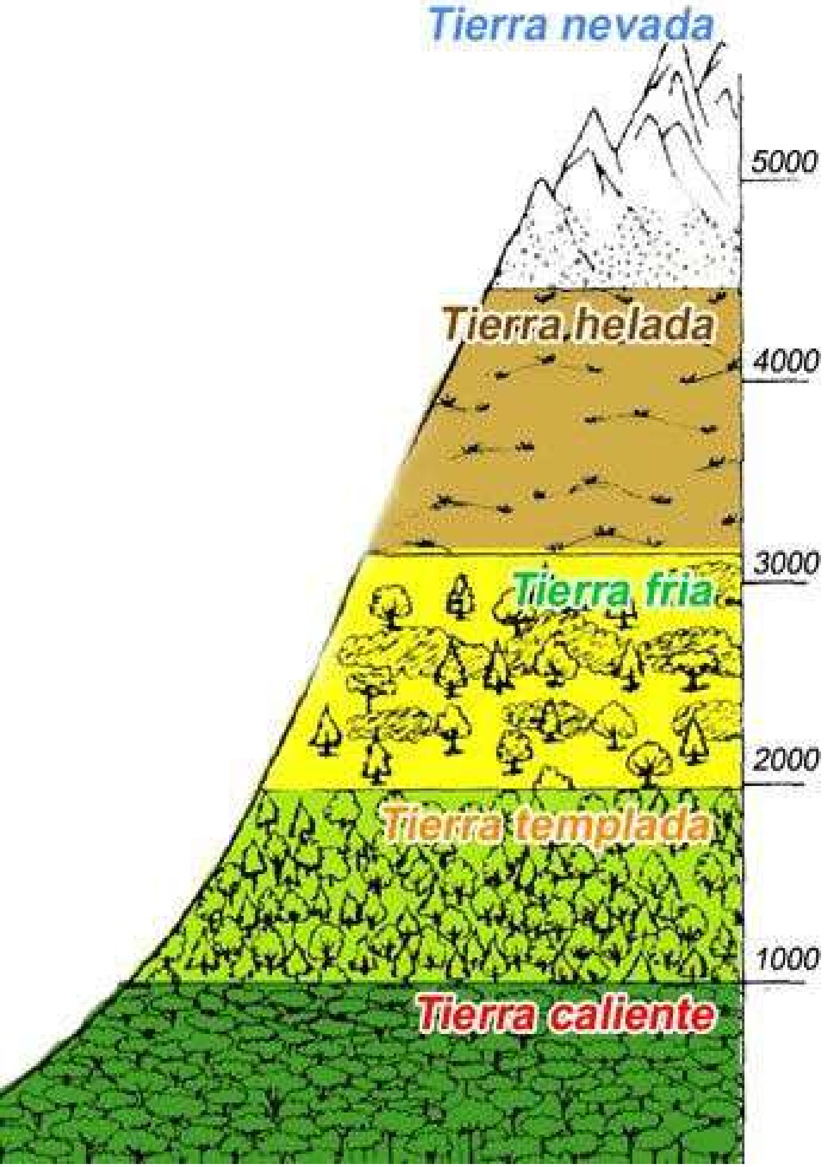
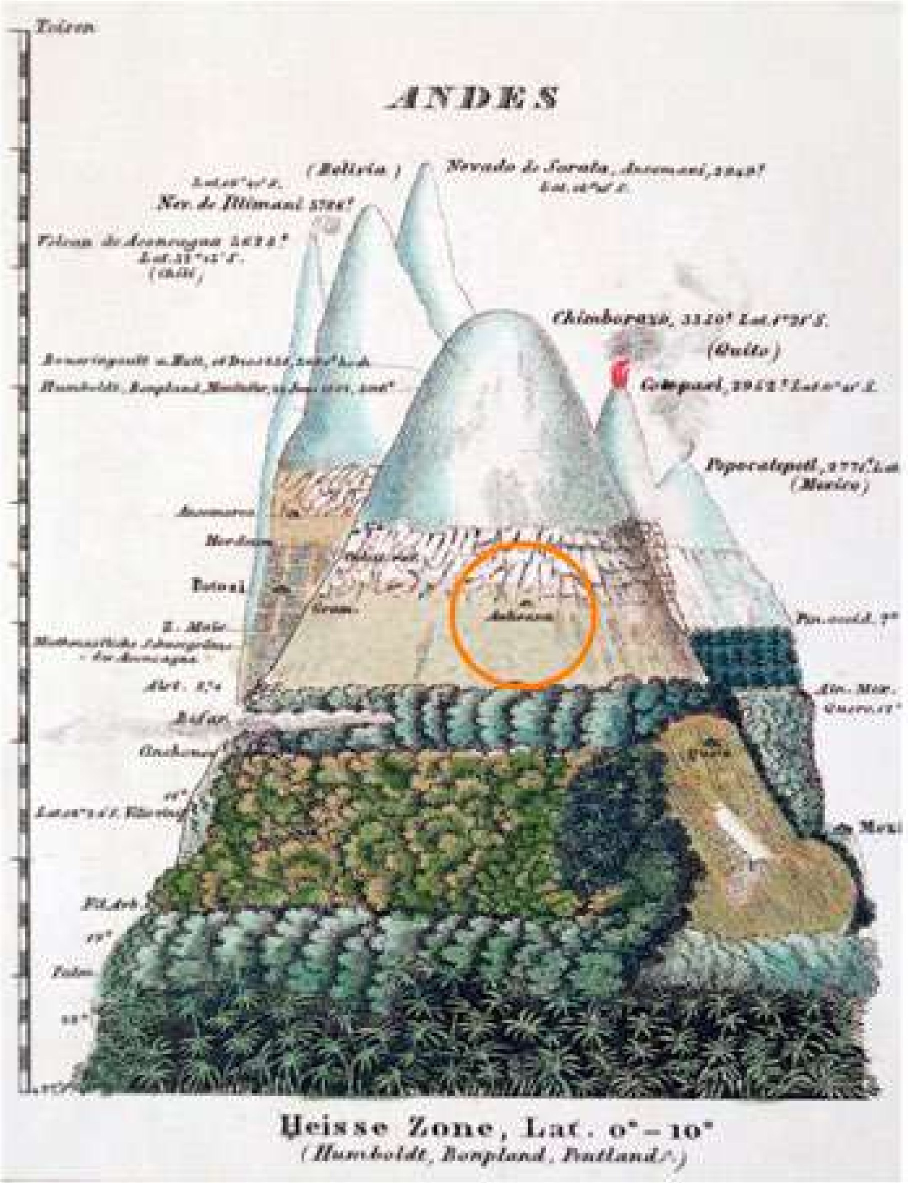
Universidad de Concepción & Instituto de Ecología y Biodiversidad (IEB)


Tierra nevada
5000
Tierra helada
4000
3000
Tierra fria
2000
Tierra templada
1000
Tierra caliente


Praderas alpinas
Praderas subalpinas
Bosques caducifolios
Selva ecuatorial
Selva ecuatorial


ANDES
Heisse Zone, Lat. 0° – 10°

Las vegetación de alta-montaña (alpina, alto-andina, etc.) es aquella que se desarrolla por sobre el límite altitudinal que crecen los árboles

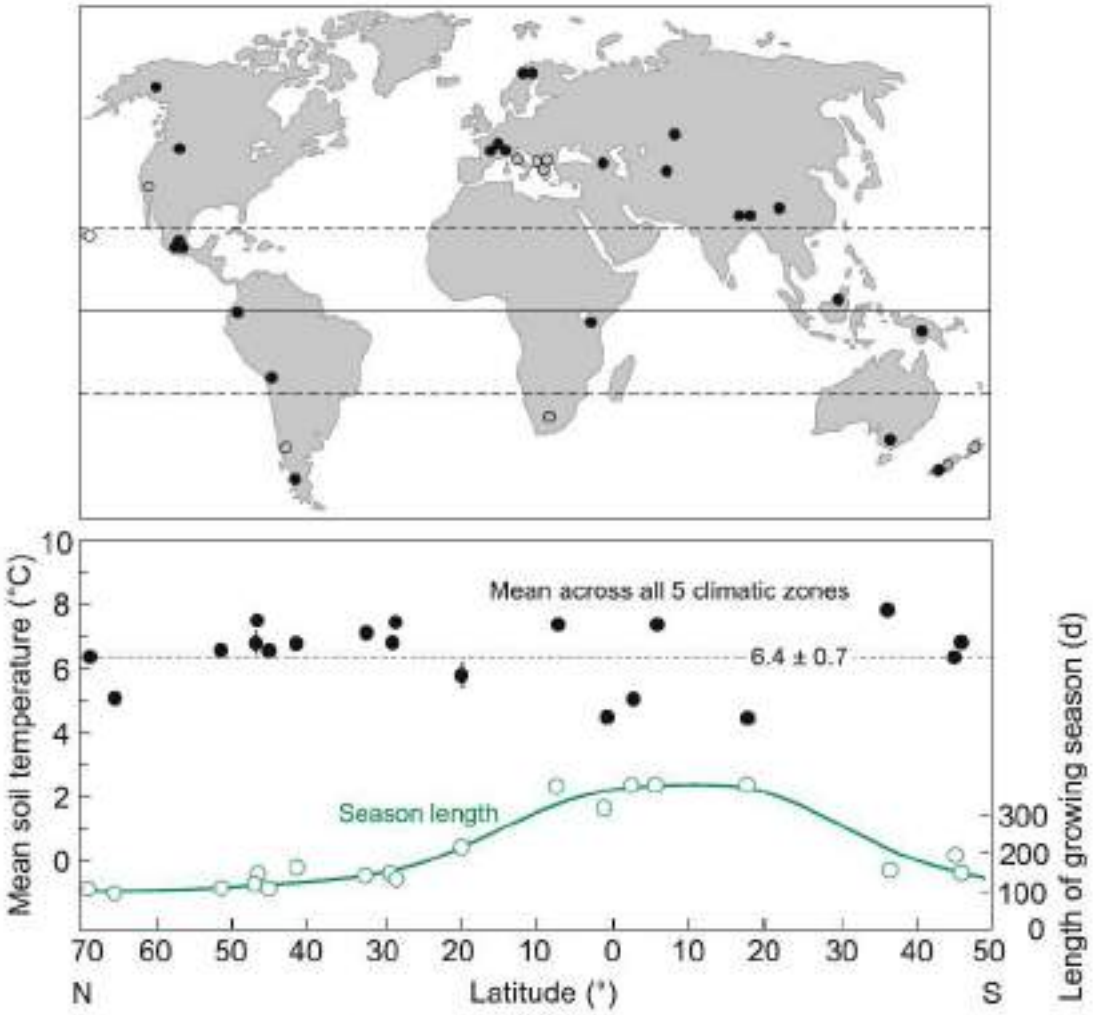
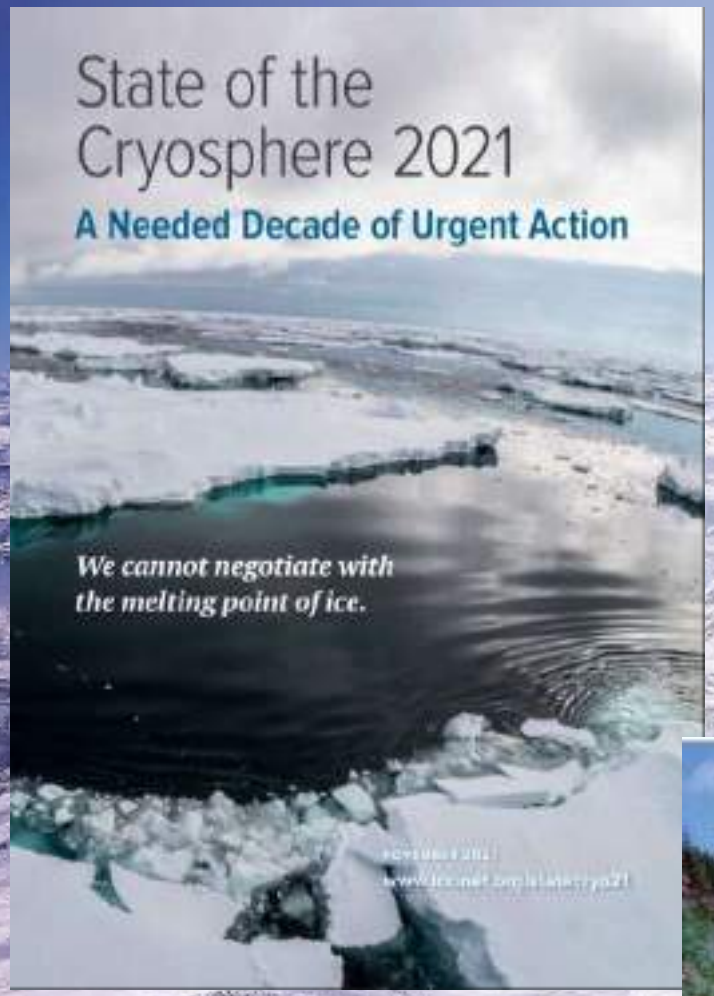


Fig. 4.10. Seasonal mean temperature and length of growing season at treeline across 40 locations worldwide, plotted against latitude (Körner and Paulsen 2004 and newer data). Closed symbols in the map are for climatic treelines, open symbols for non-treeline species limits. For regions with more than two sites only means are shown

Habitats de alta-montaña son reconocidos por su rigurosidad climática

- Bajas temperaturas
- Fuertes vientos
- Sustratos inestables
- Corta estación favorable para el crecimiento


State of the
Cryosphere 2021
A Needed Decade of Urgent Action
We cannot negotiate with
the melting point of ice.


1953
Glaciar Olivares Alfa, 2019
Louis Lliboutry, el hombre que descrifró los
ISBN 978-956-0

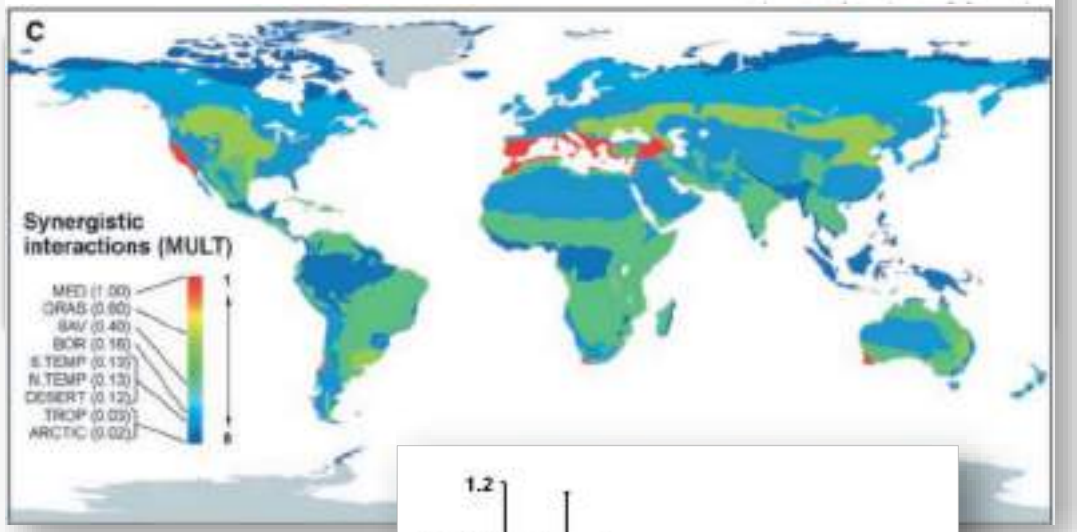

Alpine ecosystem. Species in
mountain habitats are especially
sensitive to climate change.

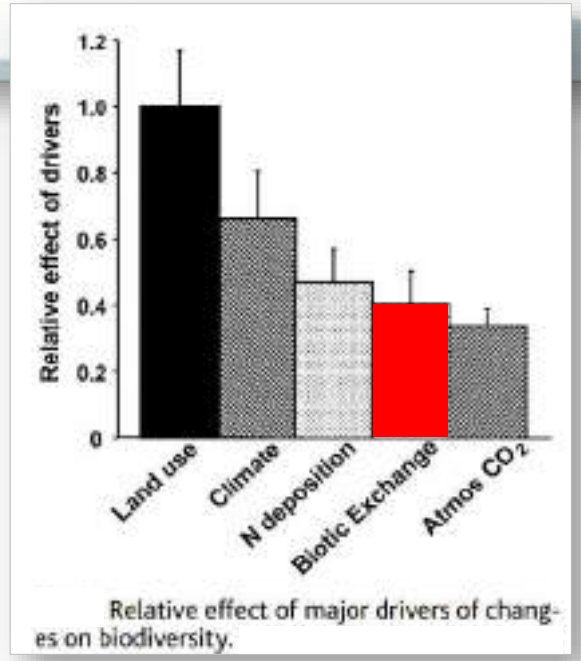
SCIENCE'S COMPASS • REVIEW

REVIEW: BIODIVERSITY

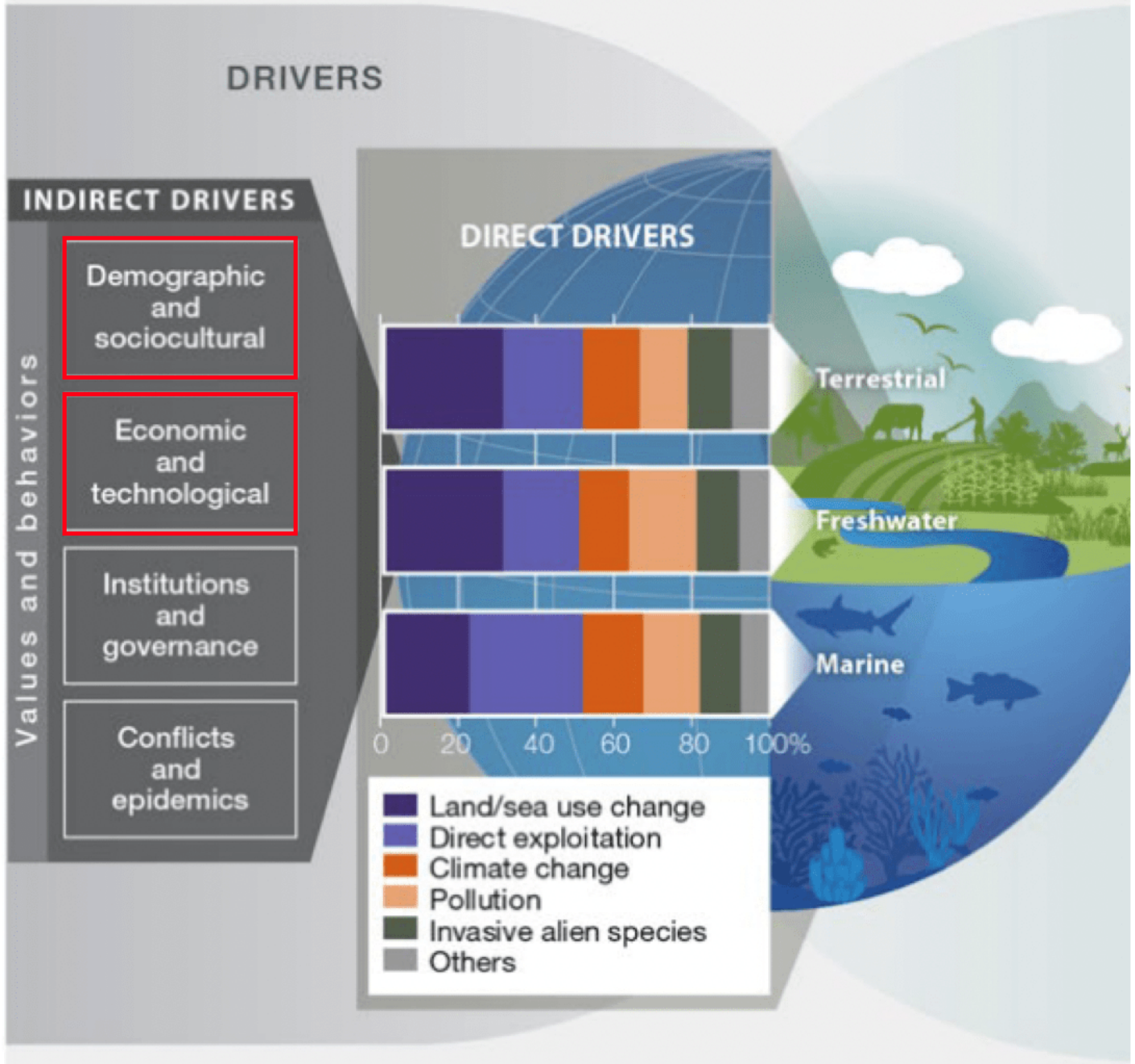
Global Biodiversity Scenarios for the Year 2100

Osvaldo E. Sala,[1]* F. Stuart Chapin III,[2] Juan J. Armesto,[3] Eric Berlow,[4] Janine Bloomfield,[5] Rodolfo Dirzo,[6] Elisabeth Huber-Sanwald,[7] Laura F. Huenneke,[8] Robert B. Jackson,[9] Ann Kinzig,[10] Rik Leemans,[11] David M. Lodge,[12] Harold A. Mooney,[13] Martin Oesterheld,[1] N. LeRoy Poff,[14] Martin T. Sykes,[15] Brian H. Walker,[16] Marilyn Walker,[5] Diana H. Wall[10]





Relative effect of major drivers of changes on biodiversity.



Vulnerabilidad de las plantas alto-andinas a agentes cambio global (especies invasoras – cambio climático)

- Monitoreo
- Experimentos/Mediciones
- Modelamiento

Andes de Chile

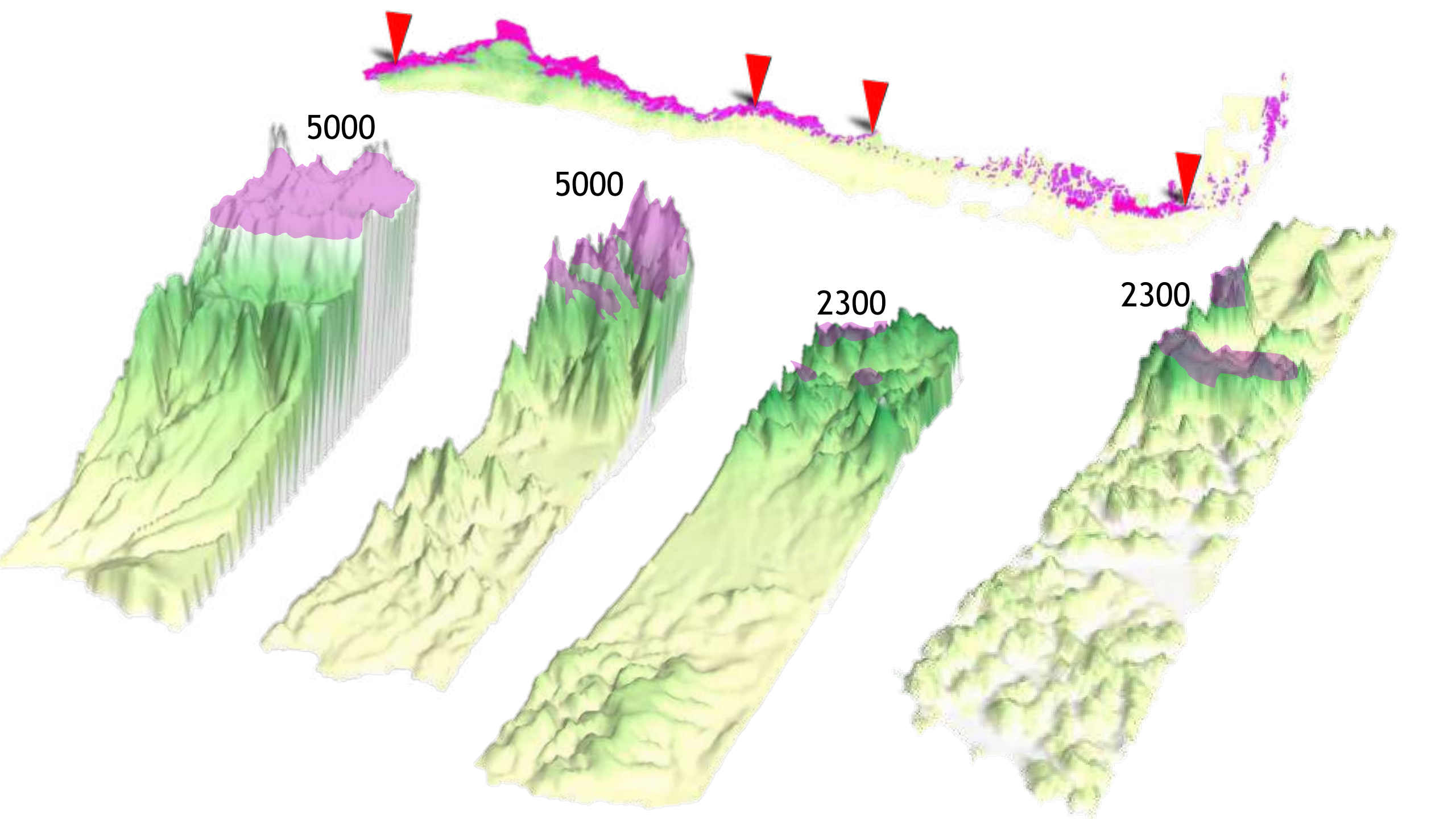
- Presente en todo Chile continental (18°-55° S).
- El territorio alto-andino **115.762 km²**, equivalentes al **15,3% del territorio nacional** (756.096 km²).

Andes de Chile

Familias	N° Especies	Porcentaje Total (%)
Asteraceae	402	24.89
Poaceae	177	10.96
Fabaceae	109	6.75
Brassicaceae	81	5.02
Solanaceae	56	3.47
Apiaceae	50	3.10
Cyperaceae	47	2.91
Montiaceae	37	2.29
Malvaceae	35	2.17
Violaceae	35	2.17

Flora alto-andina:

91 familias, 398 géneros y **1.615 especies,** de éstas **559** de las especies se encuentran de manera **exclusiva en la región Altoandina.**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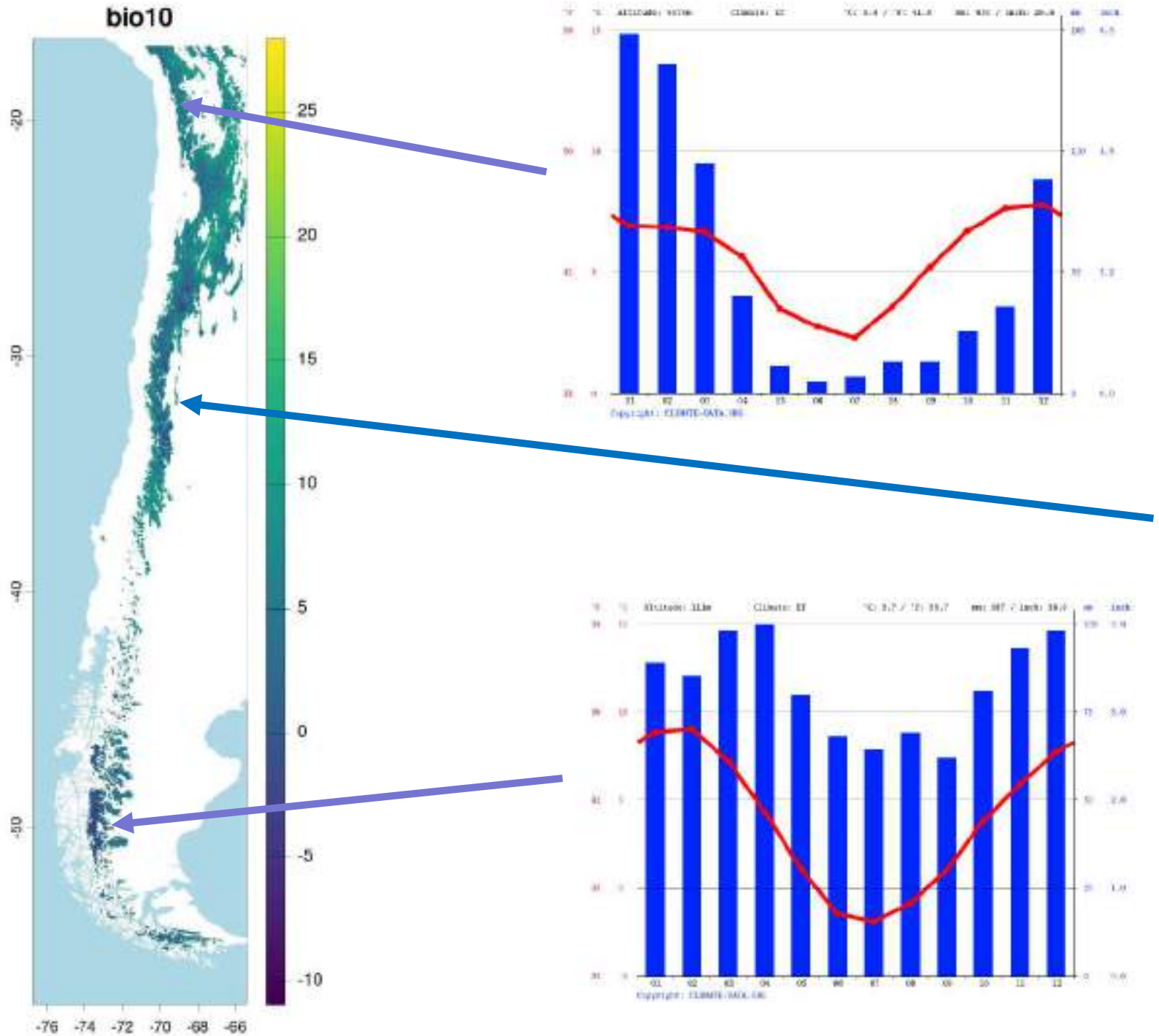
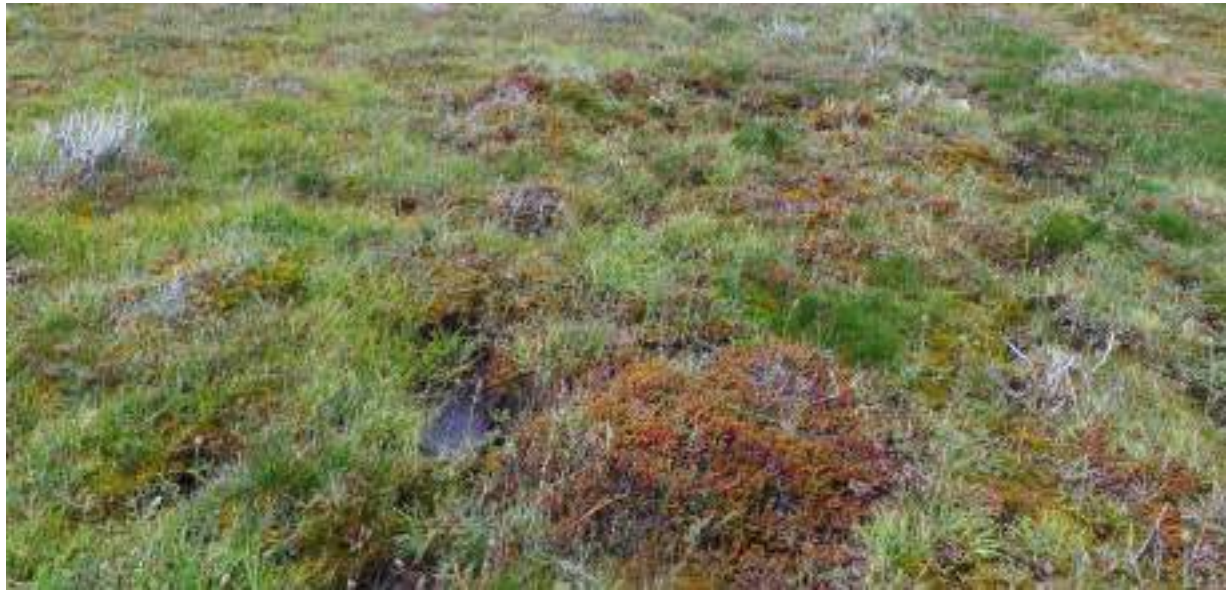
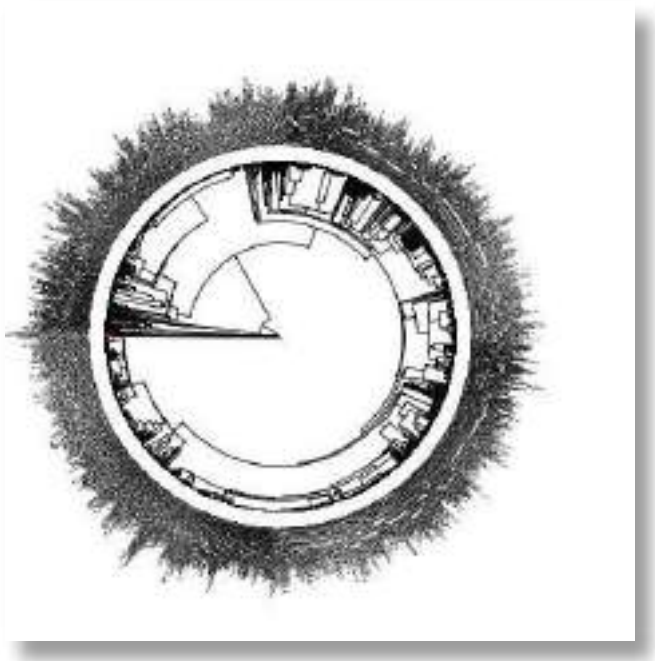
5000
2300
2300


bio10
25
20
15
10
5
0
-5
-10
-20
-30
-40
-50
-76
-74
-72
-70
-68
-66





Diversidad Taxonómica y Filogenética

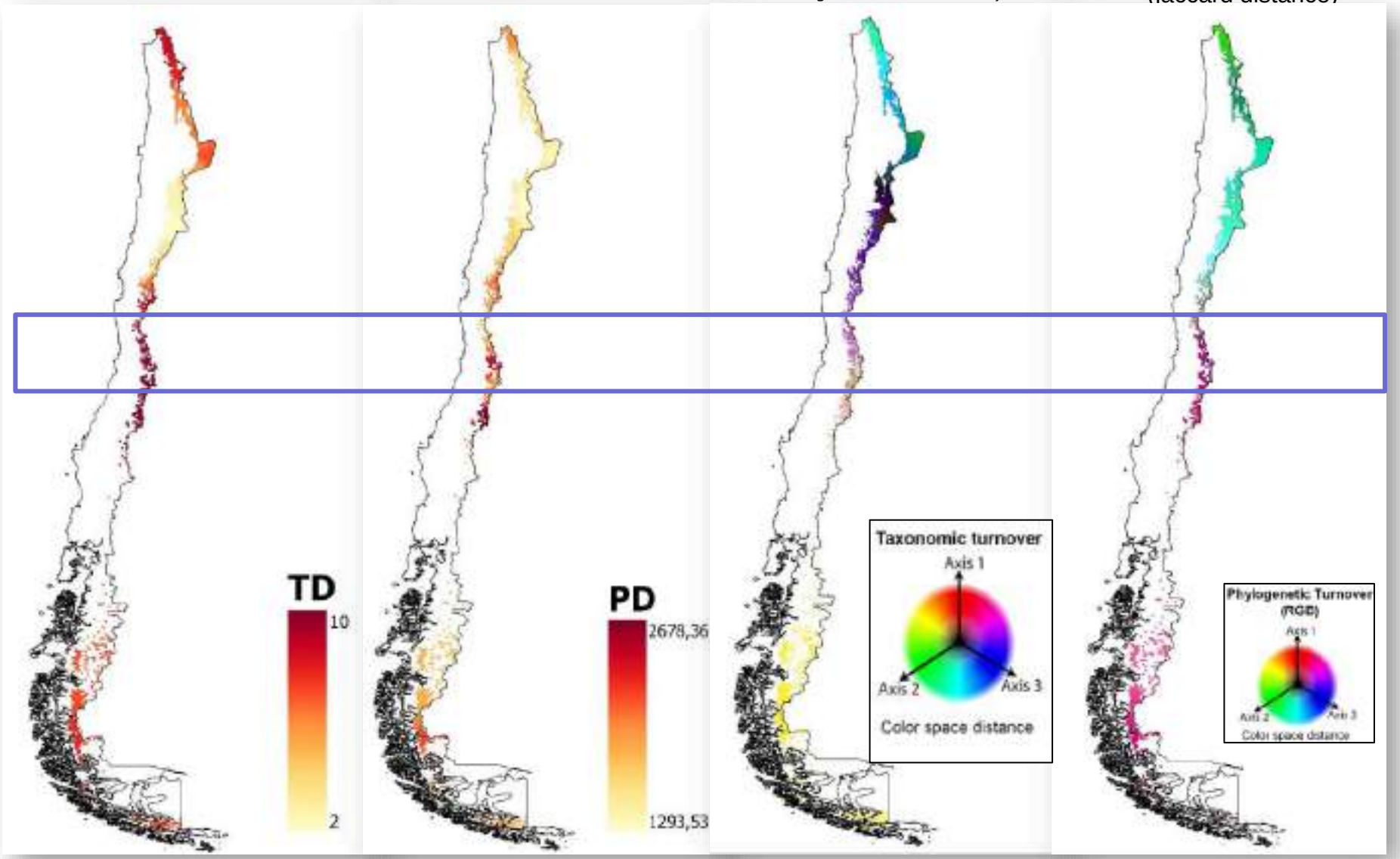
1.513 especies

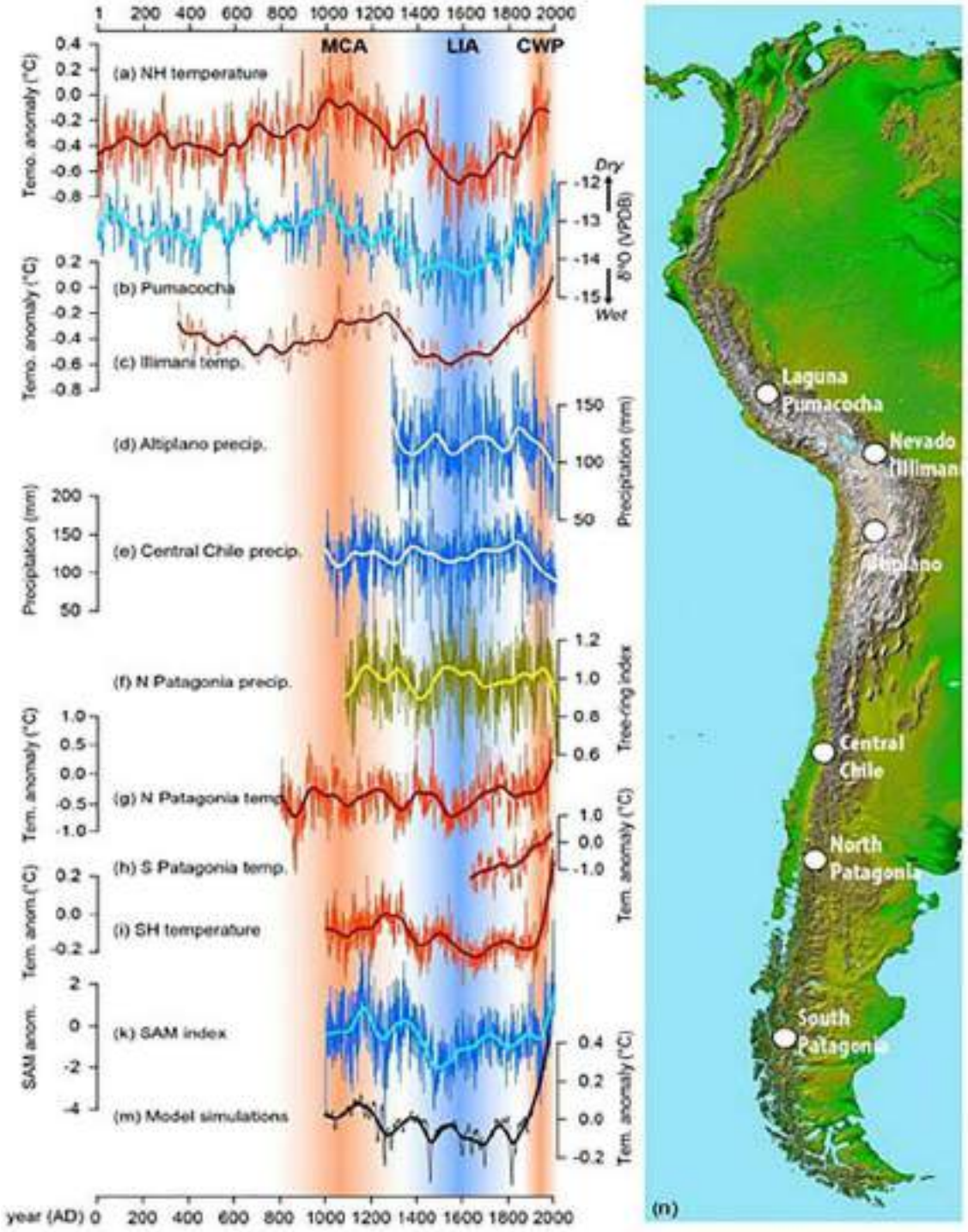
Taxonomic β Turnover

NMDS- Diversidad β (jaccard distance)

Phylogenetic β Turnover

NMDS- Diversidad β (jaccard distance)





LT LATERCERA

QUÉ PASA

Alarmante estimación proyecta que cordillera de los Andes se quedaría sin nieve y los ríos de la zona central se podrían secar en un plazo de 40 años

Proyecciones científicas señalan que al menos ocurrirá en sus partes de mayor altura, con pérdidas superiores a 10% por década. Esto afecta a la provisión de agua, ya que los diferentes ríos ubicados en la zona central, también se quedarían sin ella.

Por Carlos Montes

Invasiones por especies no-nativas

La severidad ambiental junto con otros factores (por ejemplo, perturbaciones humanas) sugirieron la escasa presencia de especies invasoras no-nativas

Biodiversity and Conservation (2023) 32:4199–4219
https://doi.org/10.1007/s10531-023-02697-6

REVIEW PAPER

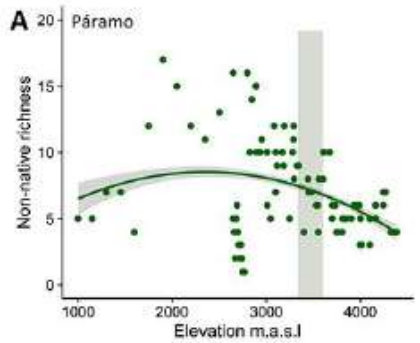
Going up the Andes: patterns and drivers of non-native plant invasions across latitudinal and elevational gradients

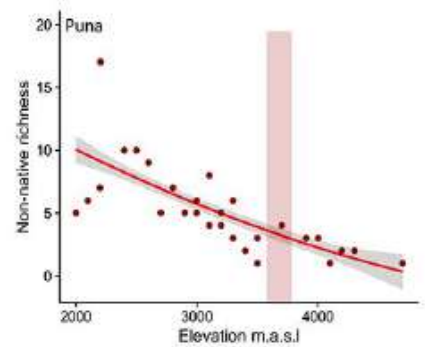
Eduardo Fuentes-Lillo[1,2,3,4] · Jonas J. Lembrechts[4] · Agustina Barros[5] · Valeria Aschero[1] · Ramiro O. Bustamante[2,6] · Lohengrin A. Cavieres[2,7] · Jan Clavel[8] · Ileana Herrera[6,9] · Alejandra Jiménez[1,2] · Paula Tecco[10] · Philip E. Hulme[11] · Martin A. Núñez[12] · Ricardo Rozzi[13,14] · Rafael A. García[1,2] · Daniel Simberloff[15] · Ivan Nijs[4] · Aníbal Pauchard[1,2]

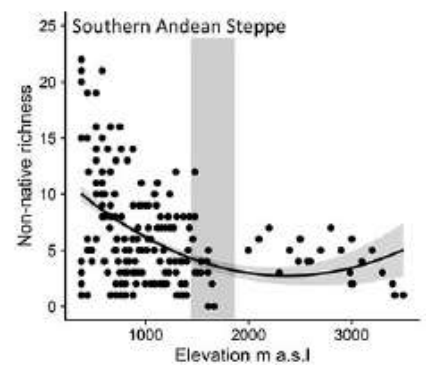
Table 1 The 20 most common non-native plant species (in Species name alphabetical order) present in the Andes mountain range, their growth form, biogeographic region of origin and countries of occurrence. For the complete list of species present in the Andes mountains, see Table S1

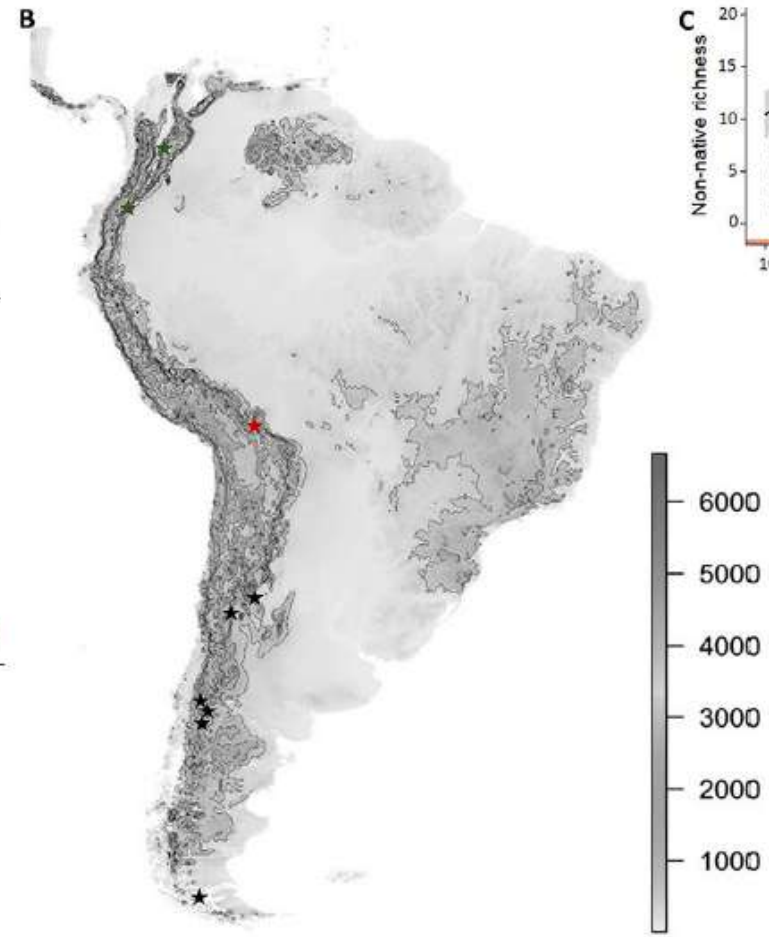
Family	Species	Growth form	Biogeographic origin	*Country
Fabaceae	*Acacia dealbata*	Tree	Oceania	ChC, ChS
Poaceae	*Agrostis capillaris*	Graminoid	Europe	EC, ChC, ChS
Poaceae	*Dactylis glomerata*	Graminoid	Europe	EC, BO, Ven, ChC, ChS
Poaceae	*Echinochloa crus-galli*	Graminoid	Europe	Arg, ChC, ChS
Poaceae	*Holcus lanatus*	Graminoid	Europe	EC, BO, ChC, ChS
Juncaceae	*Juncus bufonius*	Forb	Europe	ChC, ChS
Poaceae	*Lolium perenne*	Graminoid	Europe/Africa	Arg, ChC, ChS
Asteraceae	*Matricaria recutita*	Forb	Europe	ChC, ChS
Poaceae	*Pennisetum clandestinum*	Graminoid	Africa	EC, BO
Pinaceae	*Pinus radiata*	Tree	North America	ChC, ChS
Plantaginaceae	*Plantago lanceolata*	Forb	Europe	EC, Ven, ChC
Poaceae	*Poa annua*	Graminoid	Europe	EC, Ven, BO, ChC, ChS, Arg
Lamiaceae	*Prunella vulgaris*	Forb	Europe/Asia	EC, BO, ChC
Pinaceae	*Pseudotsuga menziesii*	Tree	North America	ChC, ChS
Polygonaceae	*Rumex acetosella*	Forb	Europe	EC, BO, ChC, ChS
Caryophyllaceae	*Sagina procumbens*	Forb	Europe	EC, BO, ChC
Caryophyllaceae	*Silene gallica*	Forb	Europe	EC, BO, ChS
Asteraceae	*Taraxacum officinale*	Forb	Europe	EC, BO, Ven, ChC, ChS
Fabaceae	*Trifolium dubium*	Forb	Europe	EC, Arg, ChC, ChS
Fabaceae	*Trifolium repens*	Forb	Europe	EC, Ven, Arg, ChC, ChS

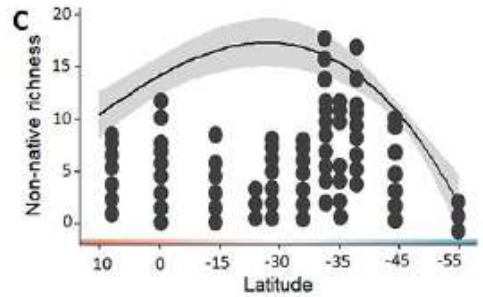
*Páramo: Ven = Venezuela, EC = Ecuador; Puna: BO = Bolivia; South Andean Steppe: Arg = Argentina, ChC = Central Chile, ChS = South Chile











Central Chile Andes

Tripleurospermum inodorum

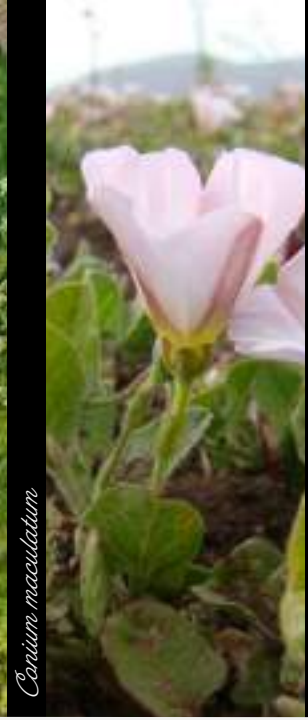
Carthamus lanatus

Lactuca virosa

Tanacetum parthenium

Eschscholzia californica

Convolvulus arvensis



Cynoglossum creticum

Erodium cicutarium

Anthriscus caucalis

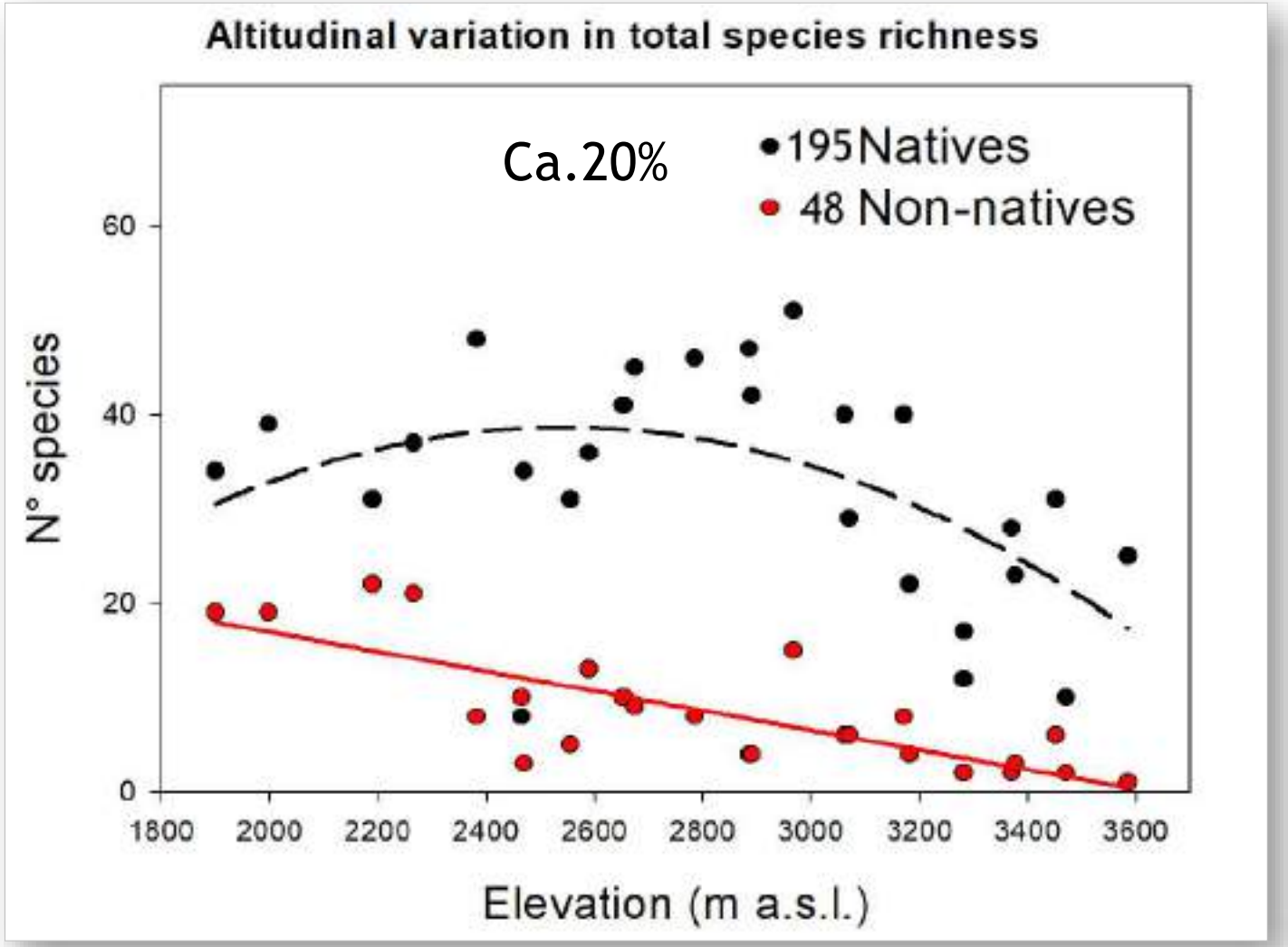
Hirschfeldia incana

Cerastium arvense

Rumex acetosella

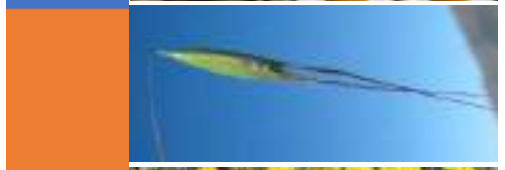
Tanacetum parthenium

Central Chile Andes



Cover ranking

Farellones 2007



Erodium cicutarium

Hirschfeldia incana

Populus nigra

Hordeum murinum

Cerastium arvense

Sisymbrium orientale

Cynoglossum creticum

Robinia pseudoacacia

Lactuca serriola

Convolvulus arvensis

Centaurea melitensis

Carduus thoermeri

Bromus rigidus

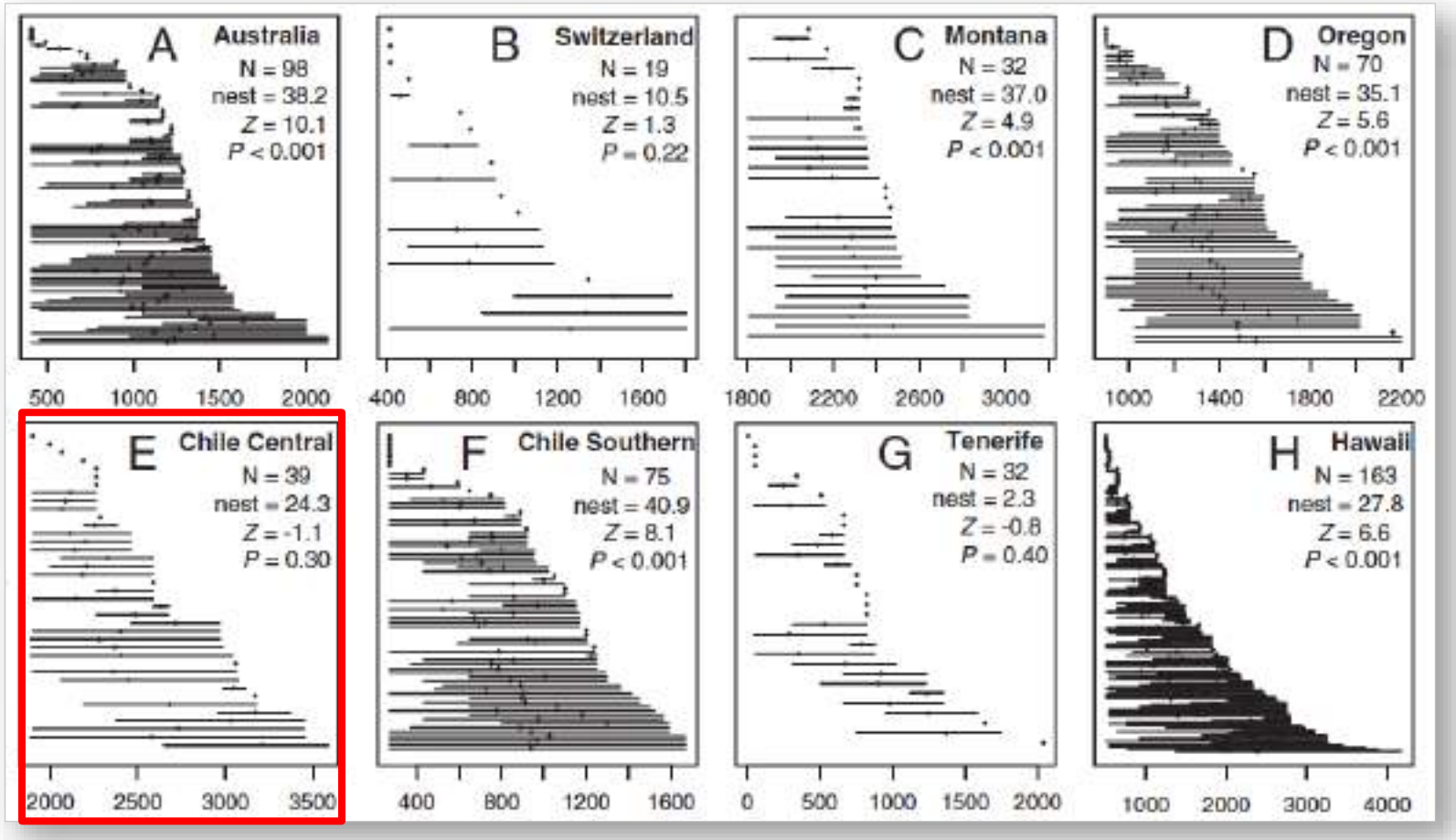
Bromus scoparius

Tripleurospermum inodorum

Galium aparine

Bromus hordeaceus

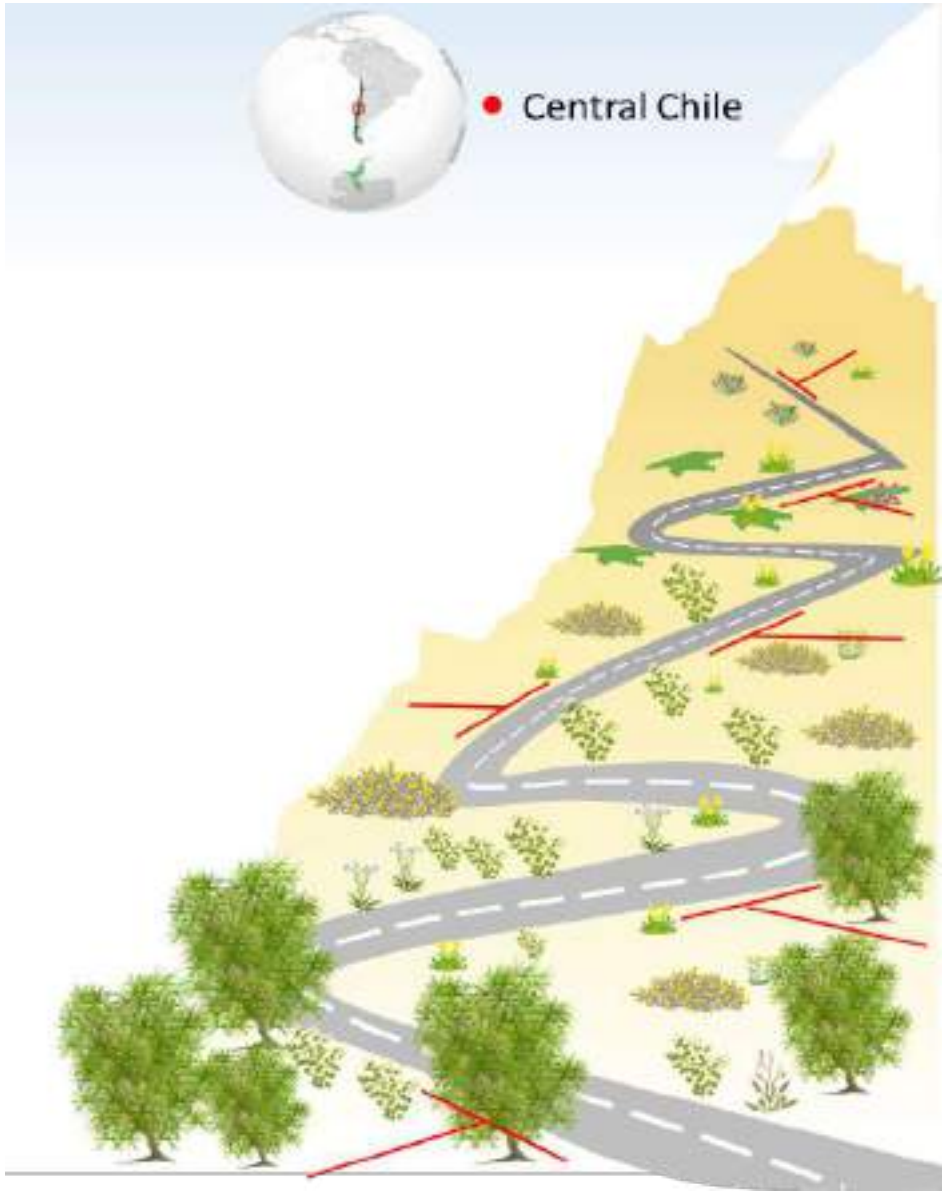
Only generalist species reach higher elevations

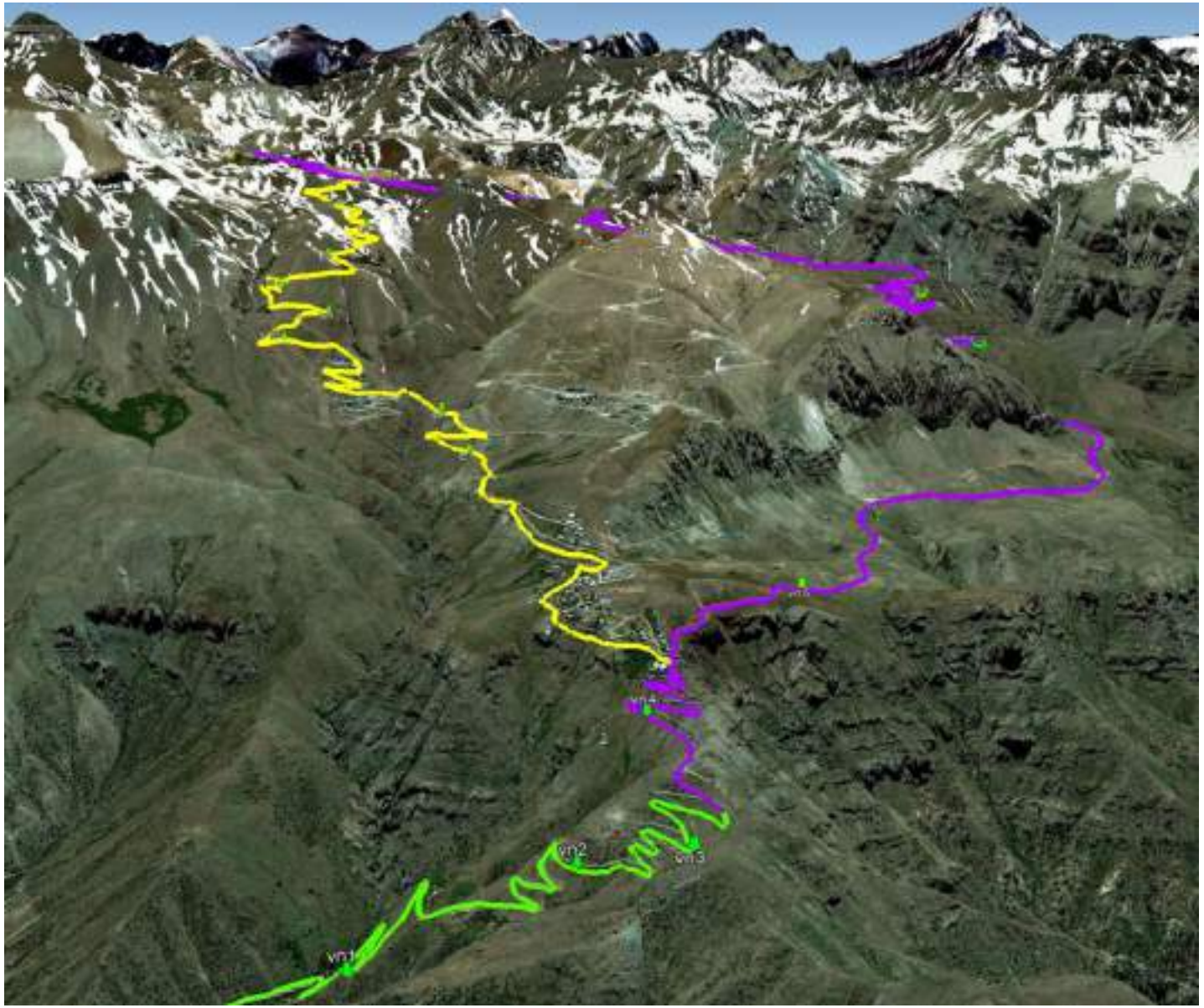


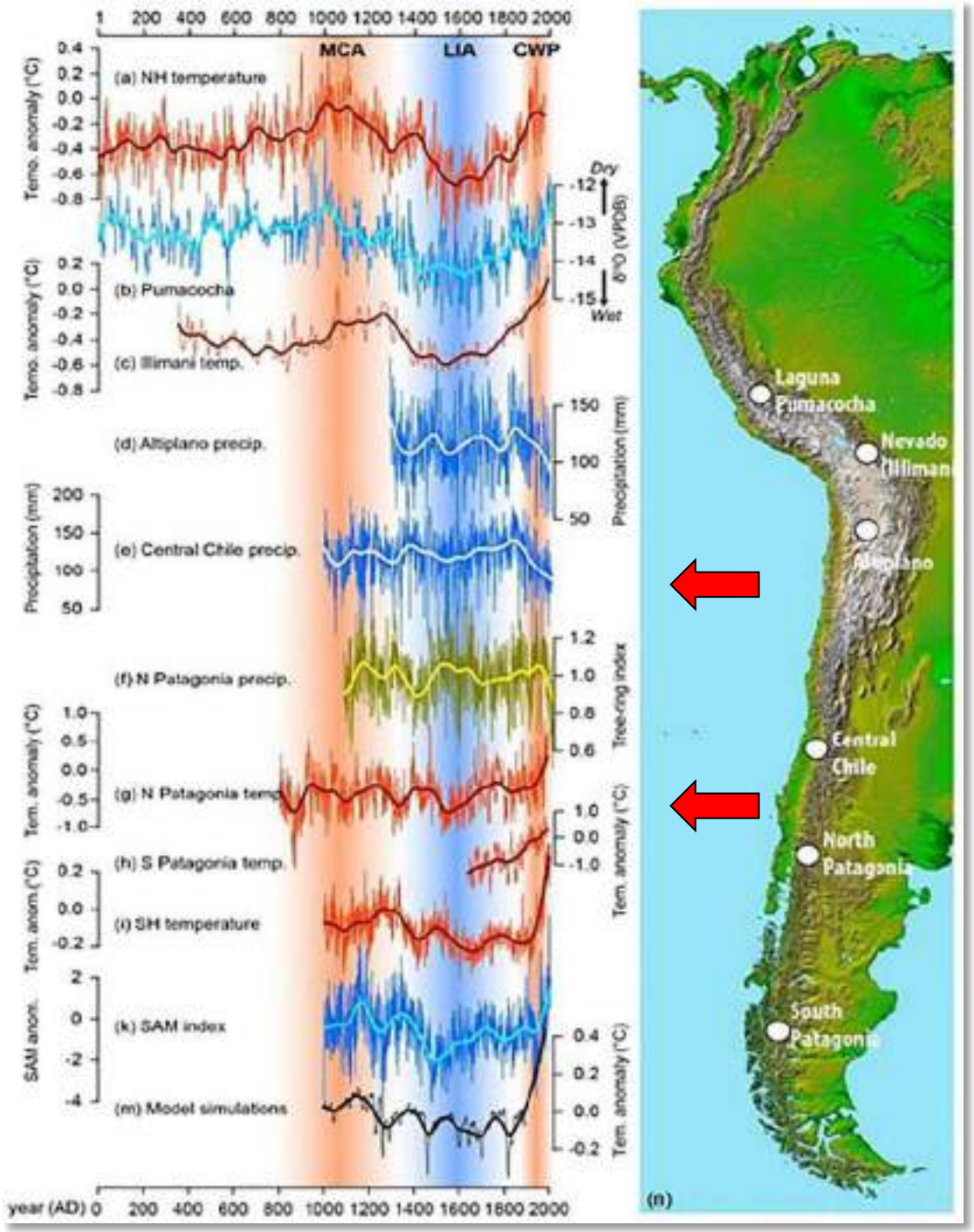
PNAS

Assembly of nonnative floras along elevational gradients explained by directional ecological filtering

Miren T-transects: 2007 - 2011 - 2017 - 2023







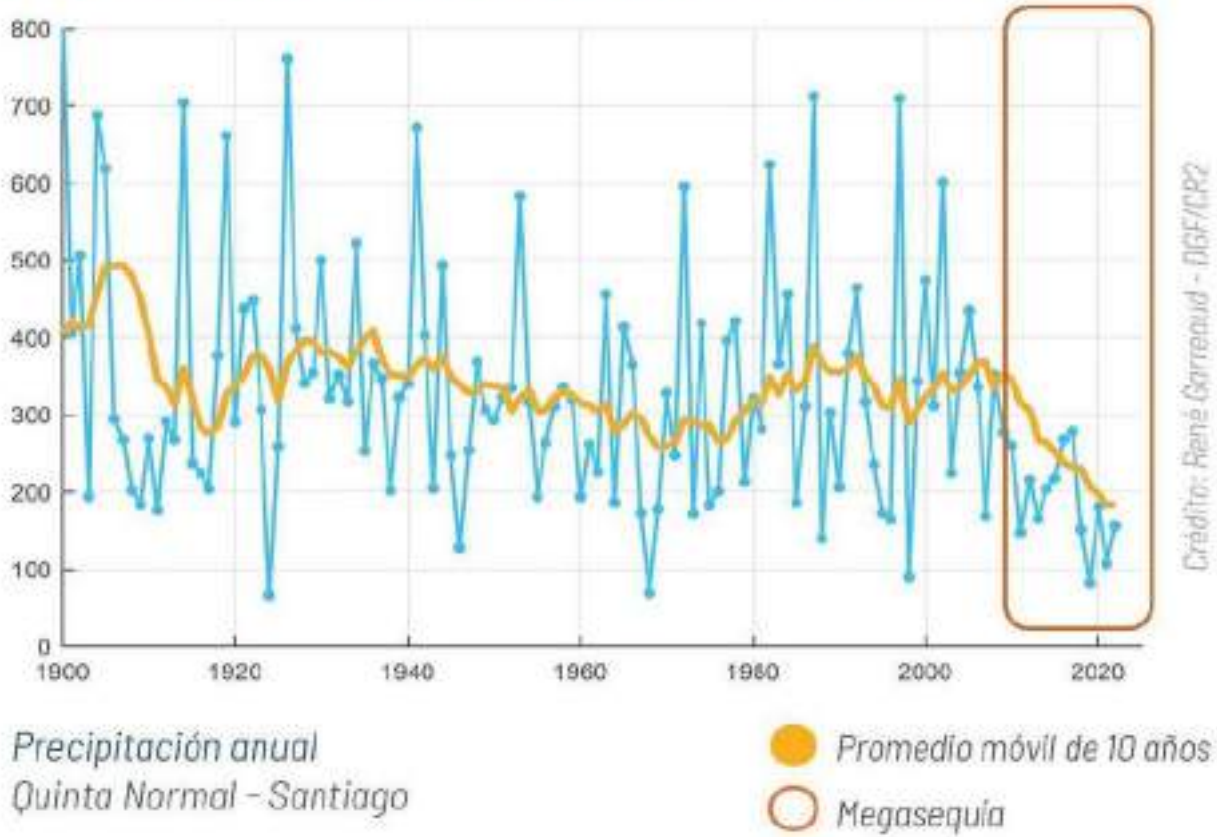
The Central Chile Mega Drought (2010–2018): A climate dynamics perspective

René D. Garreaud[1,2] | Juan P. Boisier[2] | Roberto Rondanelli[1,2] | Aldo Montecinos[3,4]
Hector H. Sepúlveda[3] | Daniel Veloso-Aguila[3]

The 2010–2020 'megadrought' drives reduction in lake surface area in the Andes of central Chile (32° - 36°S)

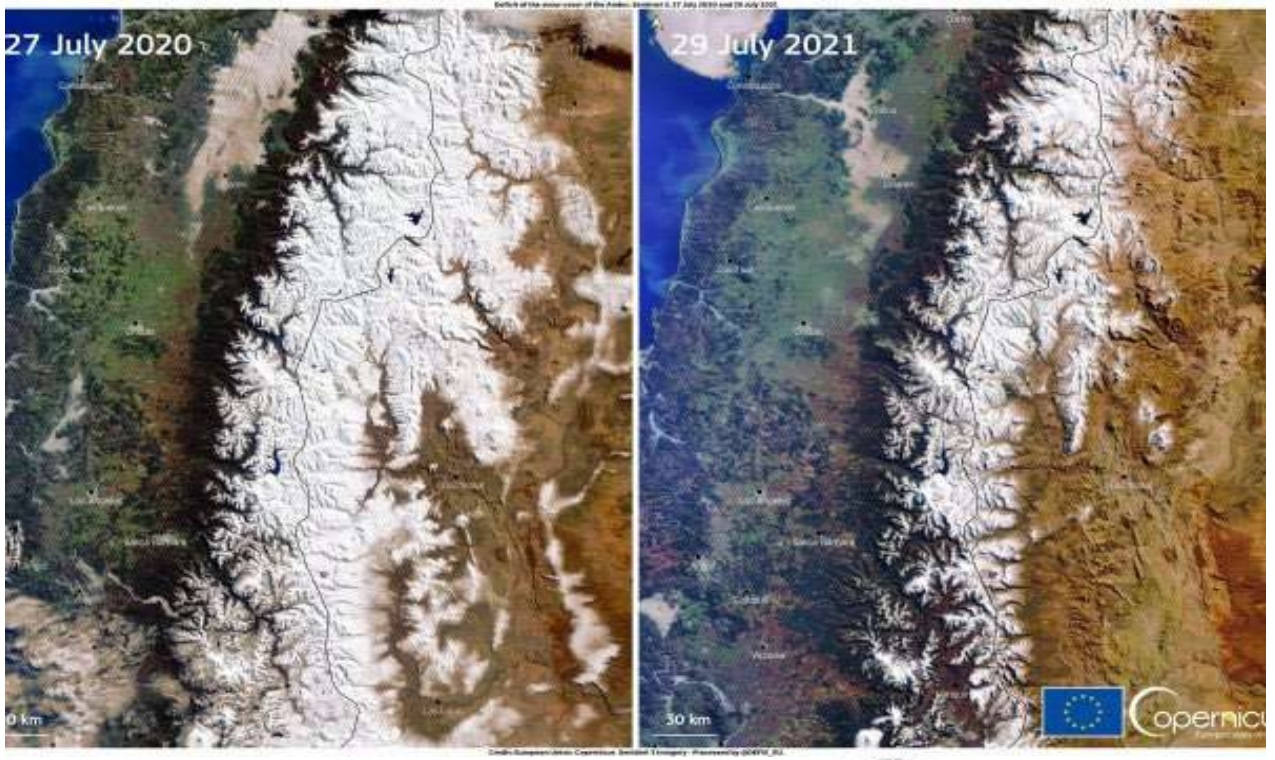
Magdalena Fuentealba[a,b,*], Camila Bahamóndez[d], Pablo Sarricolea[d], Oliver Meseguer-Ruiz[e], Claudio Latorre[a,c,*]

LA MEGASEQUÍA 2010-2022 EN CHILE CENTRAL



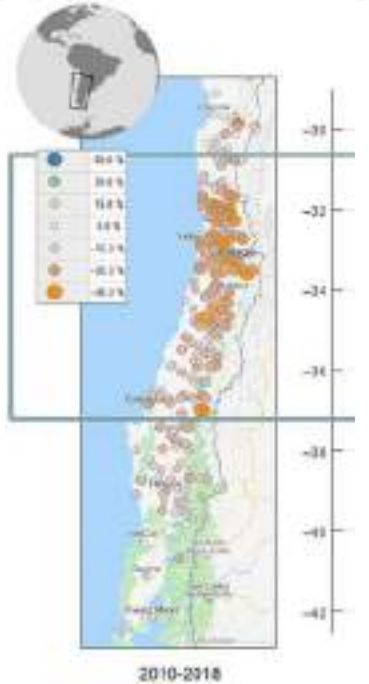

Marzo 2016

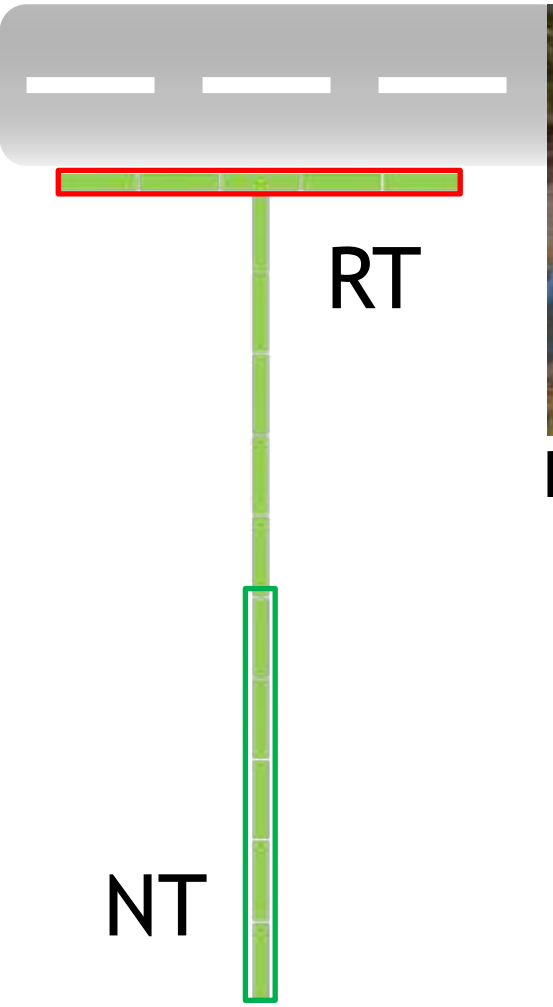

Marzo 2020
Nasa

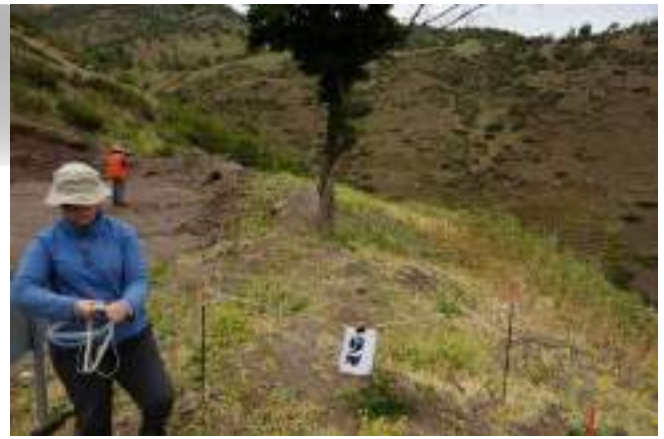

27 July 2020
29 July 2021
30 km


December
2016
Google Earth


January
2019
Google Earth

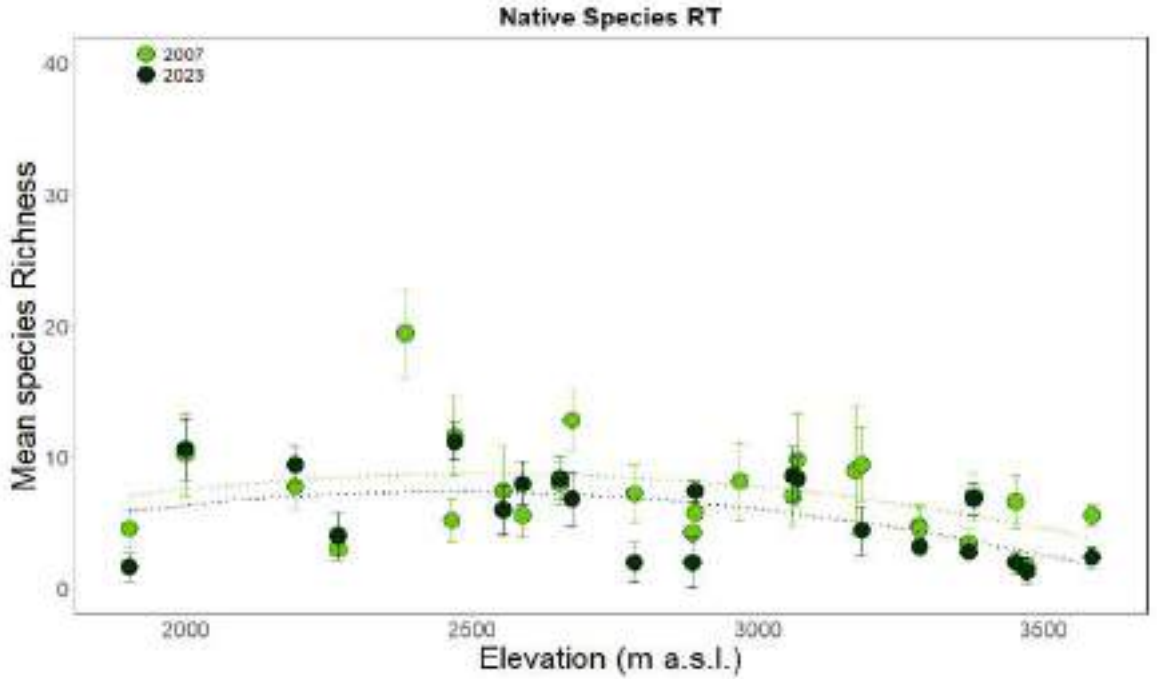

2010-2018

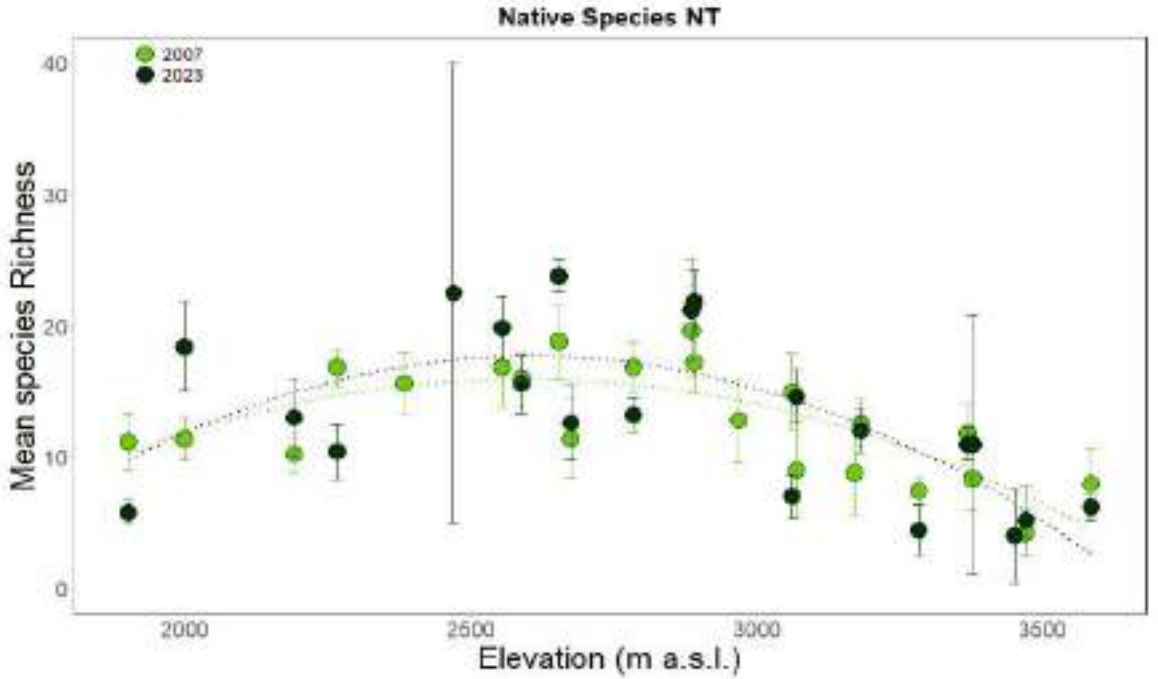




Disturbed roadside areas

Native communities areas


Native Species RT
2007
2023
Mean species Richness
0
10
20
30
40
2000
2500
3000
3500
Elevation (m a.s.l.)


Native Species NT
2007
2023
Mean species Richness
0
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40
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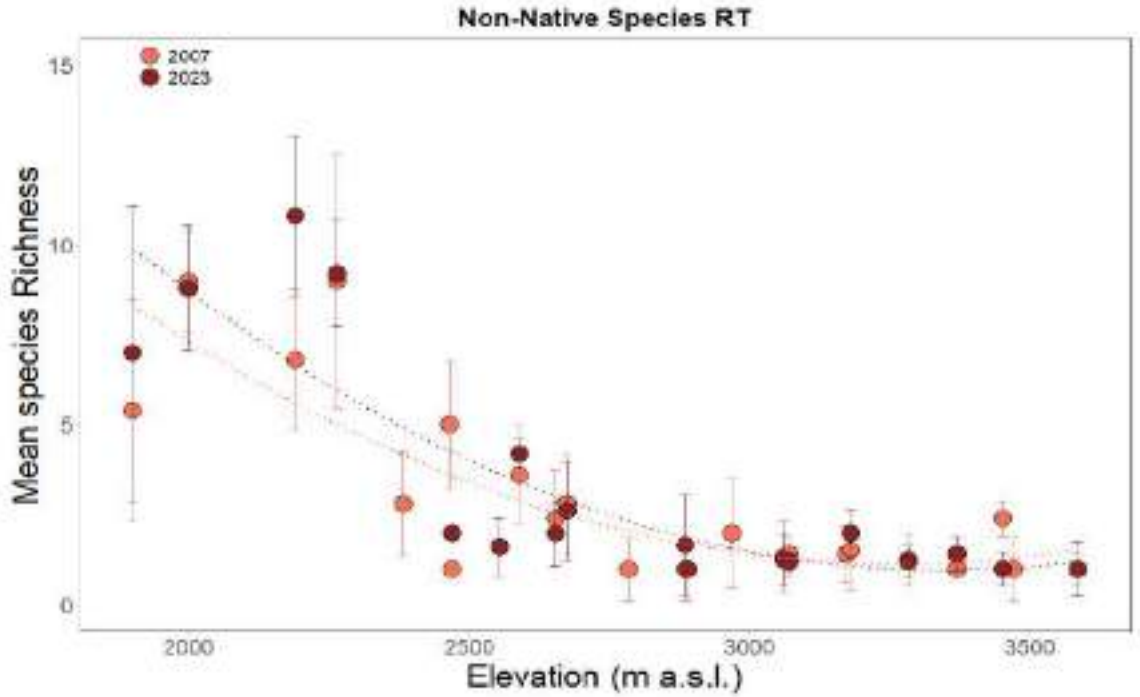
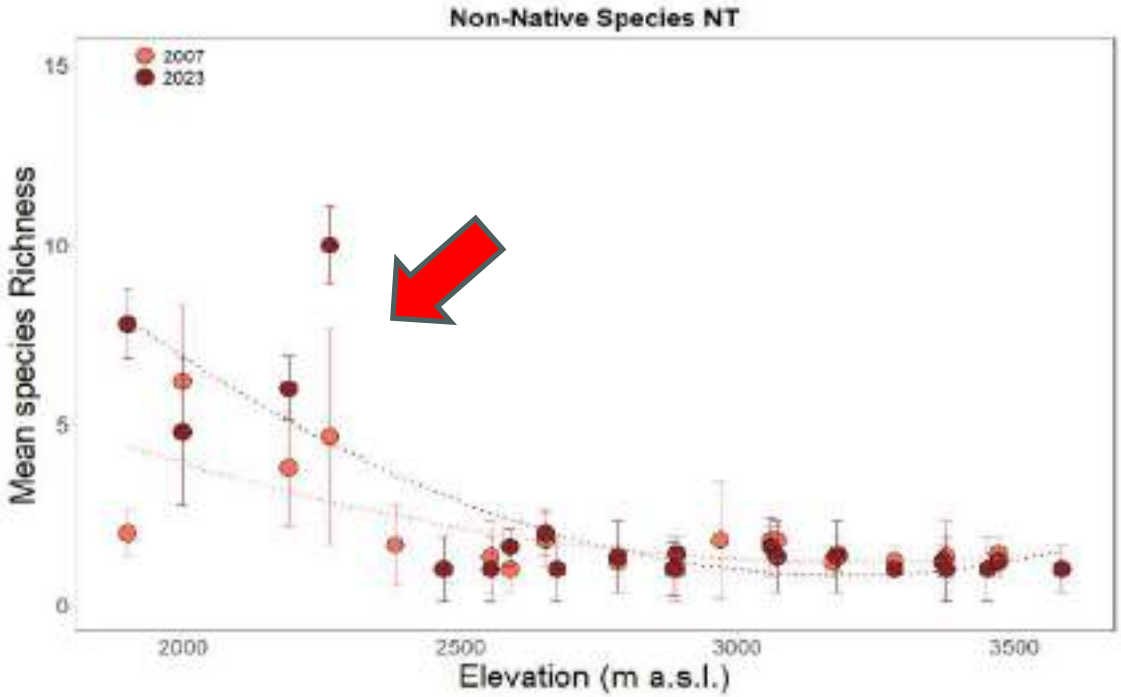
2500
3000
3500
Elevation (m a.s.l.)


Non-Native Species RT
2007
2023
Mean species Richness
0
5
10
15
2000
2500
3000
3500
Elevation (m a.s.l.)


Non-Native Species NT
2007
2023
Mean species Richness
0
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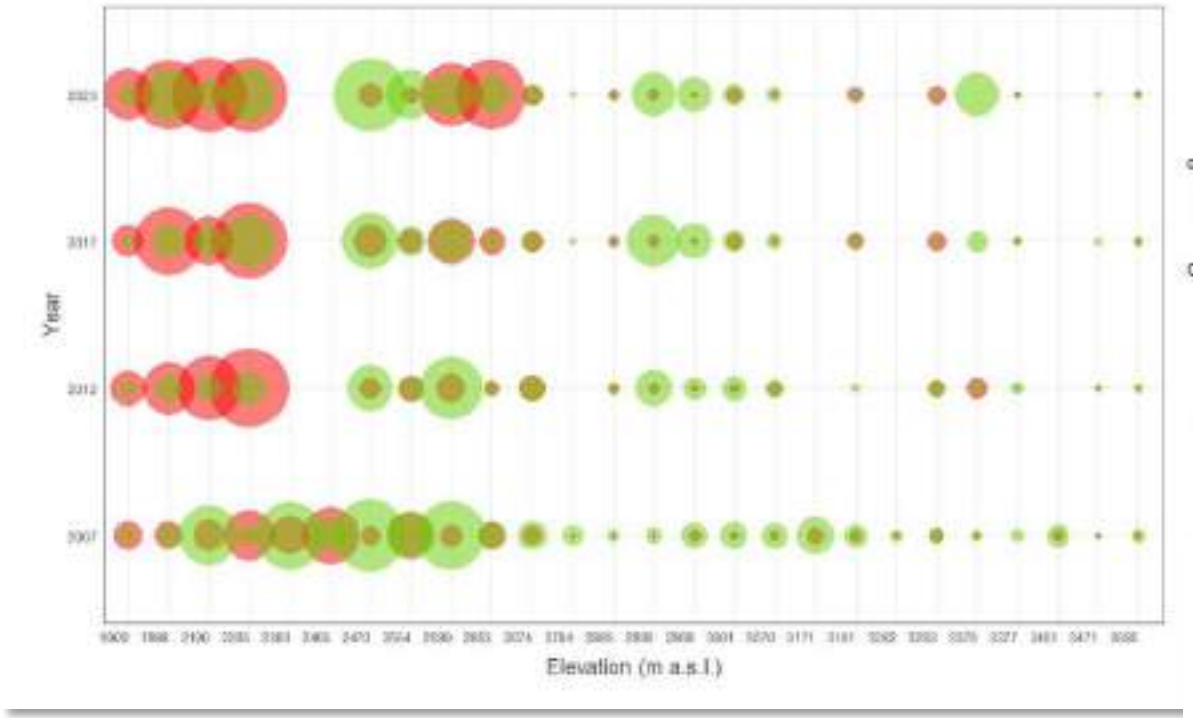
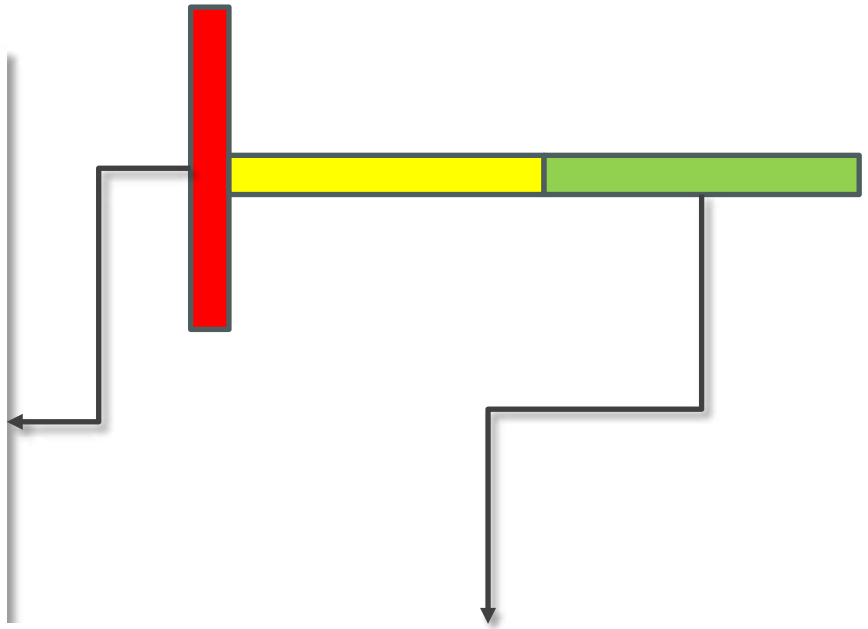
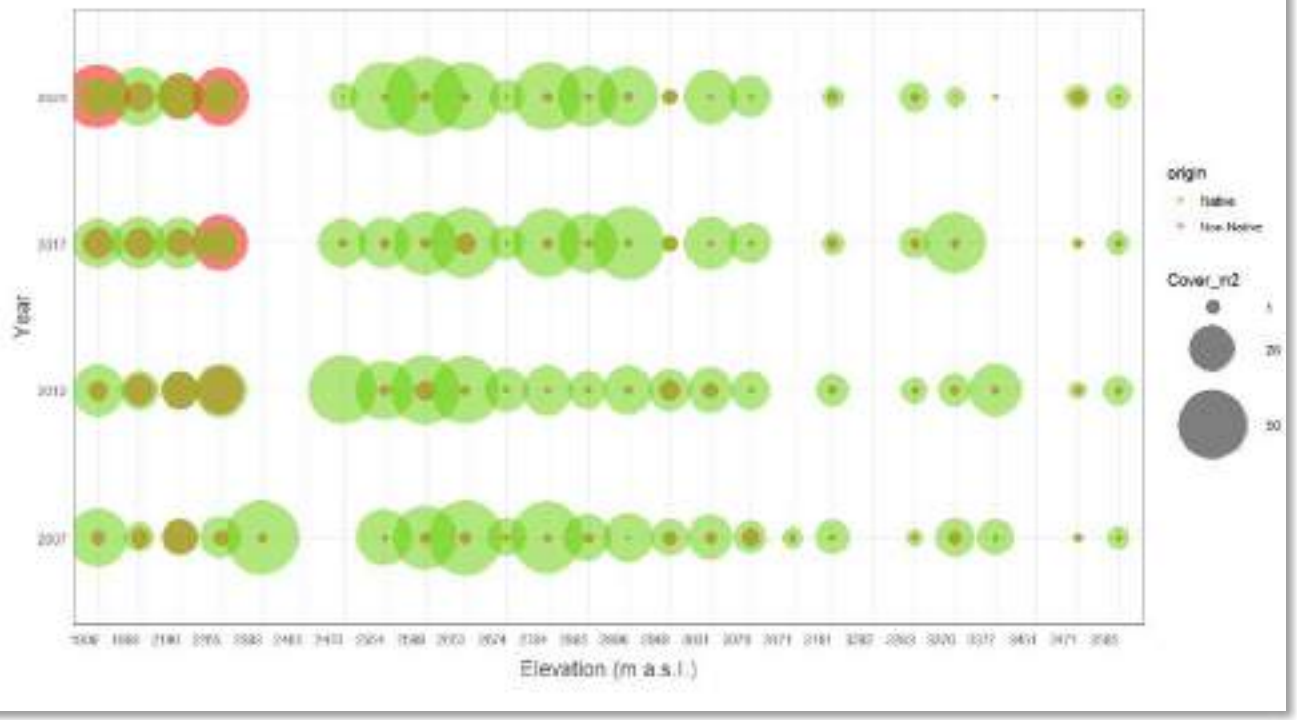
Elevation (m a.s.l.)

RTs



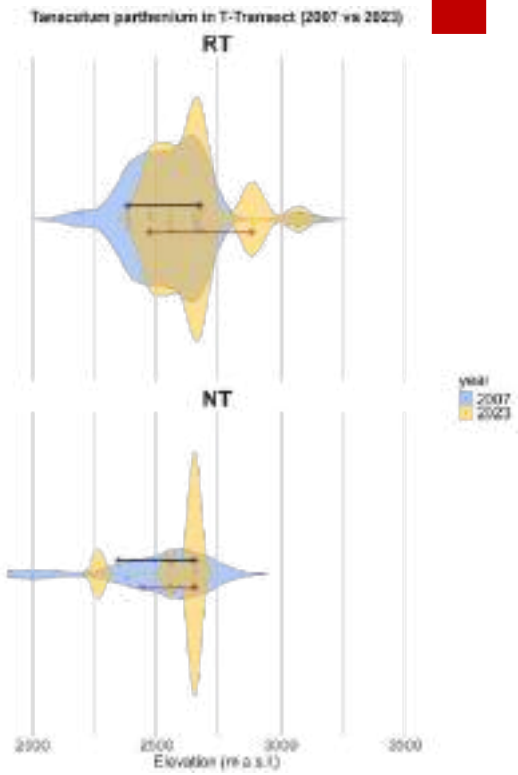


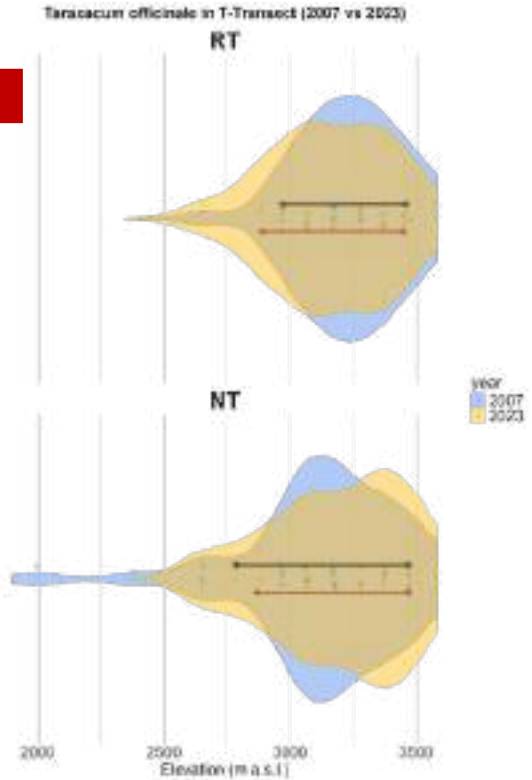
NTs

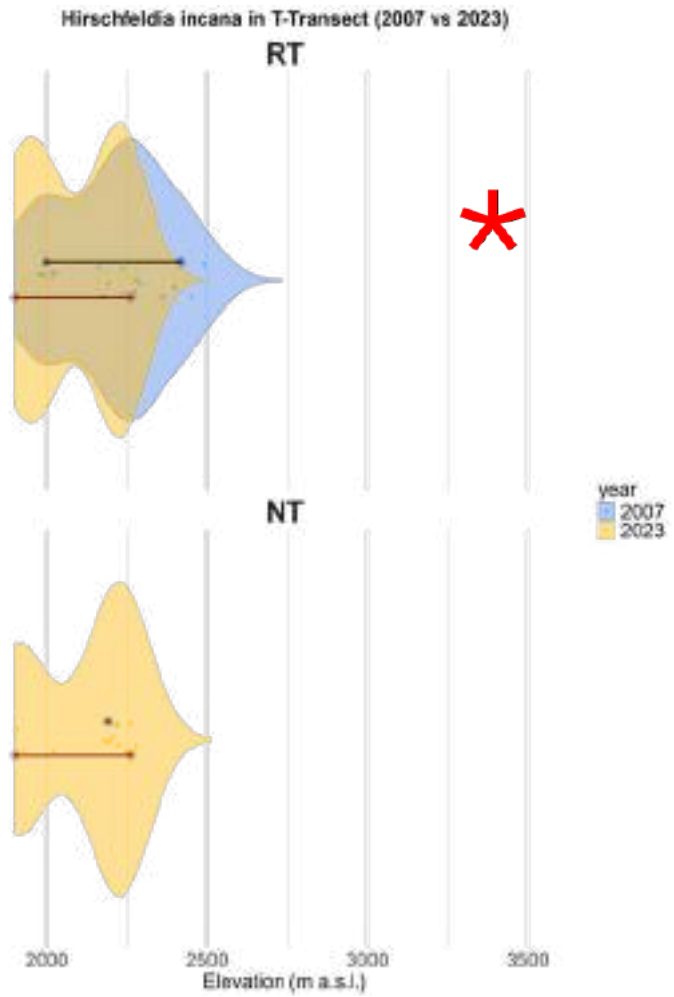


2007

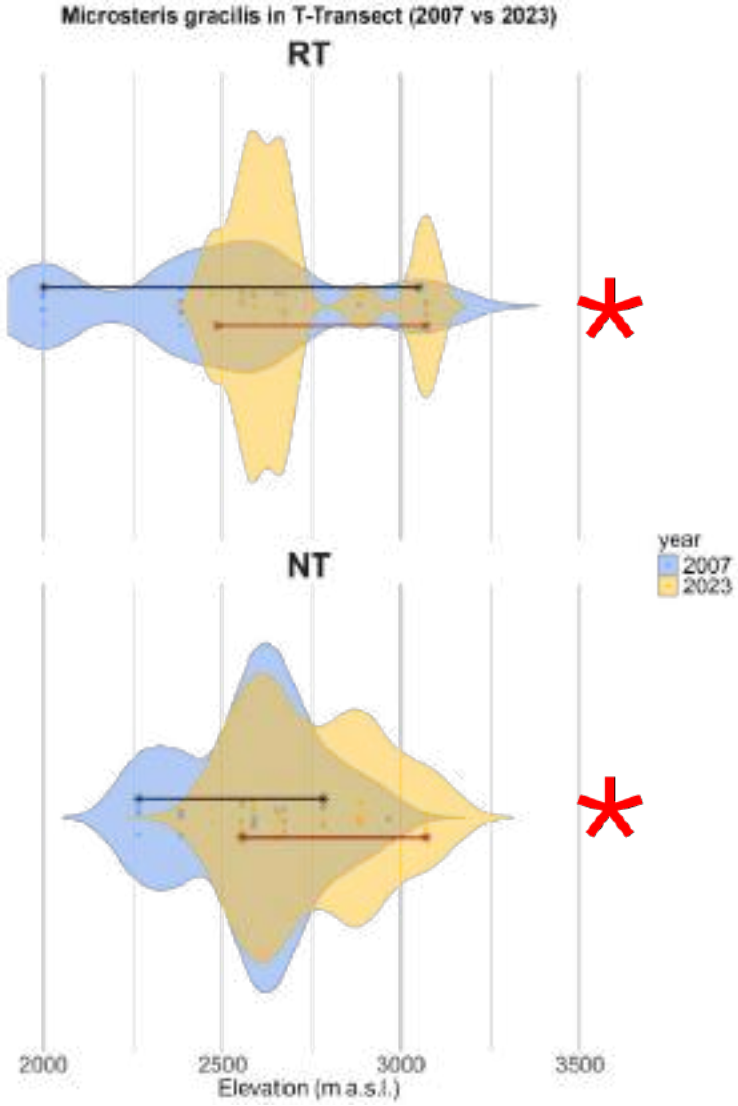
2023

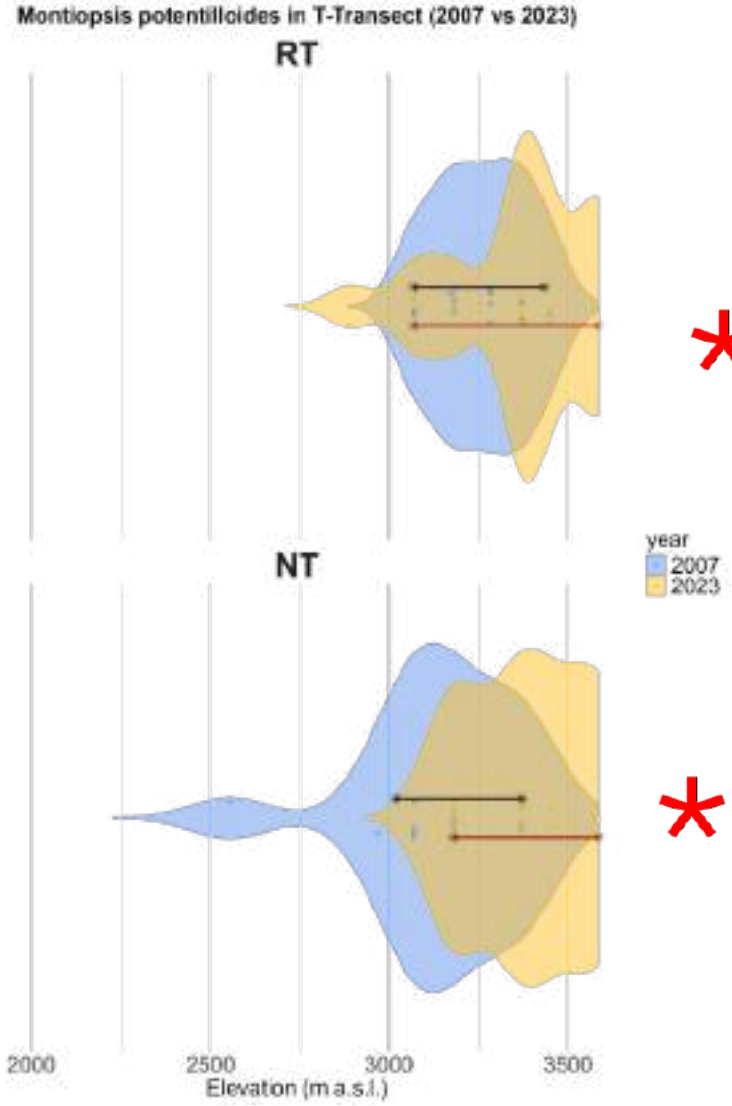

Taraxacum parthenium in T-Transect (2007 vs 2023)
RT
NT
year
2007
2023
2000
2500
3000
3500
Elevation (m a.s.l.)

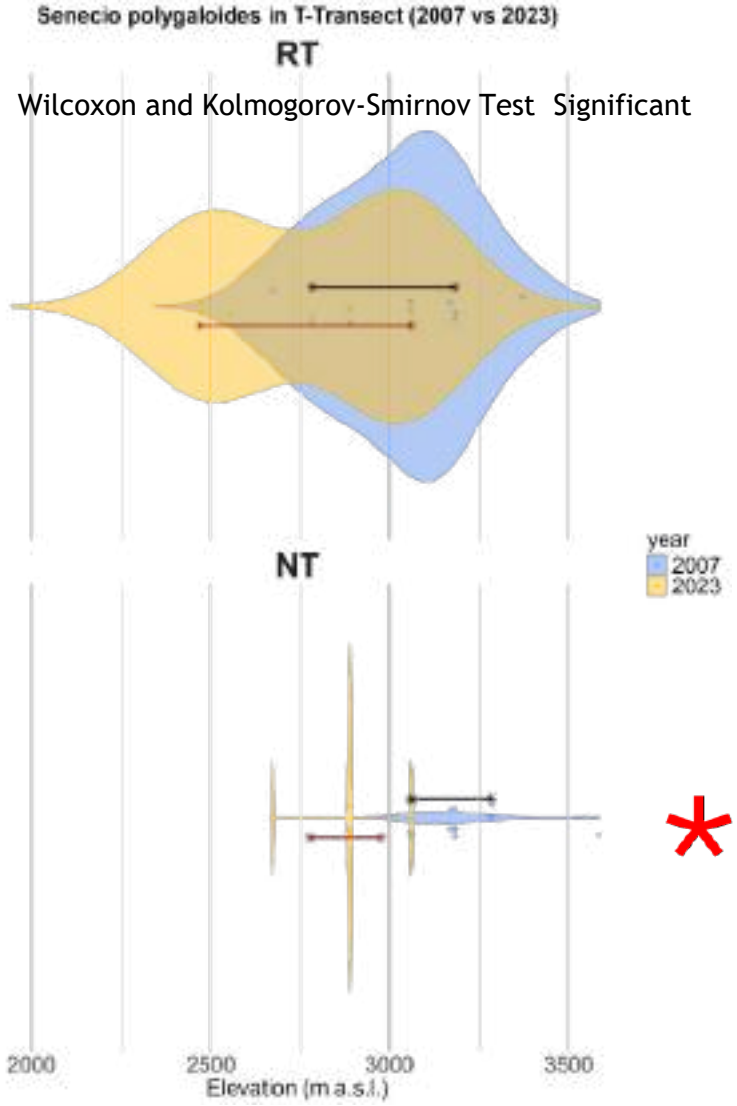

Taraxacum officinale in T-Transect (2007 vs 2023)
RT
NT
year
2007
2023
2000
2500
3000
3500
Elevation (m a.s.l.)



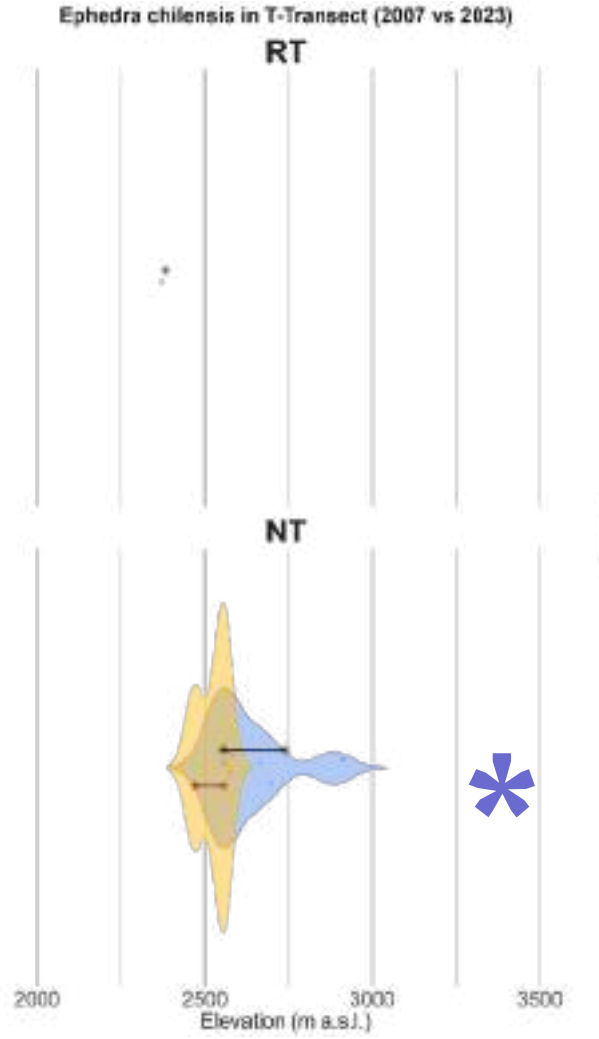
* Wilcoxon Test Significant

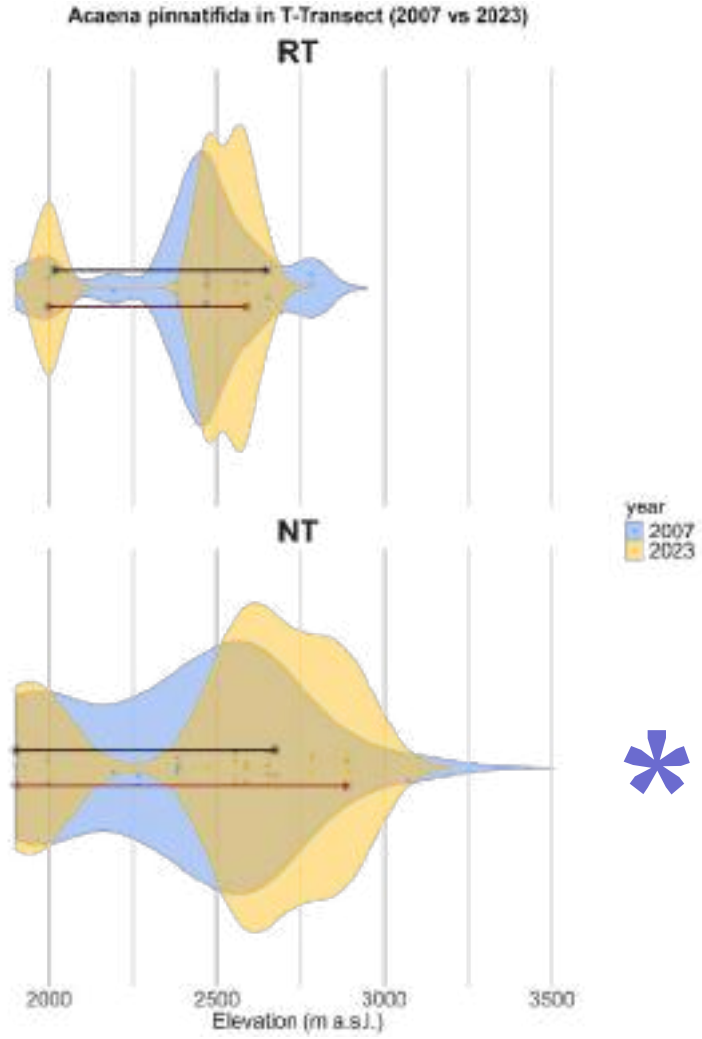


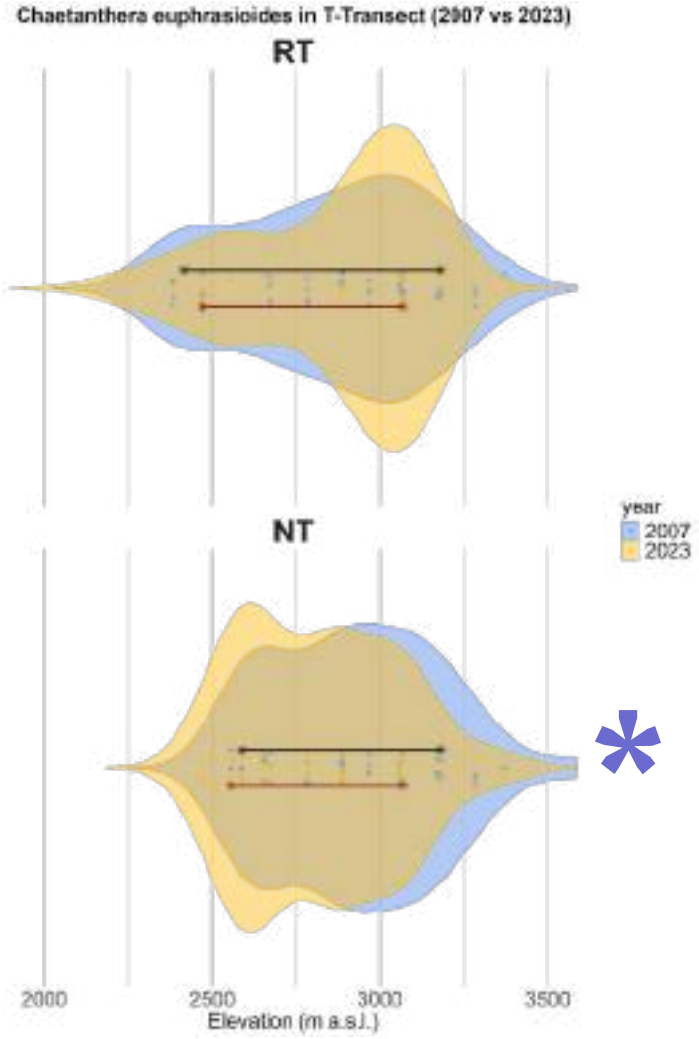




Wilcoxon and Kolmogorov-Smirnov Test Significant


Ephedra chilensis in T-Transect (2007 vs 2023)
RT
NT
year
2007
2023
2000
2500
3000
3500
Elevation (m a.s.l.)


Acaena pinnatifida in T-Transect (2007 vs 2023)
RT
NT
year
2007
2023
2000
2500
3000
3500
Elevation (m a.s.l.)


Chaetanthera euphrasioides in T-Transect (2007 vs 2023)
RT
NT
year
2007
2023
2000
2500
3000
3500
Elevation (m a.s.l.)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Miren 2007

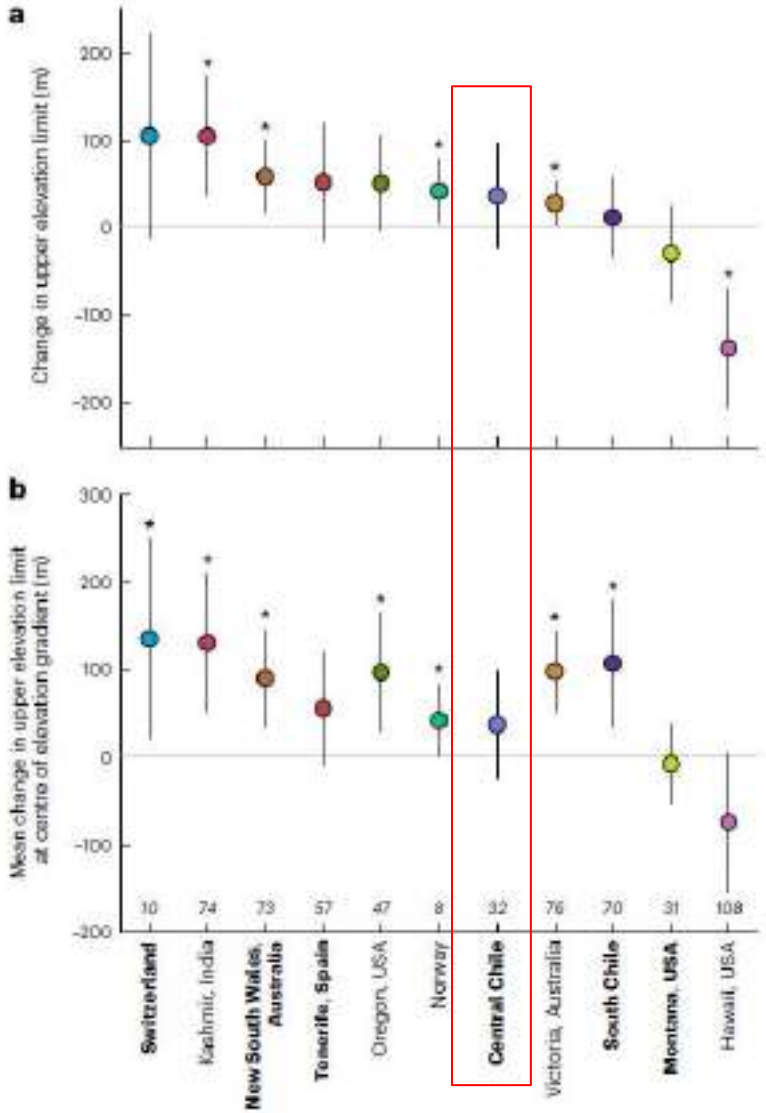
Miren 2023

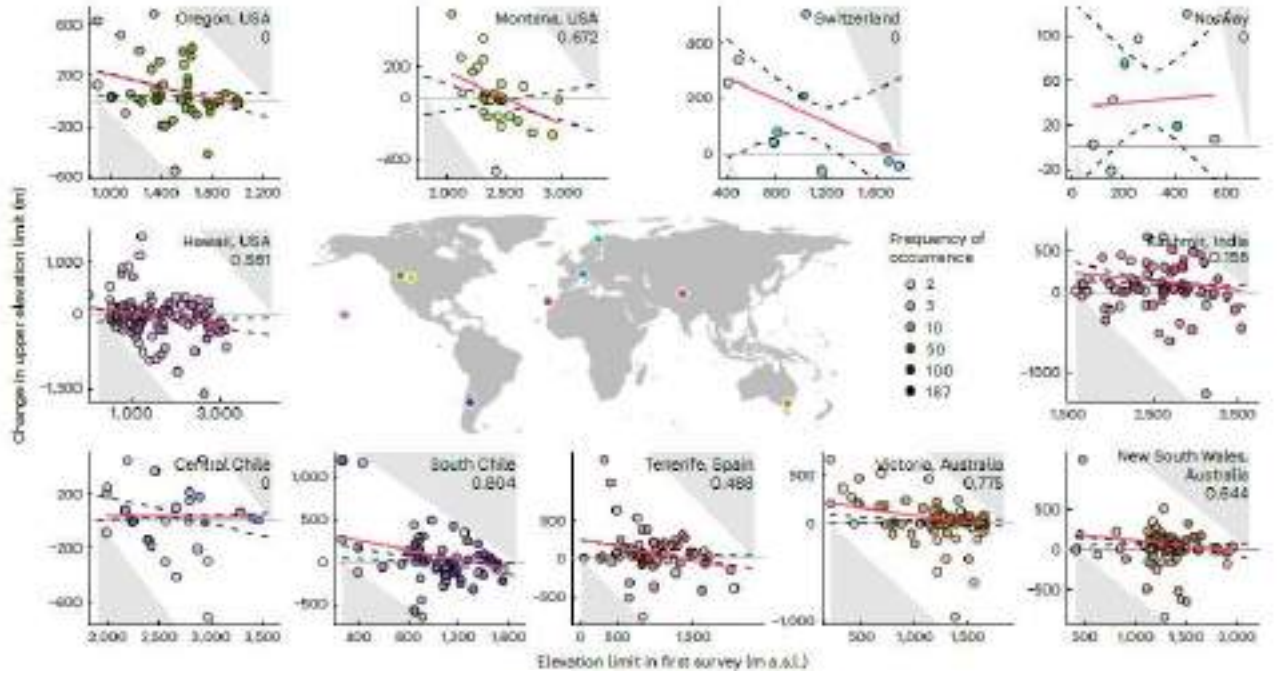
nature ecology & evolution

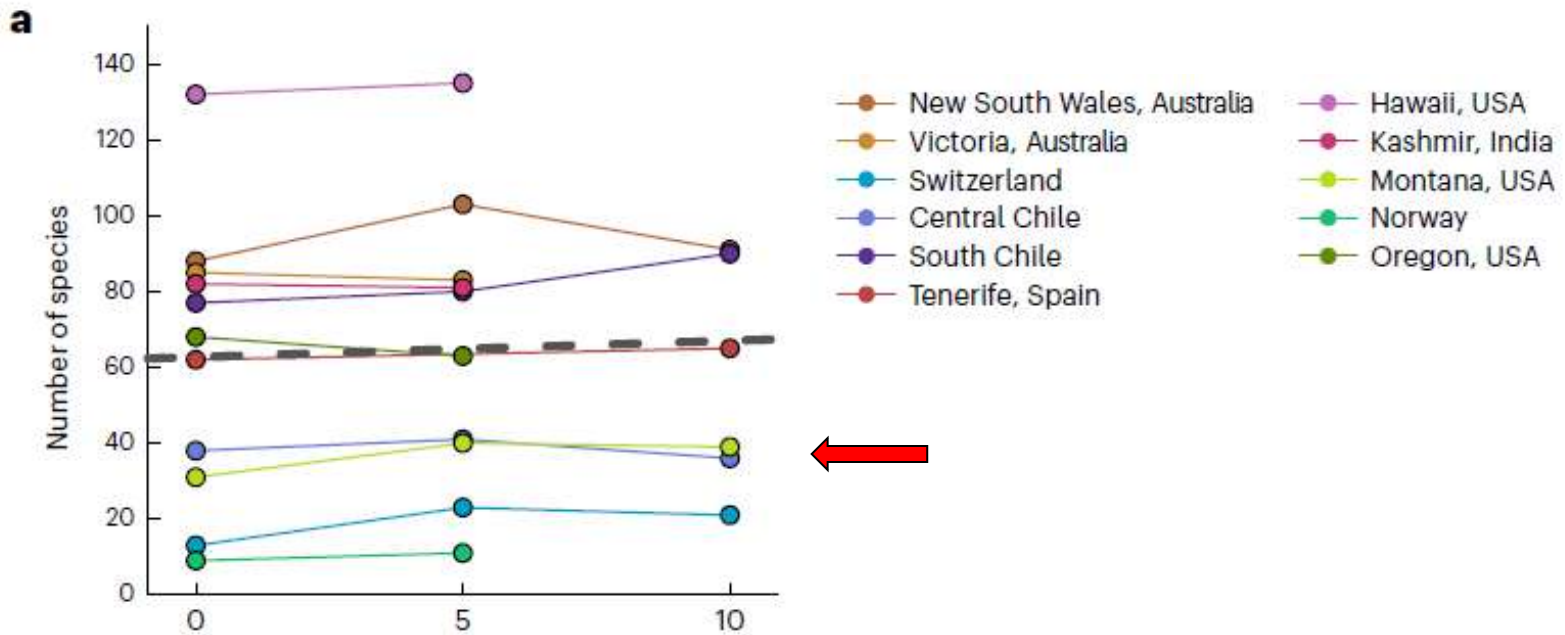
Article

https://doi.org/10.1038/s41559-022-01979-6

Rapid upwards spread of non-native plants in mountains across continents







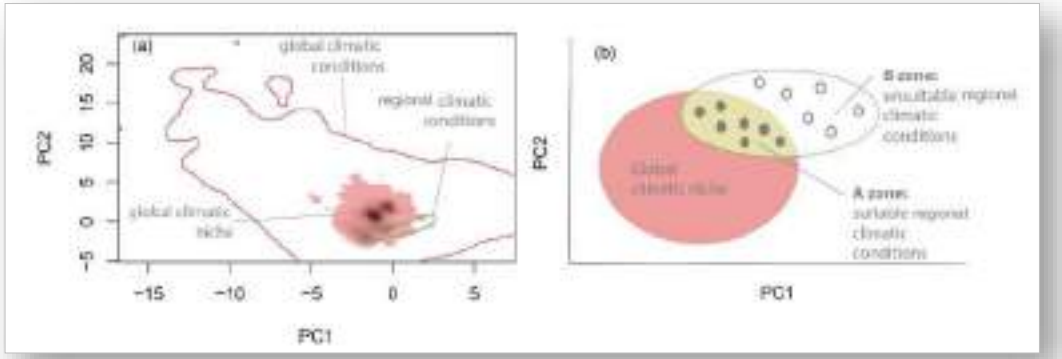
plants

MDPI

Article

The Upper Range Limit of Alien Plants Is Not in Equilibrium with Climate in the Andes of Central Chile

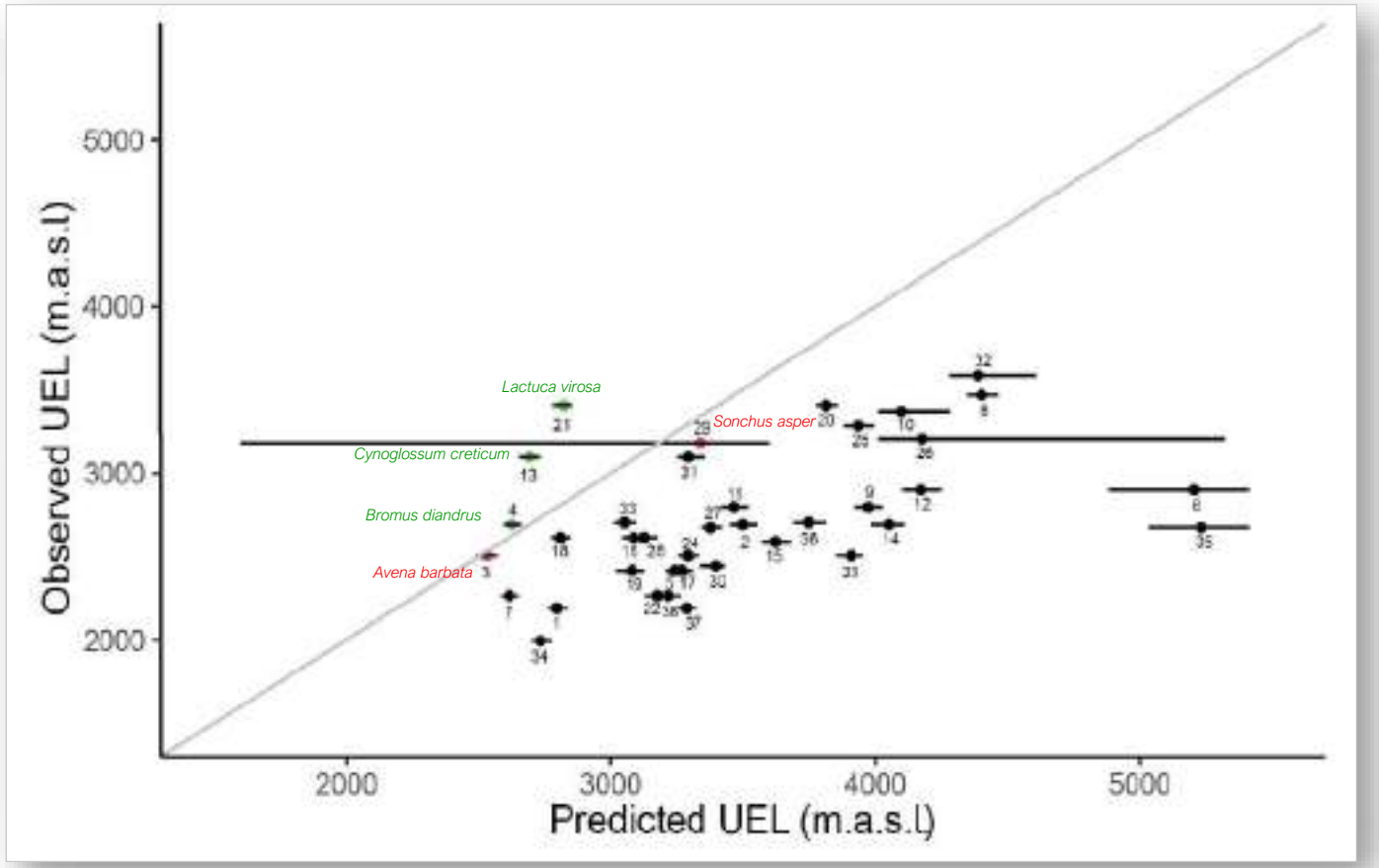
Estefany Gonçalves [1,2,*], Ileana Herrera [3,4], Jake Alexander [5], Milen Duarte [3,6], Lohengrin A. Cavieres [2,7,8], Luis Morales-Salinas [9] and Ramiro O. Bustamante [1,2,8,10,*]



Diagrammatic representation of the environmental grid to identify suitable and unsuitable habitats.

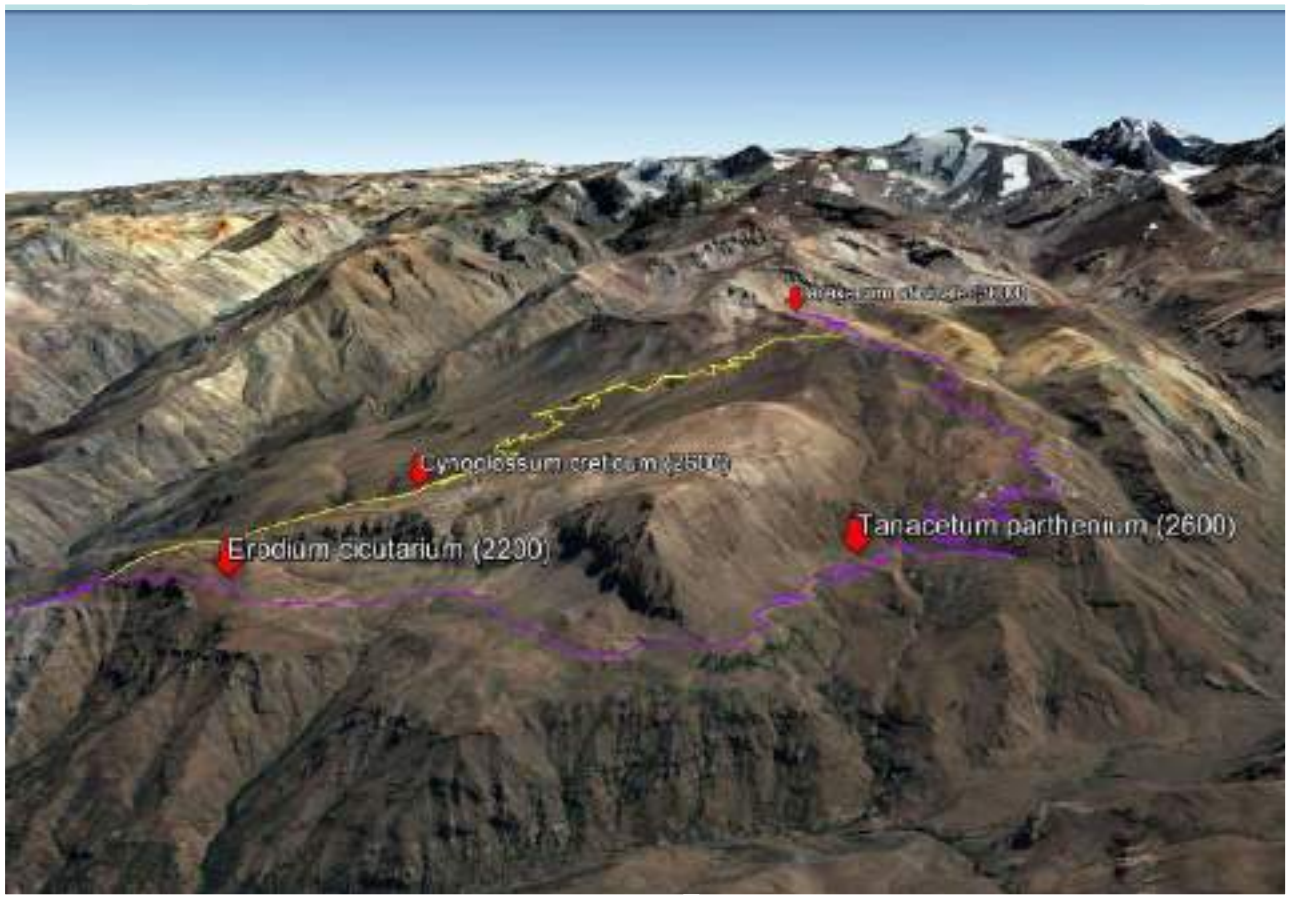
(a) PCA with global climatic niches intersected with the regional scale climate niche for Tragopogon porrifolius as an example.

(b) Identification of suitable (black points) and unsuitable conditions (white points) for the species in the study area in Chile.

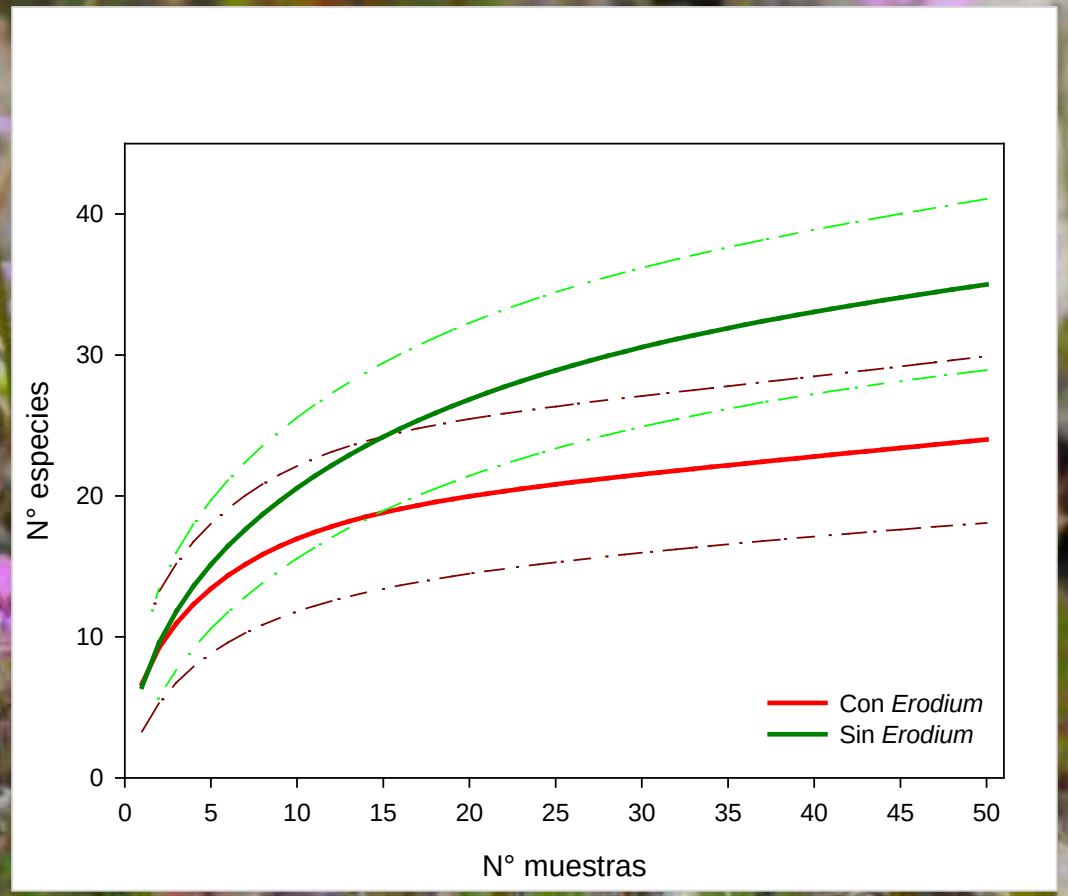


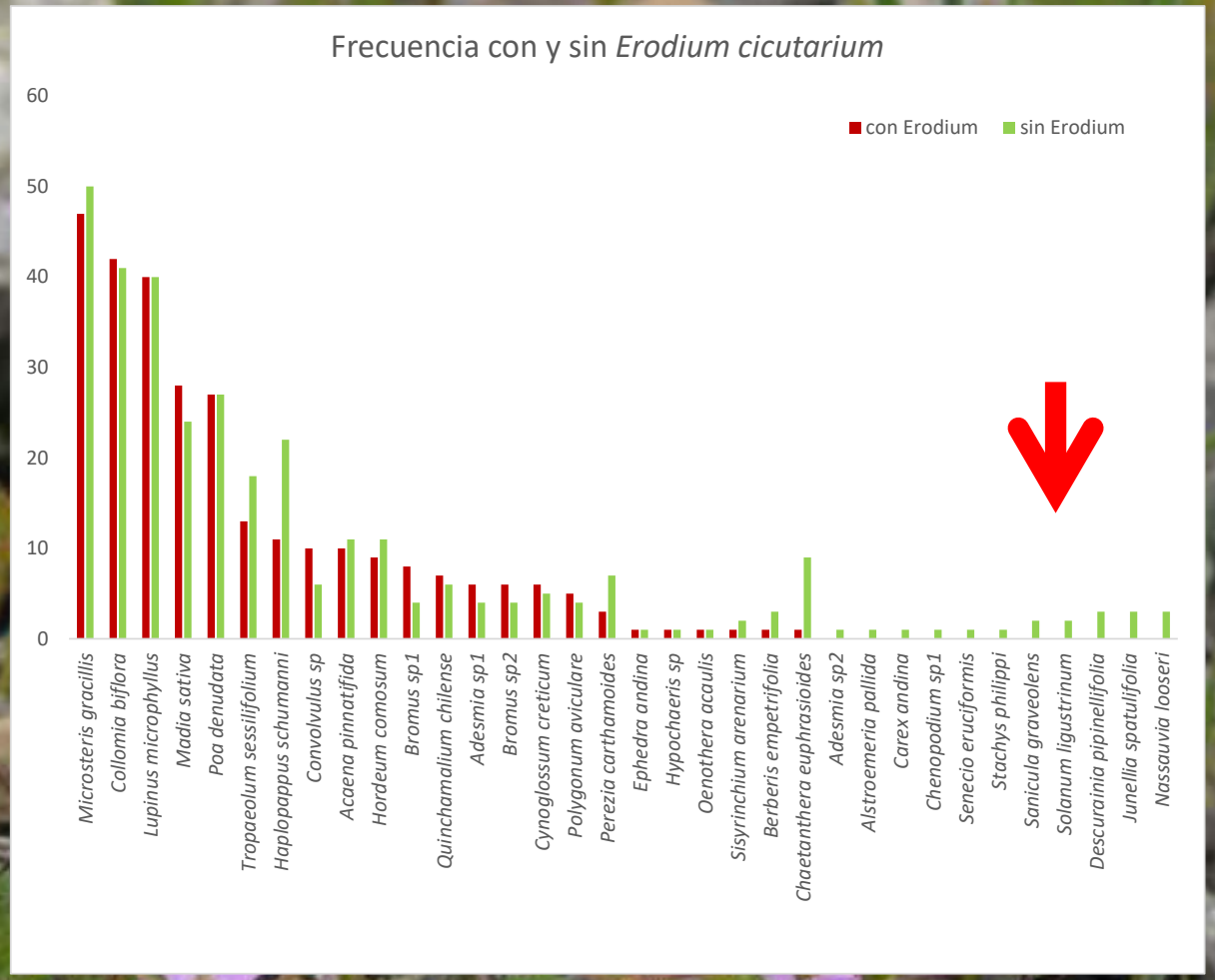
1: *Anagallis arvensis*
2: *Anthemis cotula*
3: *Avena barbata*
4: *Bromus diandrus*
5: *Bromus scoparius*
6: *Carduus nutans*
7: *Centaurea melitensis*
8: *Cerastium arvense*
9: *Chamomilla suaveolens*
10: *Chenopodium album*
11: *Conium maculatum*
12: *Convolvulus arvensis*
13: *Cynoglossum creticum*
14: *Echium vulgare*
15: *Erodium cicutarium*
16: *Eschscholzia californica*
17: *Galium aparine*
18: *Hirschfeldia incana*
19: *Hordeum murinum*
20: *Lactuca serriola*
21: *Lactuca virosa*
22: *Marrubium vulgare*
23: *Onopordum acanthium*
24: *Plantago lanceolata*
25: *Polygonum aviculare*
26: *Rumex acetosella*
27: *Rumex crispus*
28: *Sisymbrium orientale*
29: *Sonchus asper*
30: *Sonchus oleraceus*
31: *Tanacetum parthenium*
32: *Taraxacum officinale*
33: *Tragopogon porrifolius*
34: *Trifolium glomeratum*
35: *Tripleurospermum maritimum*
36: *Verbascum thapsus*
37: *Veronica persica*
38: *Vulpia myuros*

¿Tiene consecuencias para la comunidad nativa la presencia de especies no-nativas?

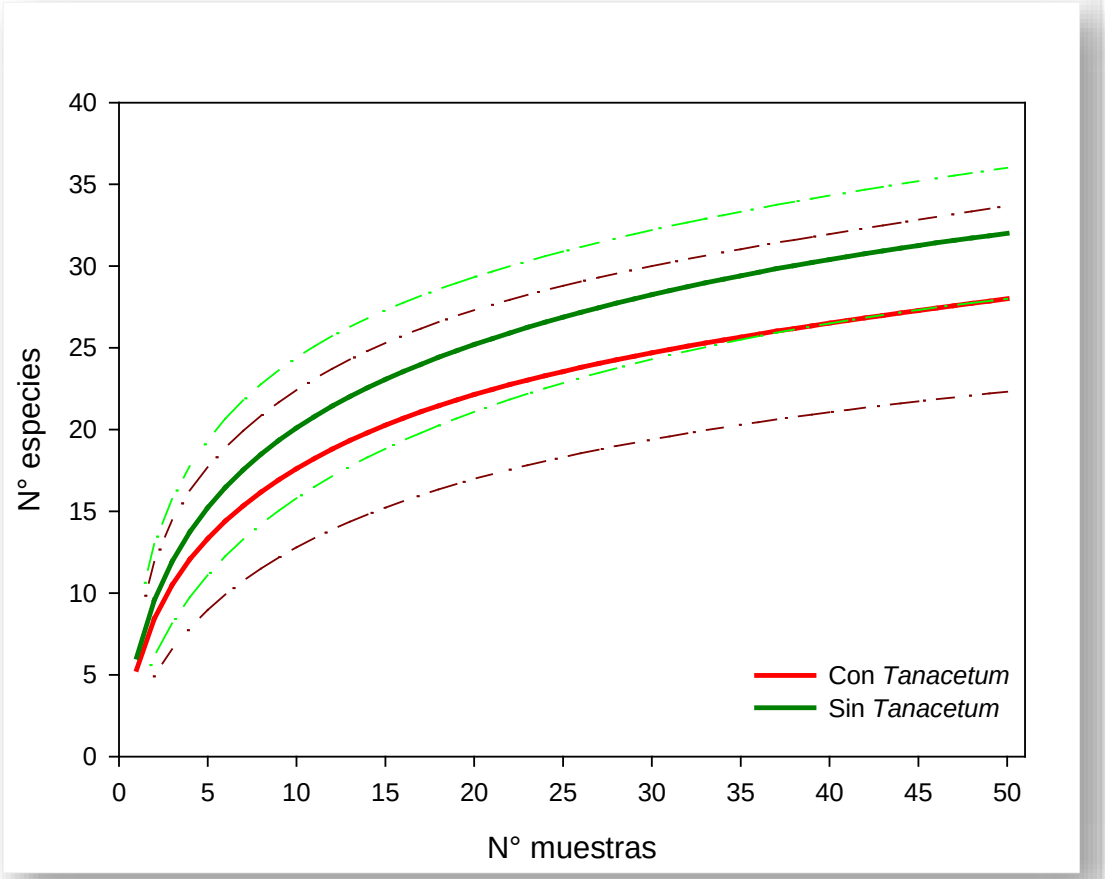

Cynoglossum creticum (2600)
Erodium cicutarium (2200)
Tanacetum parthenium (2600)

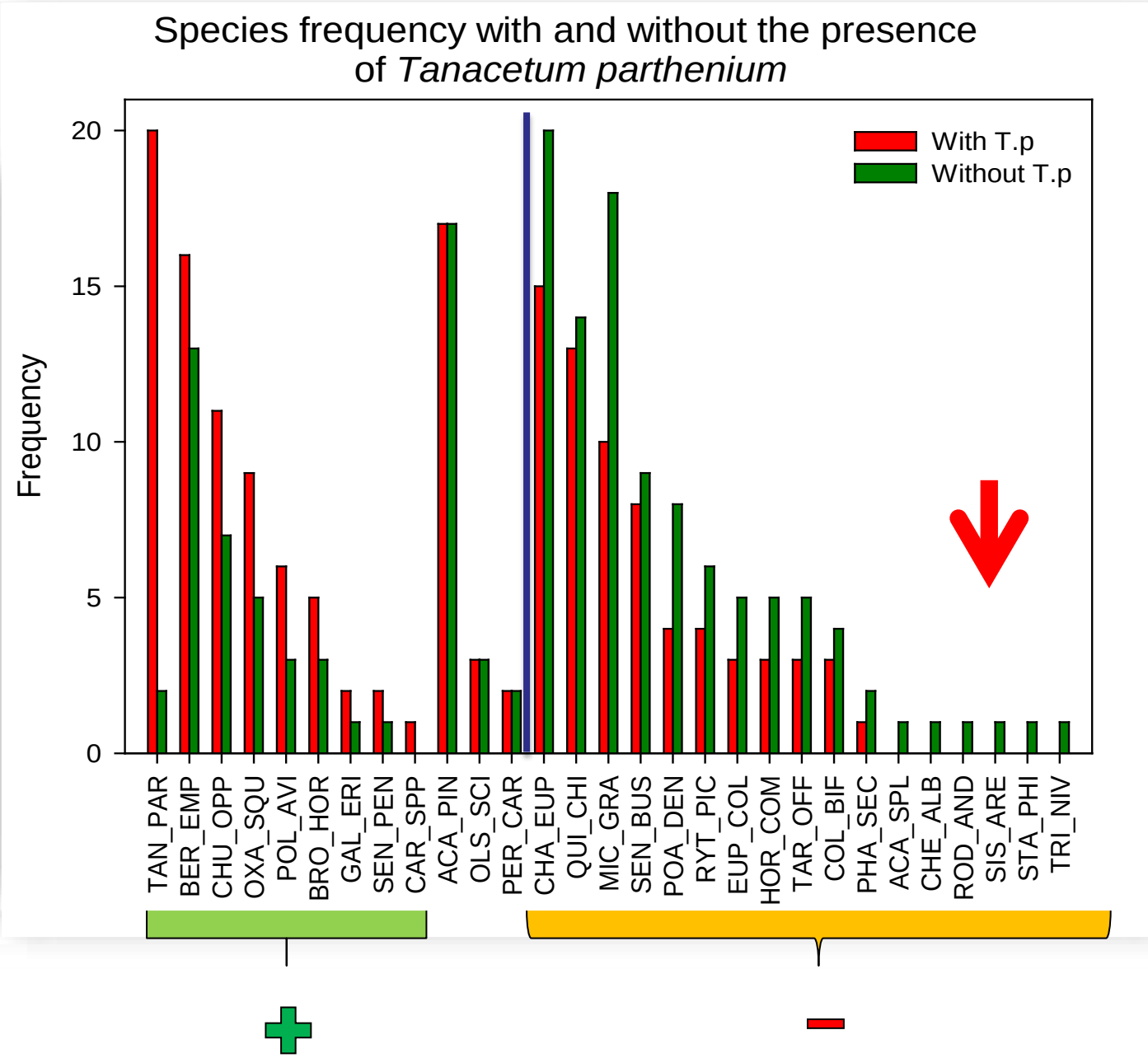
Erodium cicutarium (2200 m)

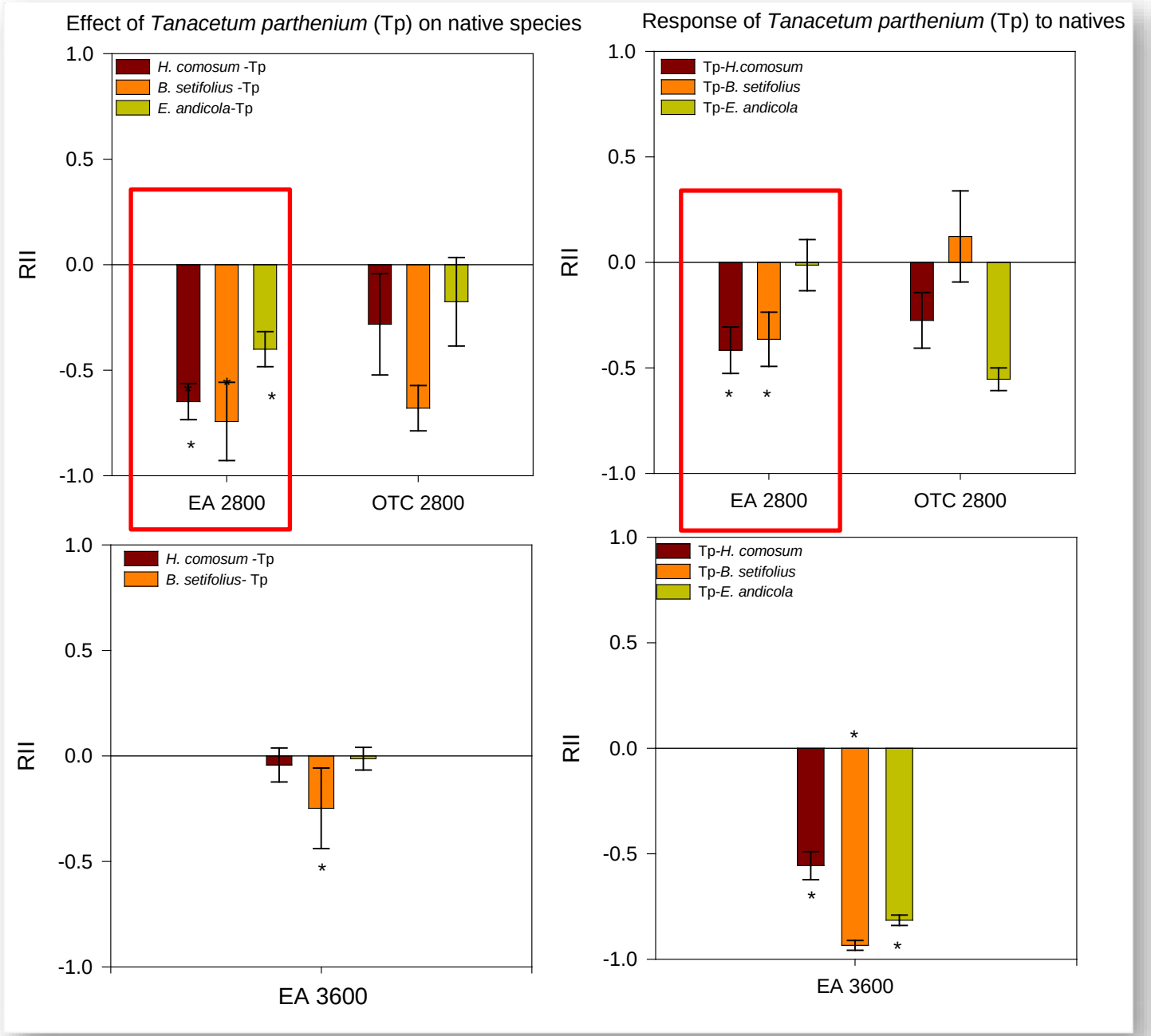




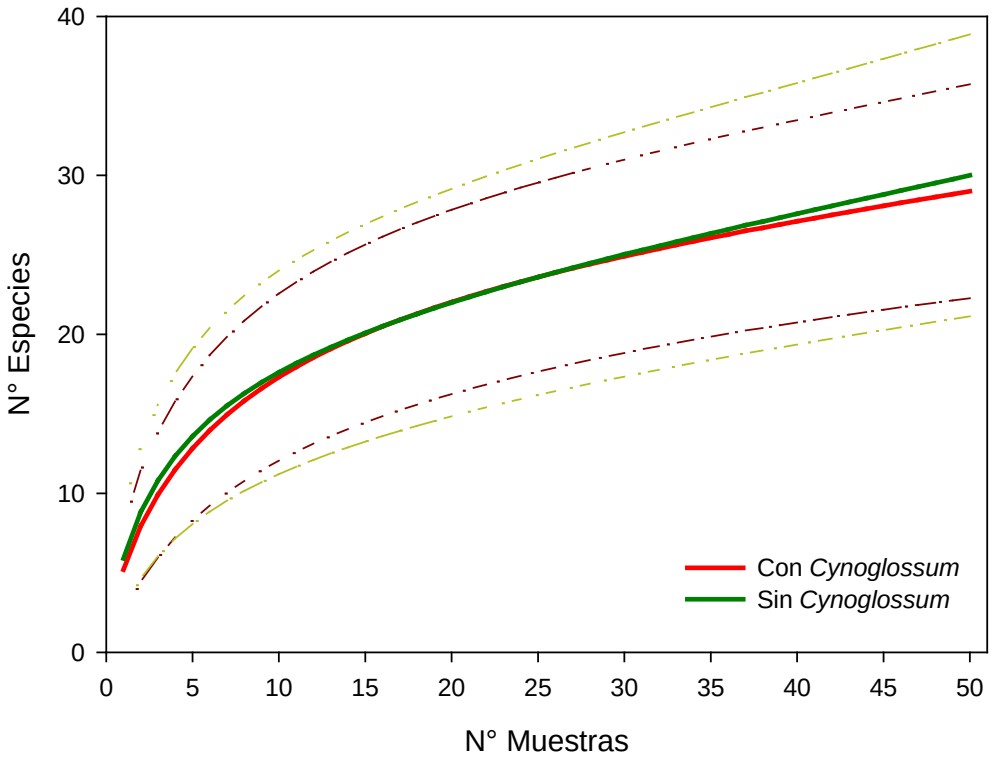
Tanacetum parthenium (2600 m)

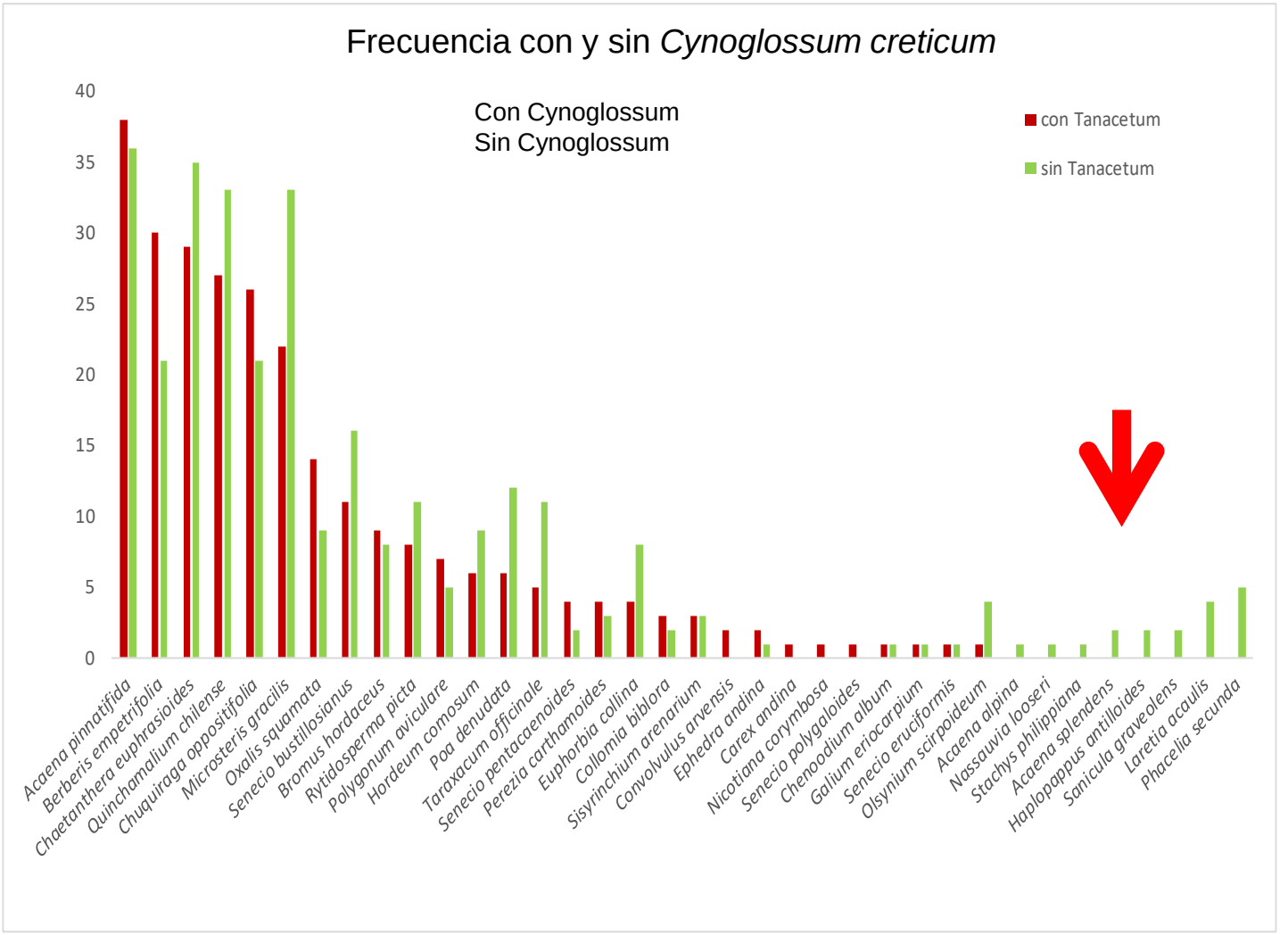


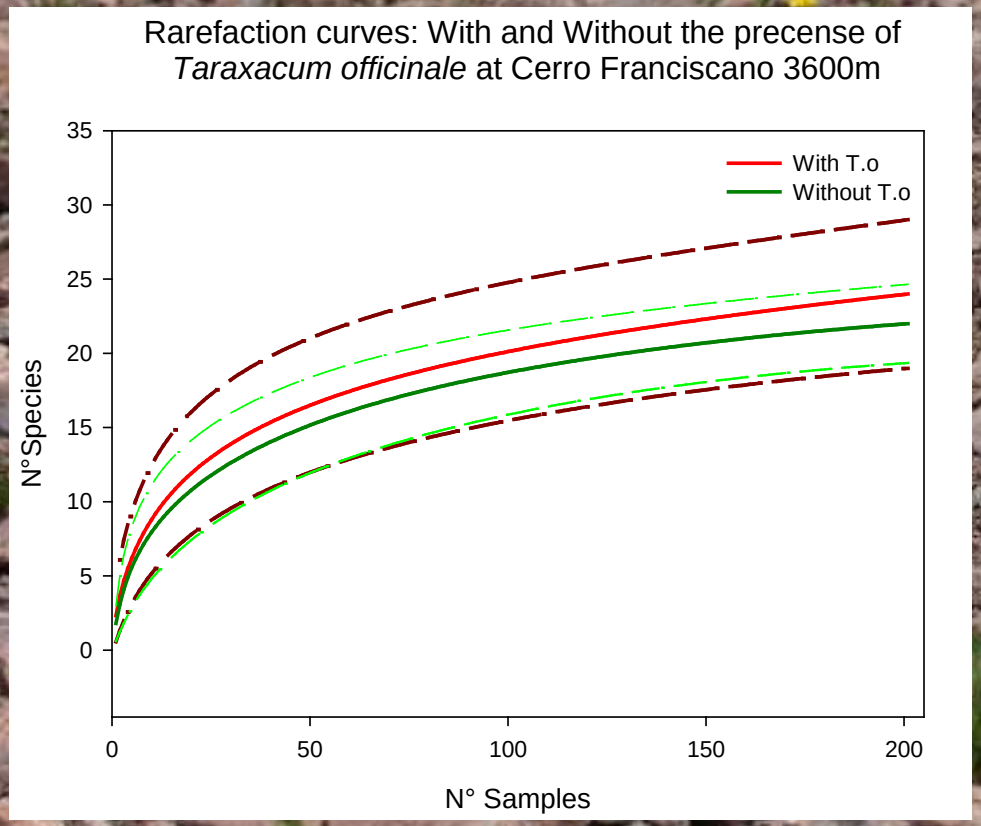


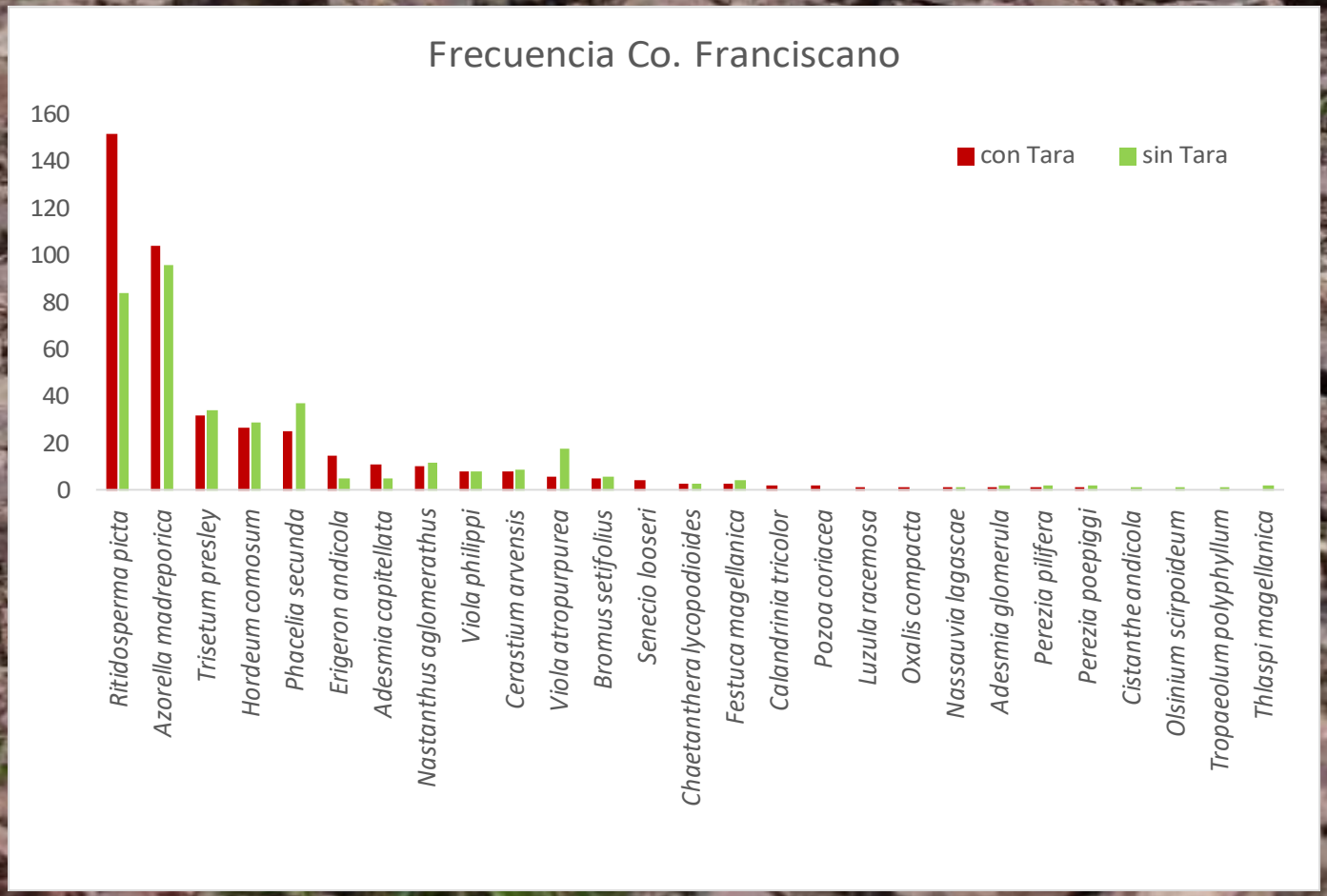

Effect of Tanacetum parthenium (Tp) on native species
H. comosum -Tp
B. setifolius -Tp
E. andicola-Tp
RII
1.0
0.5
0.0
-0.5
-1.0
EA 2800
OTC 2800
Response of Tanacetum parthenium (Tp) to natives
Tp-H.comosum
Tp-B. setifolius
Tp-E. andicola
H. comosum -Tp
B. setifolius- Tp
EA 3600
Tp-H. comosum
Tp-B. setifolius
Tp-E. andicola

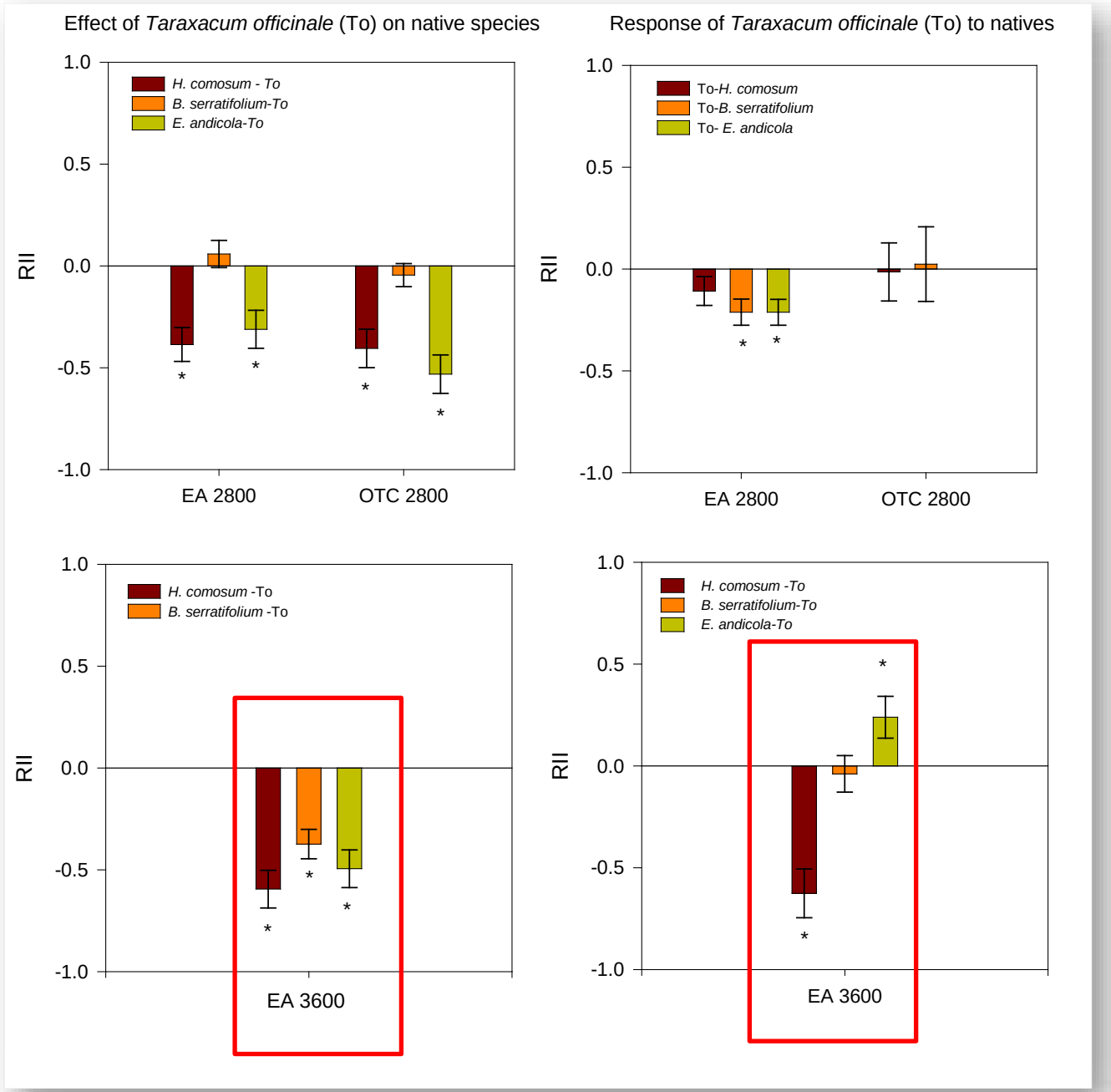
Cynoglossum creticum (2600 m)






Rarefaction curves: With and Without the precense of
Taraxacum officinale at Cerro Franciscano 3600m
With T.o
Without T.o
N°Species
N° Samples
0
5
10
15
20
25
30
35
0
50
100
150
200

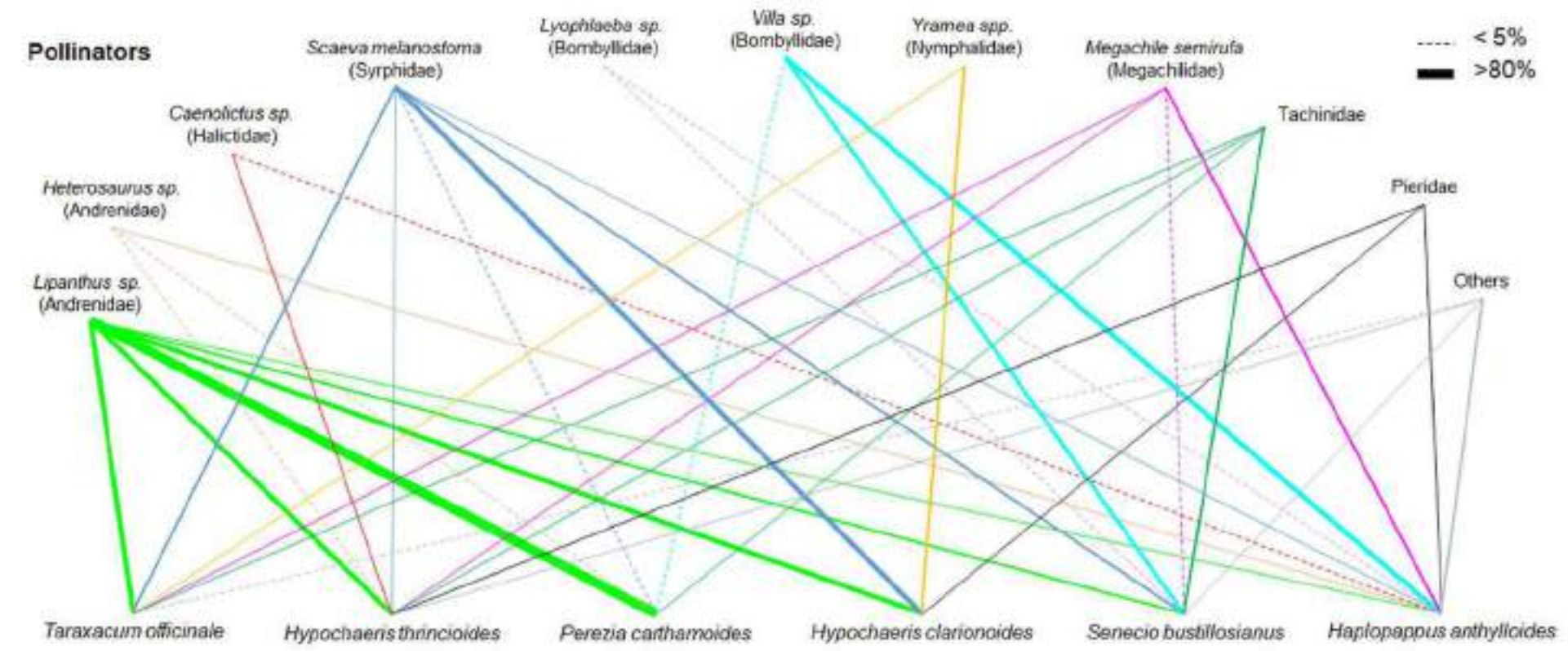

Frecuencia Co. Franciscano
con Tara
sin Tara
160
140
120
100
80
60
40
20
0
Ritidosperma picta
Azorella madreporica
Trisetum presley
Hordeum comosum
Phacelia secunda
Erigeron andicola
Adesmia capitellata
Nastanthus aglomerathus
Viola philippi
Cerastium arvensis
Viola atropurpurea
Bromus setifolius
Senecio looseri
Chaetanthera lycopodioides
Festuca magellanica
Calandrinia tricolor
Pozoa coriacea
Luzula racemosa
Oxalis compacta
Nassauvia lagascae
Adesmia glomerula
Perezia pilifera
Perezia poepiggi
Cistanthe andicola
Olsinium scirpoideum
Tropaeolum polyphyllum
Thlaspi magellanica

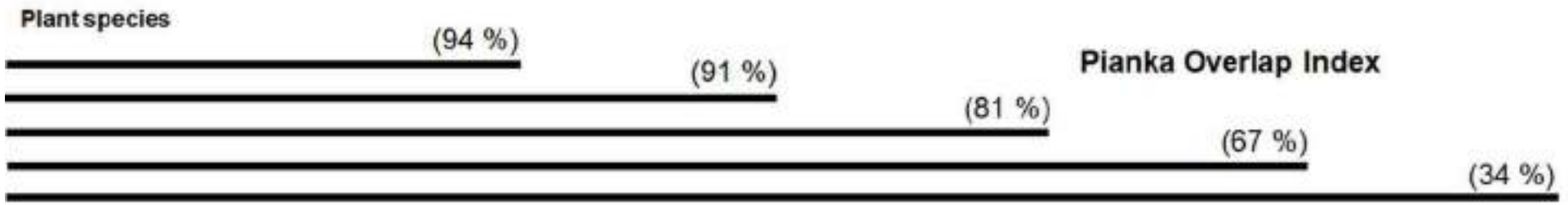

Effect of Taraxacum officinale (To) on native species
Response of Taraxacum officinale (To) to natives
H. comosum - To
B. serratifolium-To
E. andicola-To
To-H. comosum
To-B. serratifolium
To- E. andicola
RII
1.0
0.5
0.0
-0.5
-1.0
EA 2800
OTC 2800
H. comosum -To
B. serratifolium -To
E. andicola-To
EA 3600

Senecio bustillosianus

Haplopappus anthylloides

Hypochaeris thrincioides


Pollinators
Scaeva melanostoma (Syrphidae)
Lyophlaeba sp. (Bombyllidae)
Villa sp. (Bombyllidae)
Yramea spp. (Nymphalidae)
Megachile semirufa (Megachilidae)
< 5%
>80%
Caenolictus sp. (Halictidae)
Tachinidae
Heterosaurus sp. (Andrenidae)
Pieridae
Lipanthus sp. (Andrenidae)
Others
Taraxacum officinale
Hypochaeris thrincioides
Perezia carthamoides
Hypochaeris clarionoides
Senecio bustillosianus
Haplopappus anthylloides


Plant species
(94 %)
(91 %)
(81 %)
(67 %)
(34 %)
Pianka Overlap Index

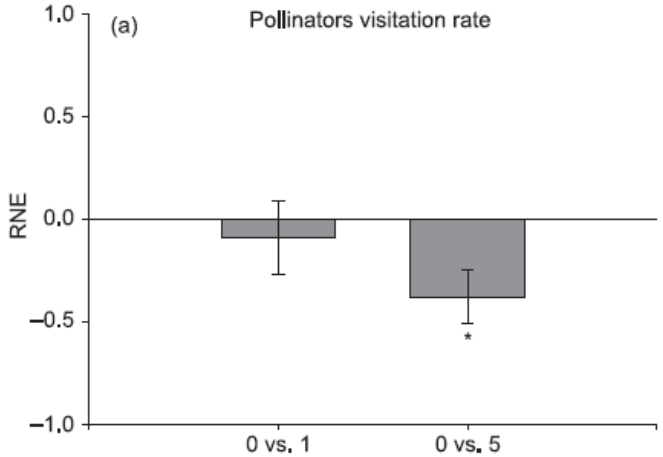

S. bustillosianus
H. anthylloides
H. thrincioides
T. officinale

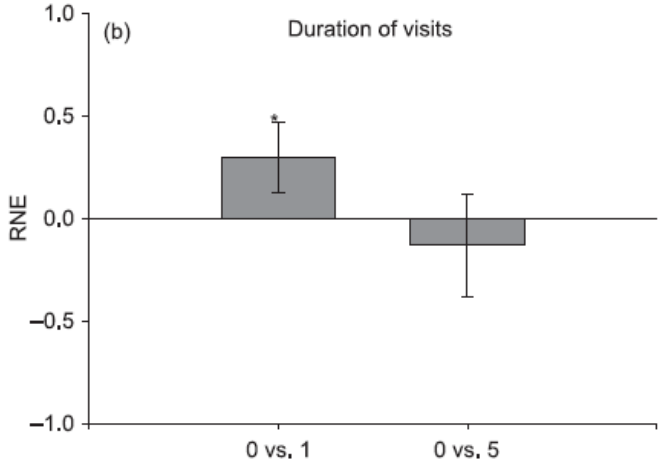
We planted *Taraxacum officinale* individuals at different densities (0,1,5 ind.) around target plant of these native species and quantified pollinator visitation rates and seed output

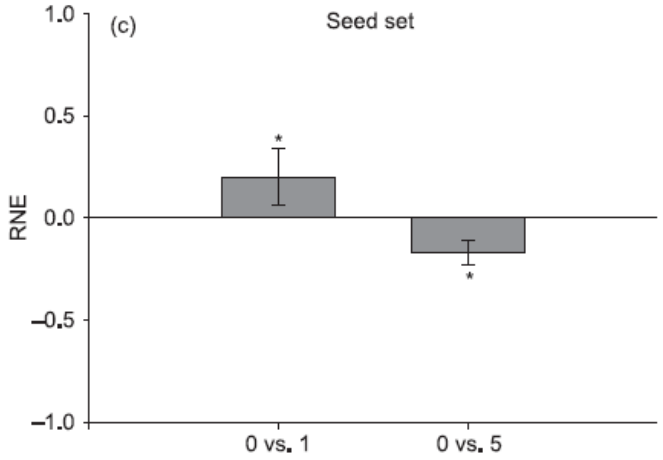
Perezia carthamoides

Hypochaeris thrincioides

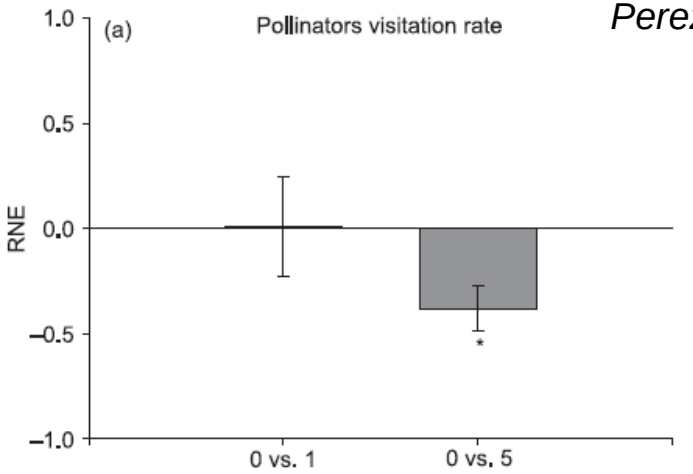
Hypochaeris thrincioides

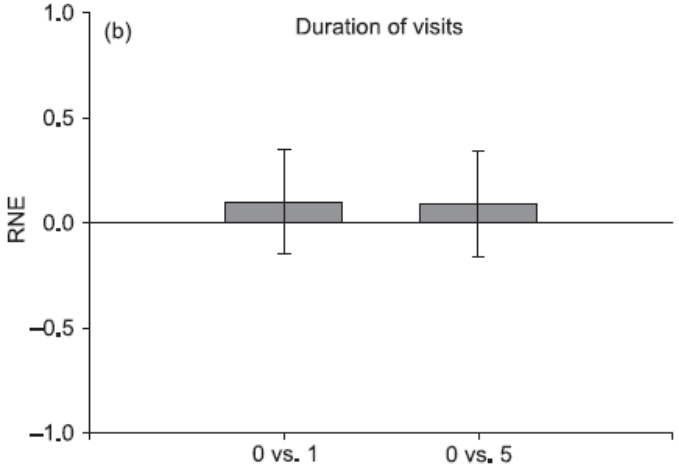


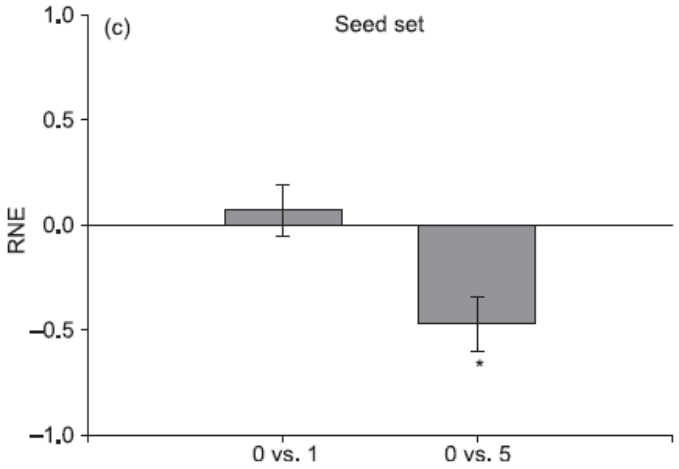




Perezia carthamoides







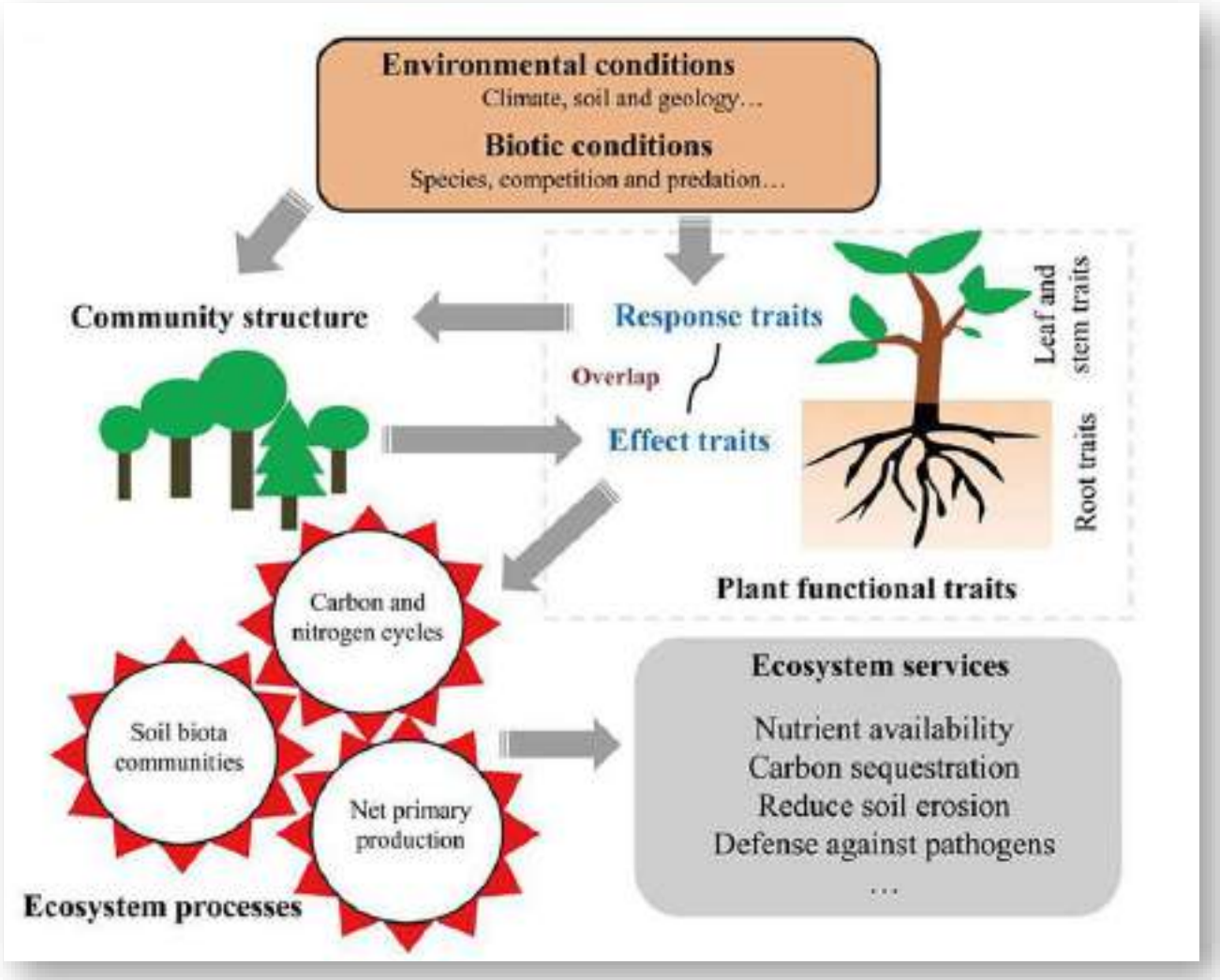
Rasgos funcionales

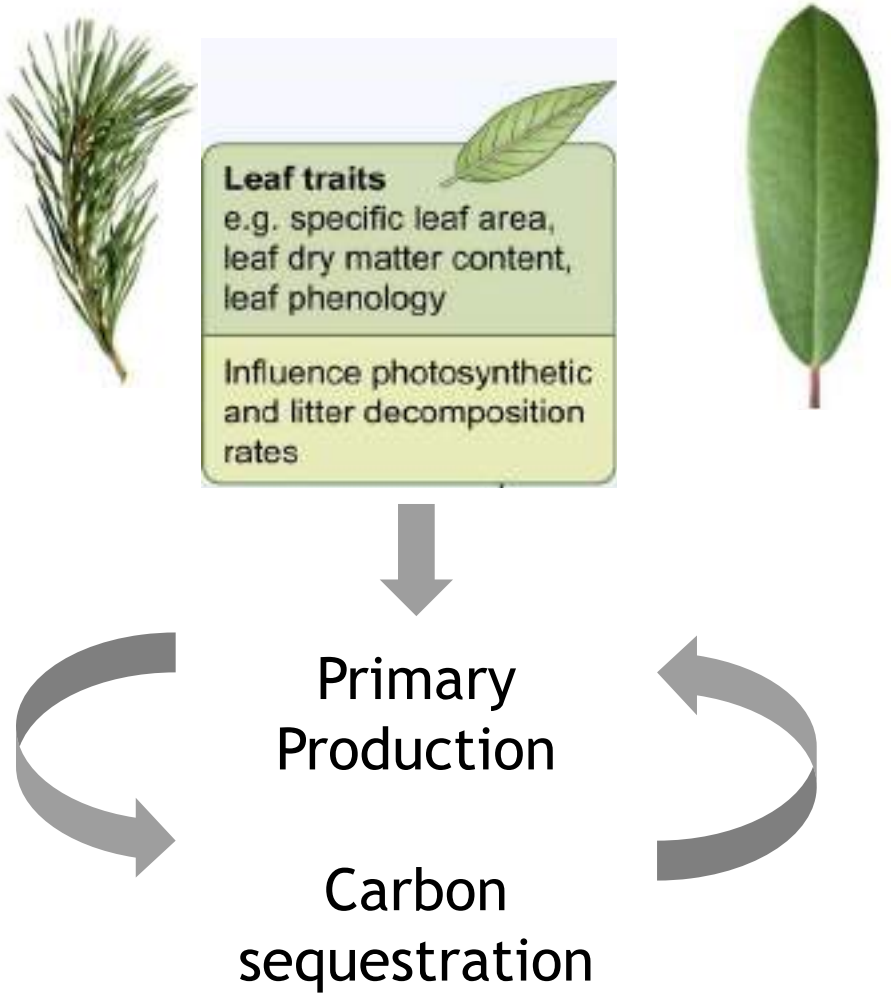
Se definen como cualquier rasgo morfológico o fisiológico que afecta el desempeño individual

- Tamaño de planta
- Tipo/forma de hoja
- Forma raíz
- Profundidad Raíz

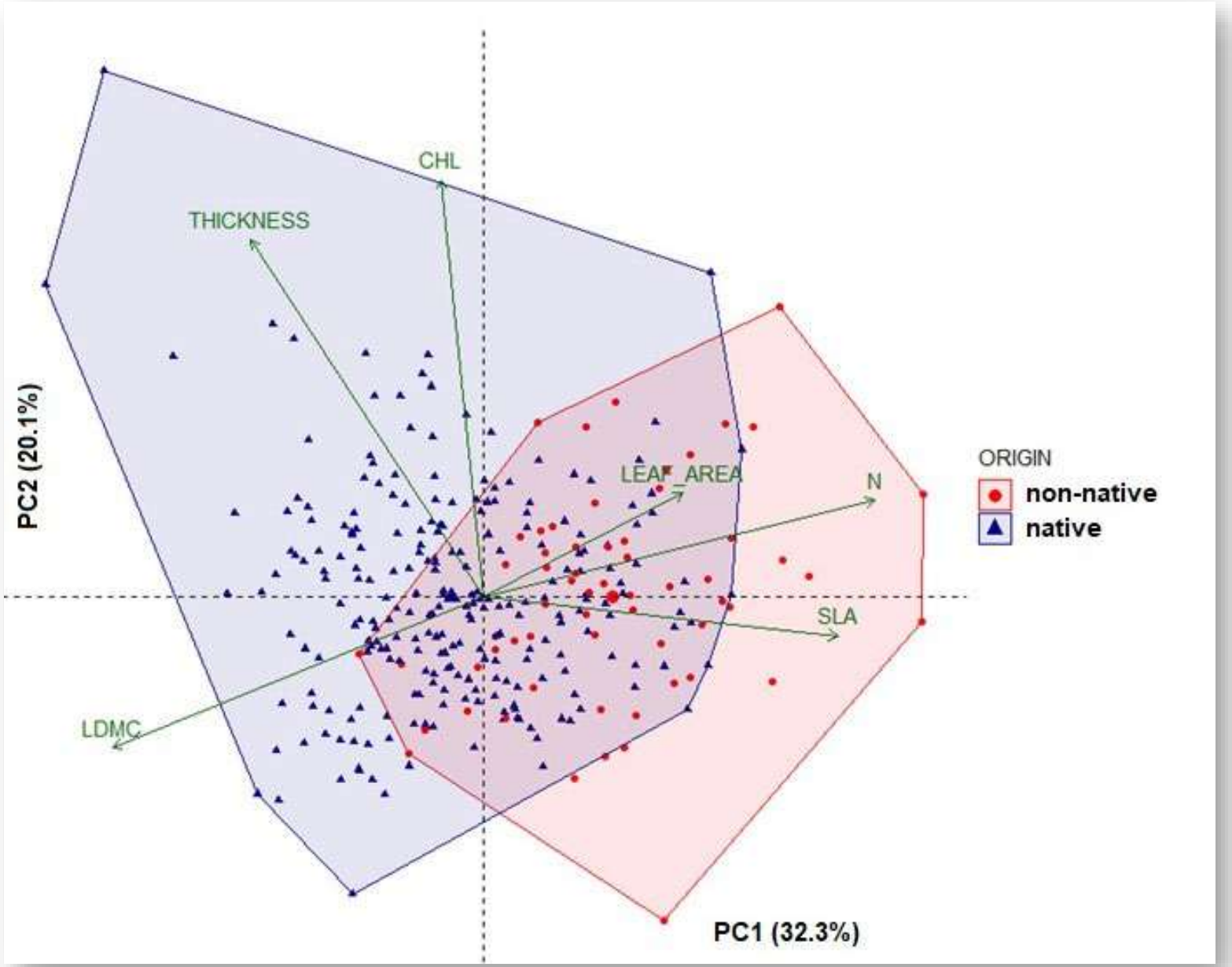
- Tipo vía fotosintética (C3/C4)
- Eficiencia uso de agua en fotosíntesis
- Tolerancia a sequía

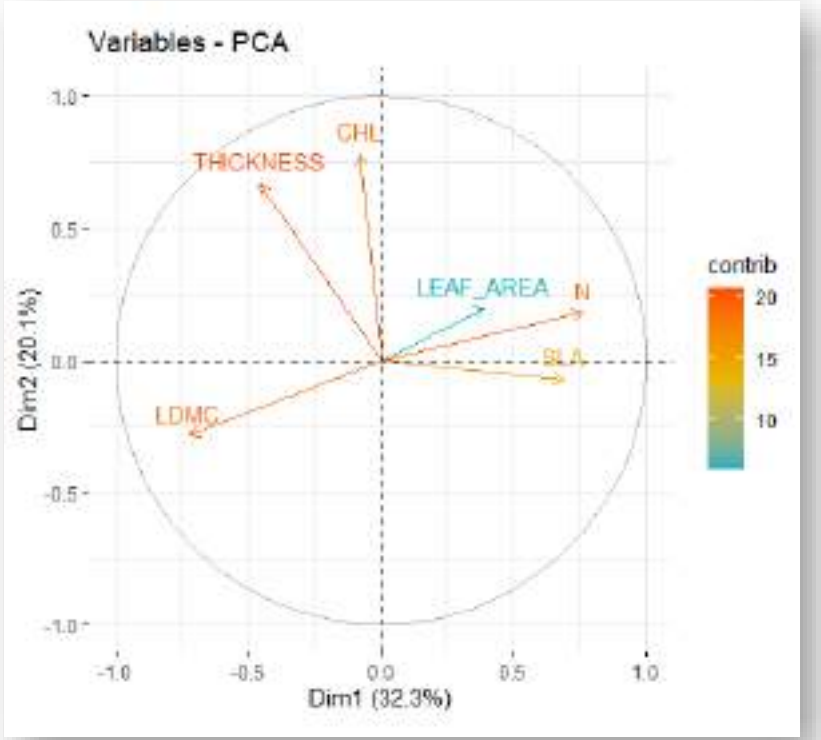
Rasgos funcionales y su diversidad se relacionan directamente con funcionamiento (servicios) de los ecosistemas

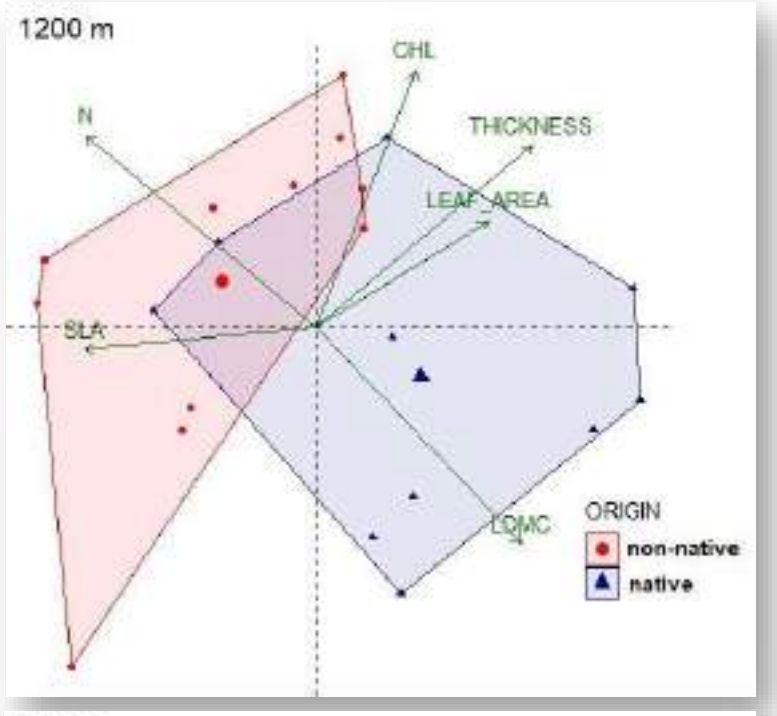


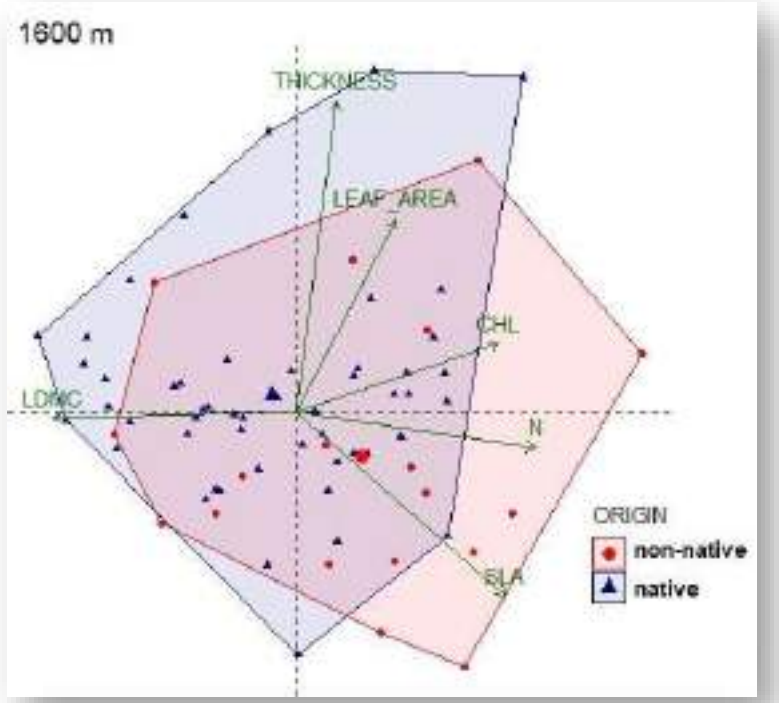


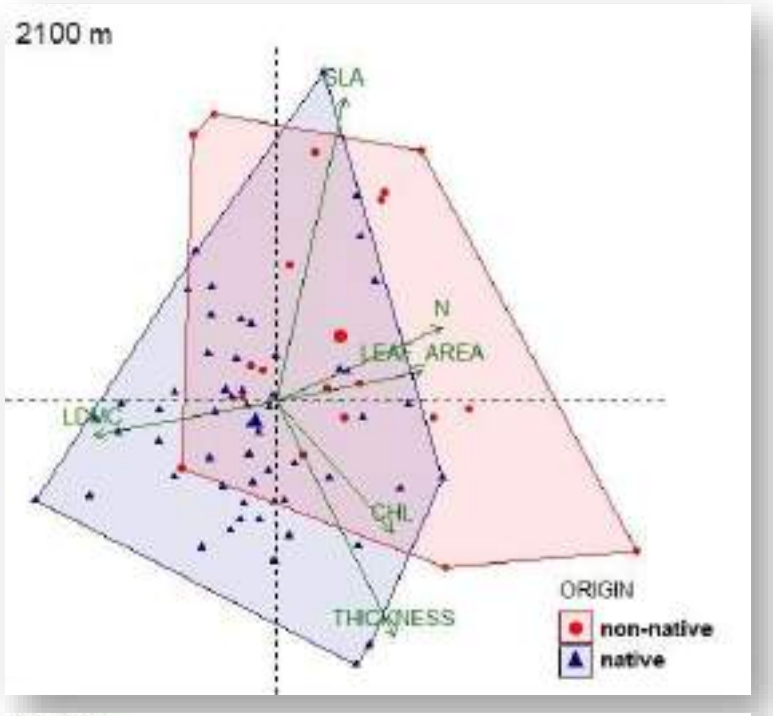

ADQUISITIVAS
CONSERVATIVAS

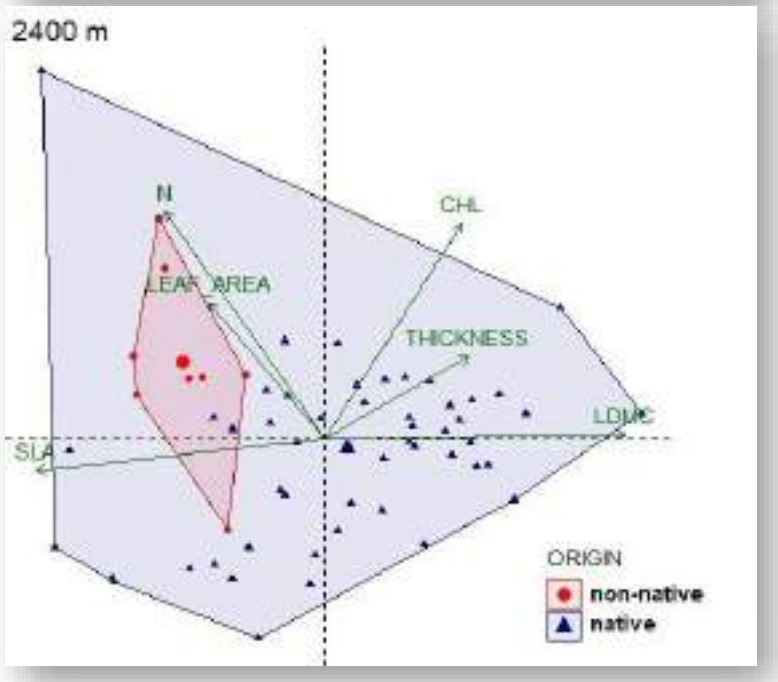

CHL
THICKNESS
LEAF_AREA
N
SLA
LDMC
PC2 (20.1%)
PC1 (32.3%)
ORIGIN
non-native
native

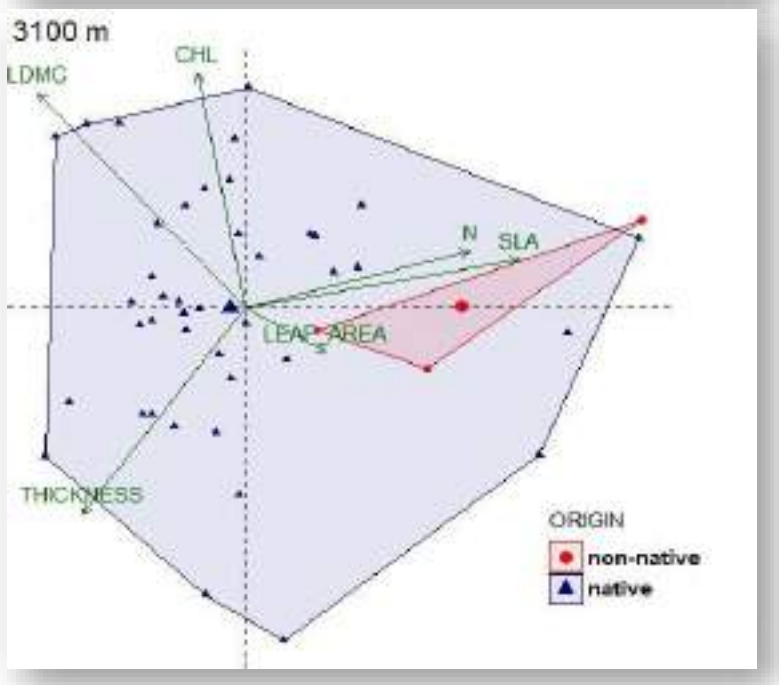

Variables - PCA
CHL
THICKNESS
LEAF_AREA
N
SLA
LDMC
contrib
20
15
10
Dim2 (20.1%)
Dim1 (32.3%)
1.0
0.5
0.0
-0.5
-1.0

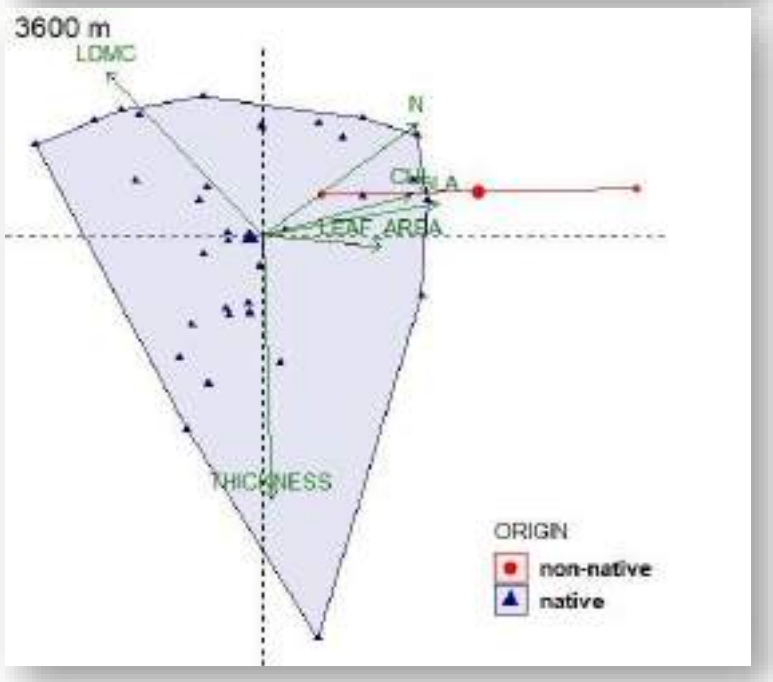

1200 m
CHL
N
THICKNESS
LEAF_AREA
SLA
LDMC
ORIGIN
non-native
native


1600 m
THICKNESS
LEAF_AREA
CHL
LDMC
N
SLA
ORIGIN
non-native
native

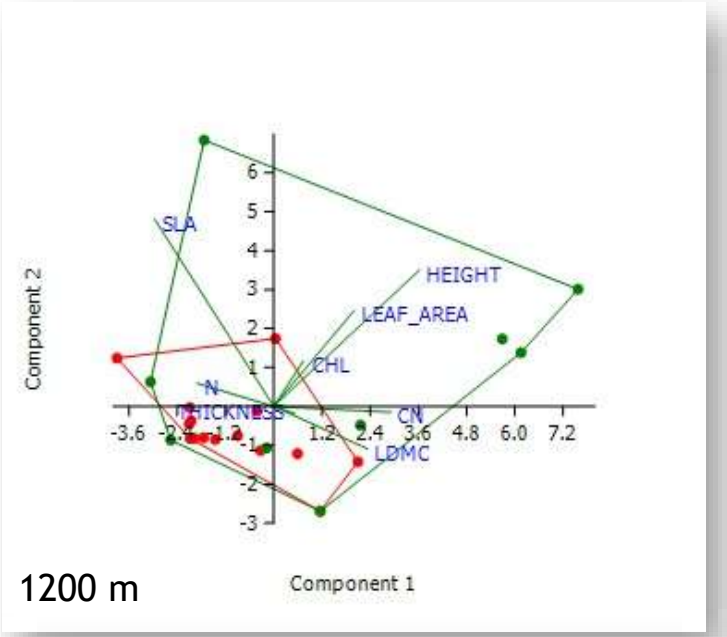

2100 m
SLA
N
LEAF_AREA
LDMC
CHL
THICKNESS
ORIGIN
non-native
native


2400 m
N
CHL
LEAF_AREA
THICKNESS
LDMC
SLA
ORIGIN
non-native
native

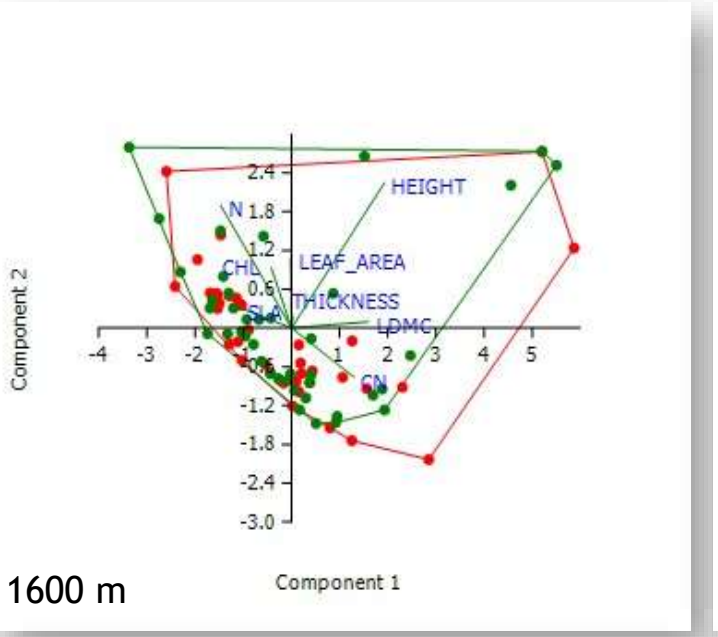

3100 m
LDMC
CHL
N
SLA
LEAF_AREA
THICKNESS
ORIGIN
non-native
native


3600 m
LDMC
N
SLA
LEAF_AREA
THICKNESS
ORIGIN
non-native
native

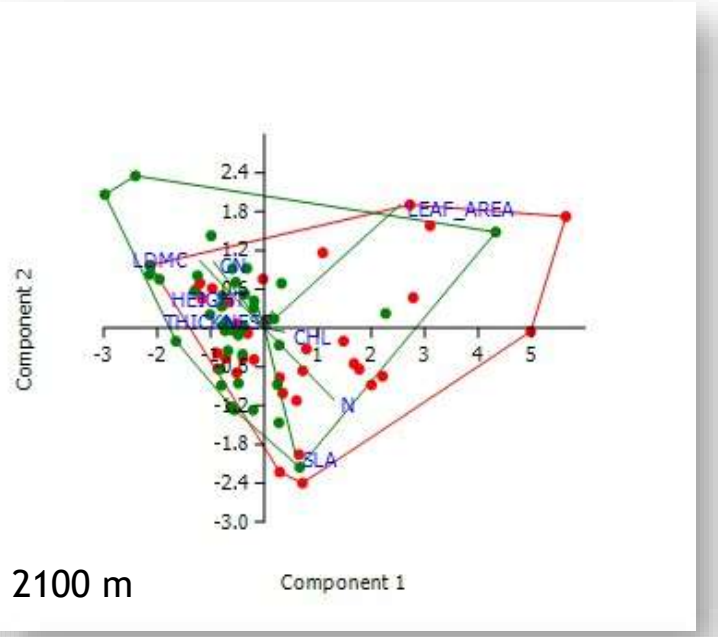
Consecuencias funcionales: Distribución rasgos funcionales



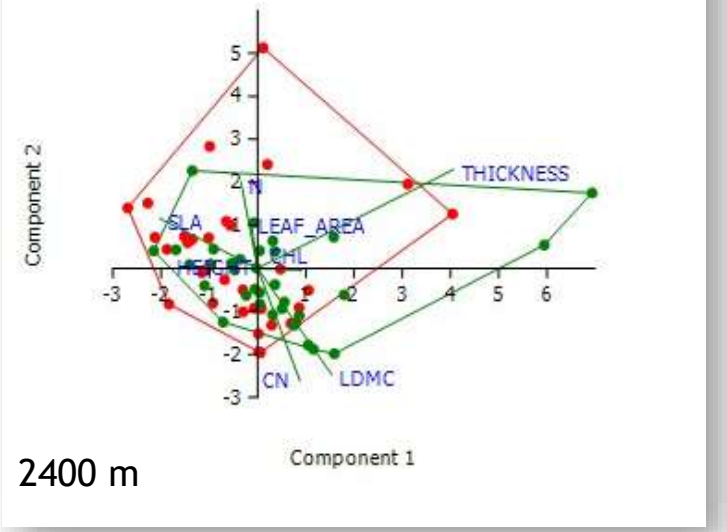
1200 m



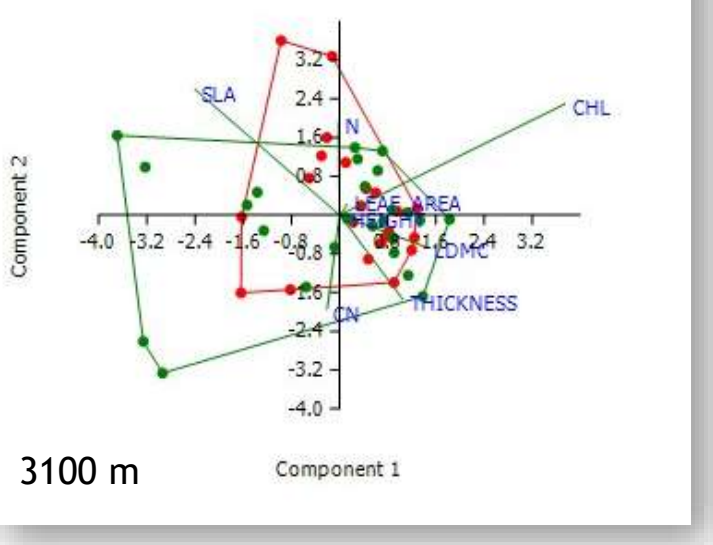
1600 m



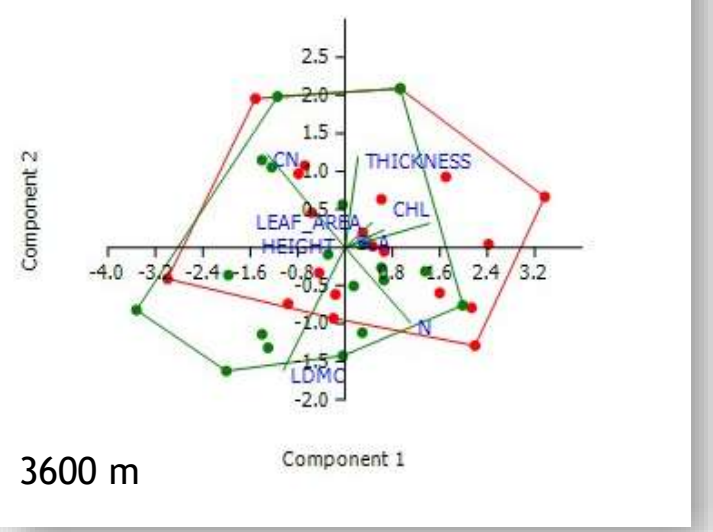
2100 m



2400 m

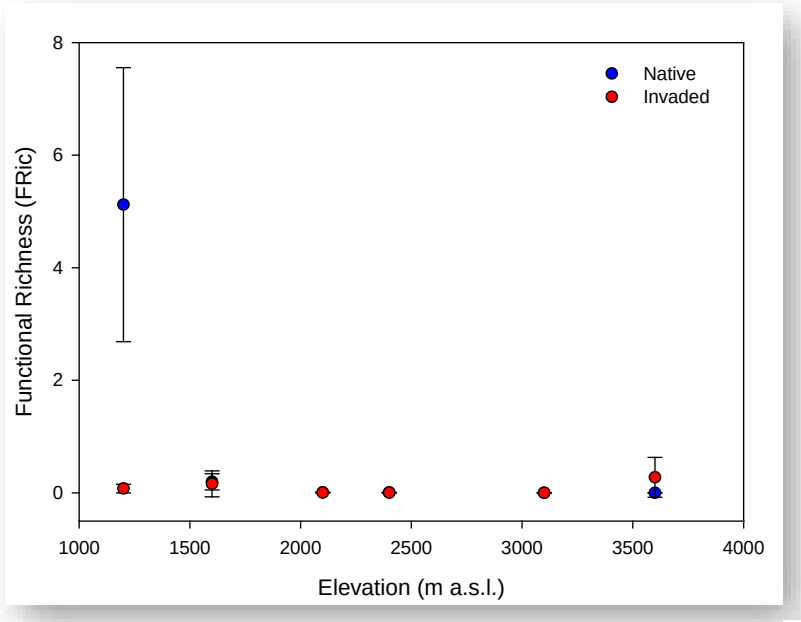


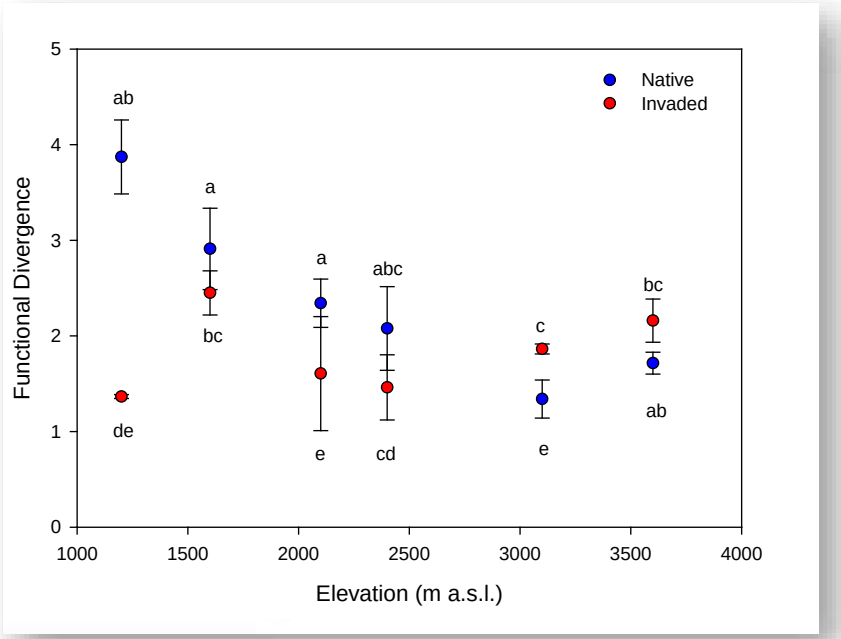
3100 m

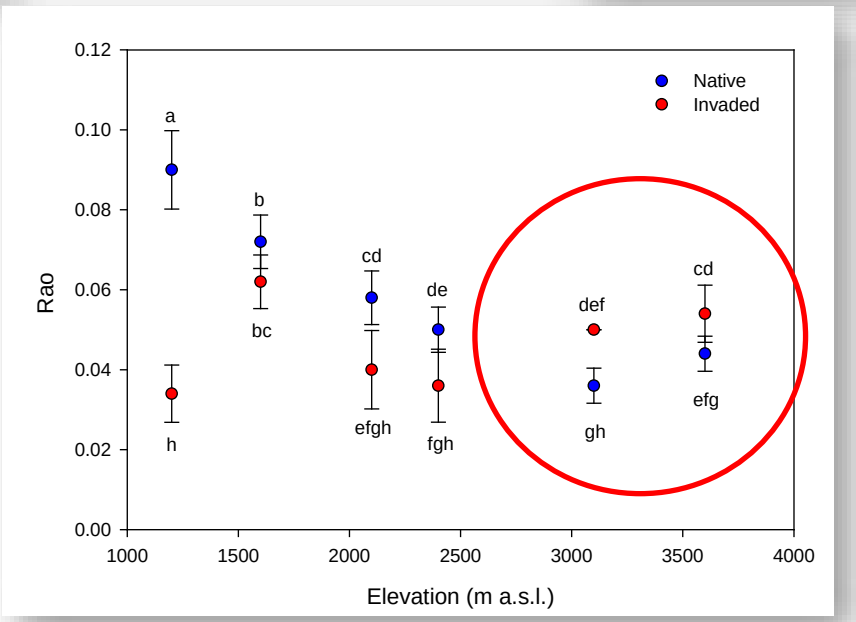


3600 m

Consecuencias funcionales: Diversidad funcional



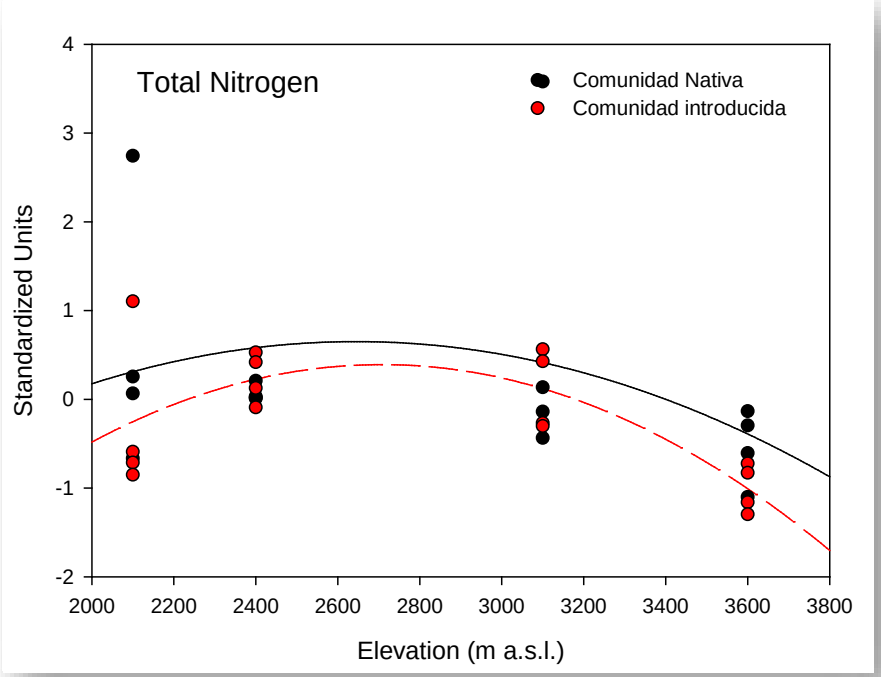


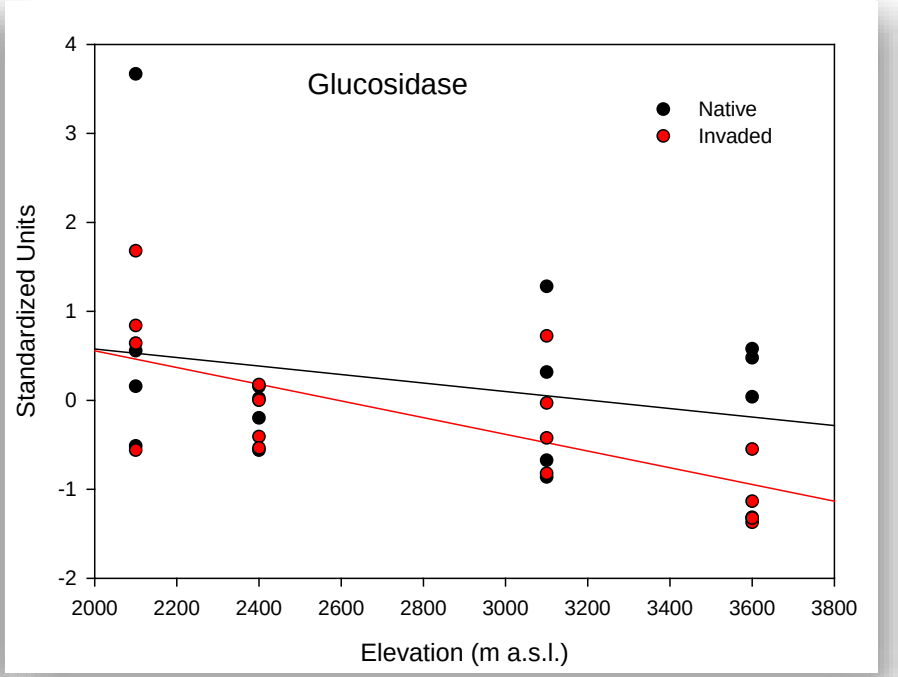


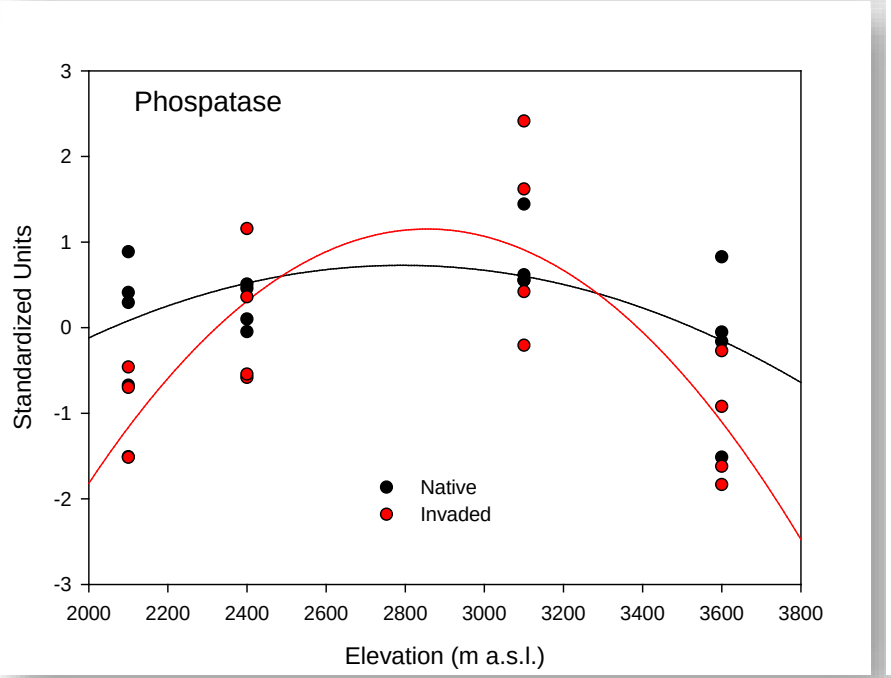
Consecuencias funcionales:

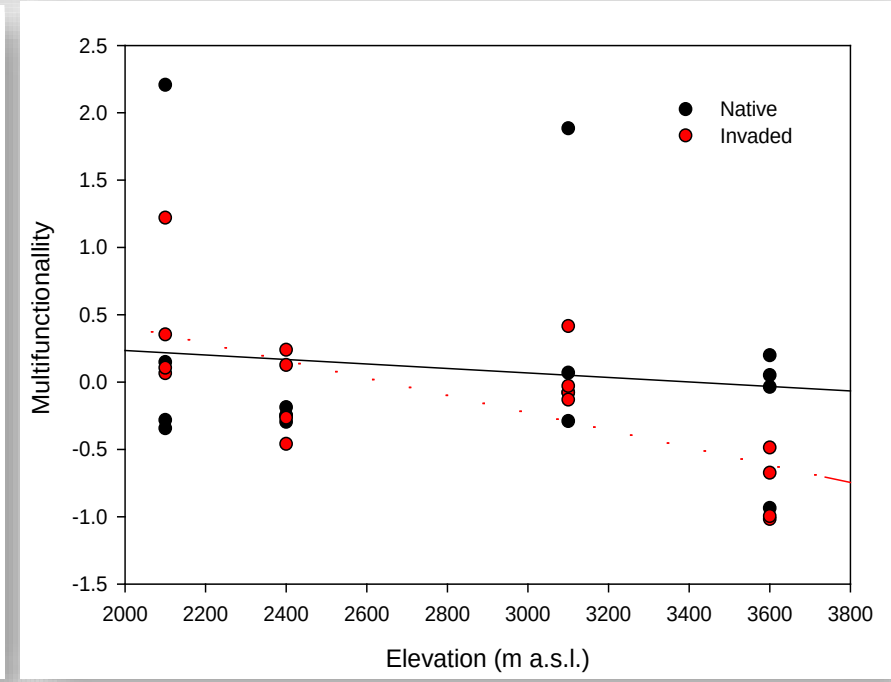
funcionalidad suelo

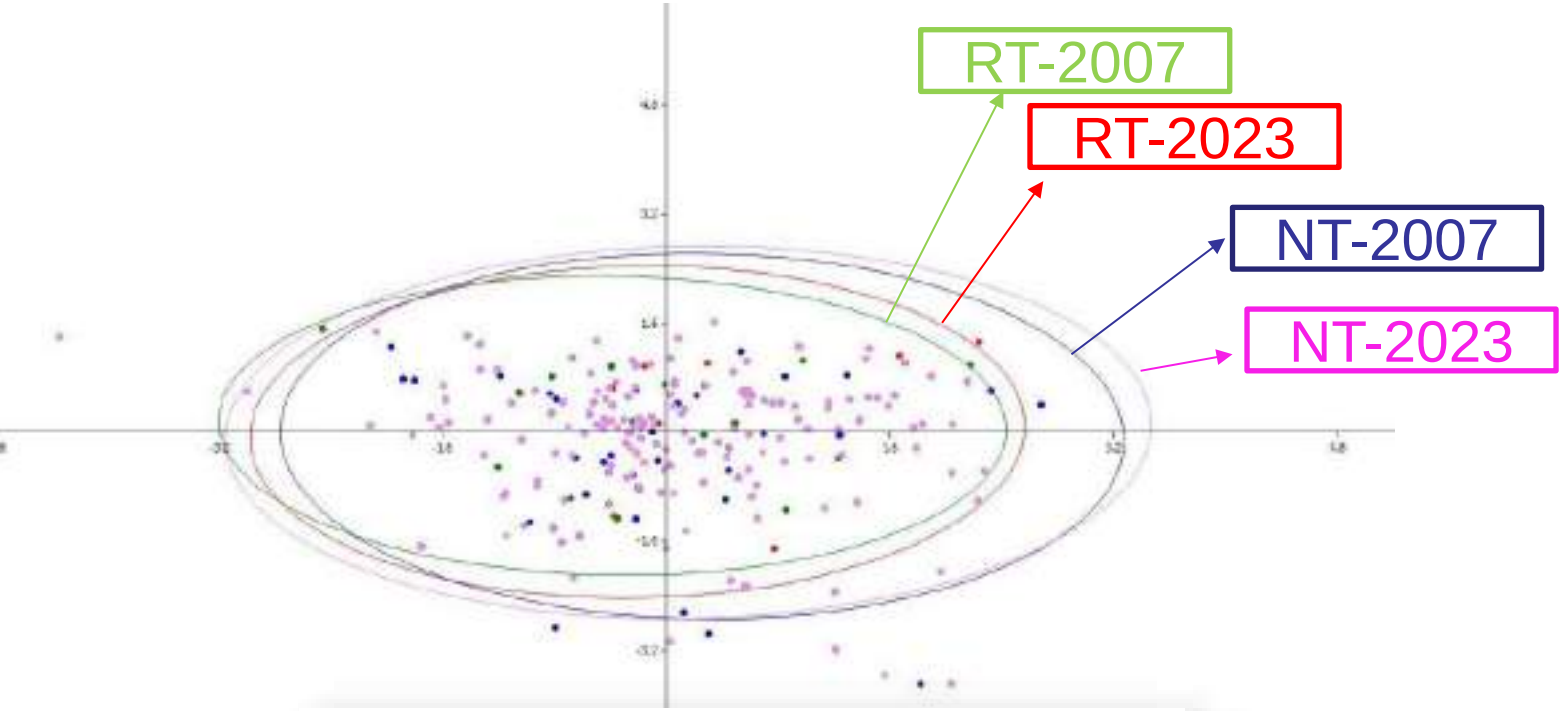
ciclaje de nutrientes (N, C, P)

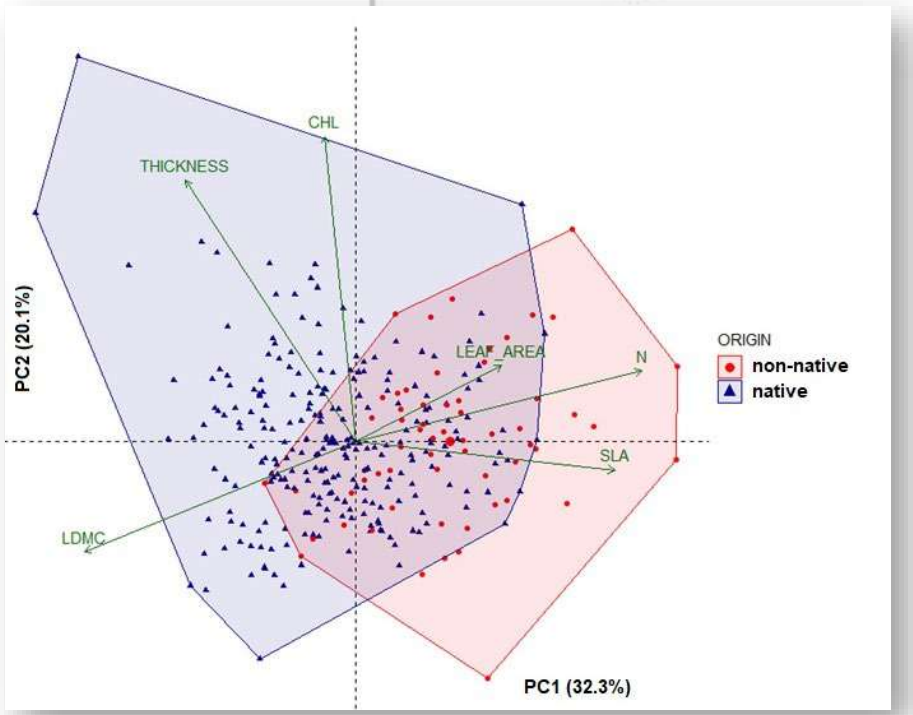


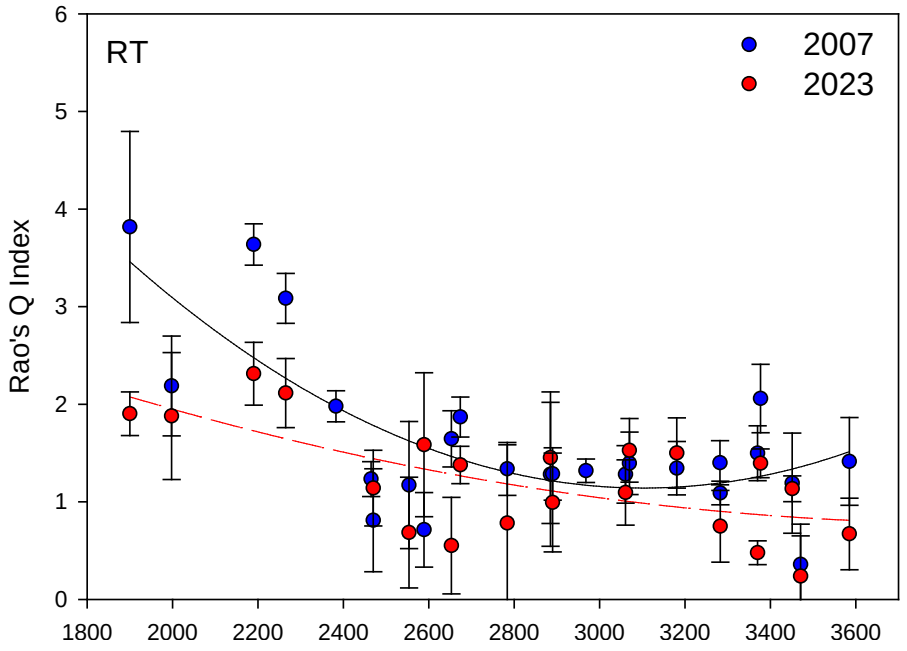


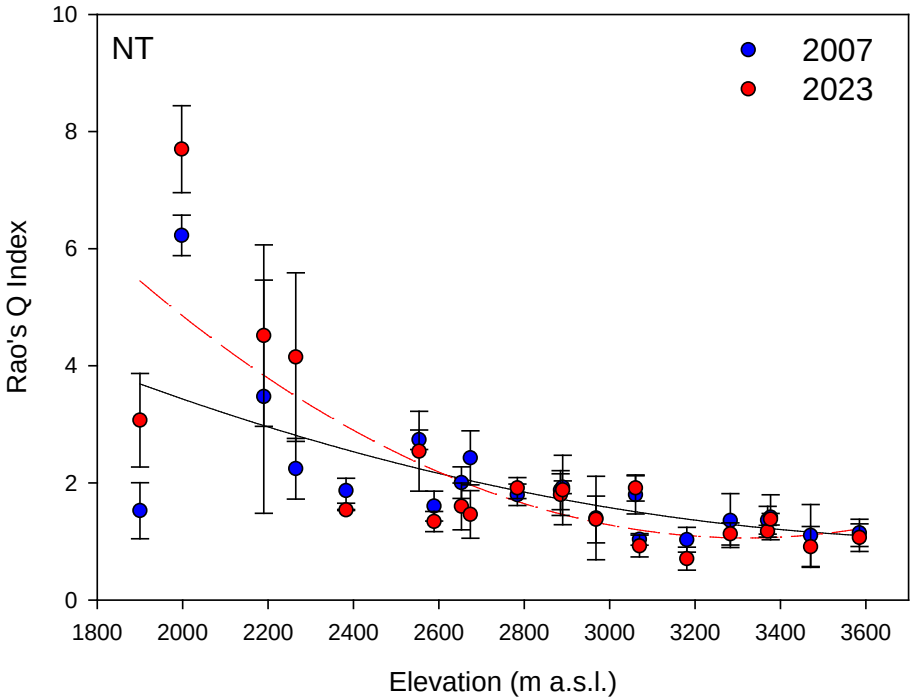




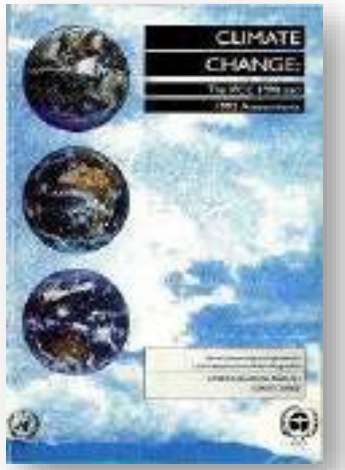

RT-2007
RT-2023
NT-2007
NT-2023


CHL
THICKNESS
LEAF_AREA
N
SLA
LDMC
PC2 (20.1%)
PC1 (32.3%)
ORIGIN
non-native
native


RT
2007
2023
Rao's Q Index
0
1
2
3
4
5
6
1800
2000
2200
2400
2600
2800
3000
3200
3400
3600

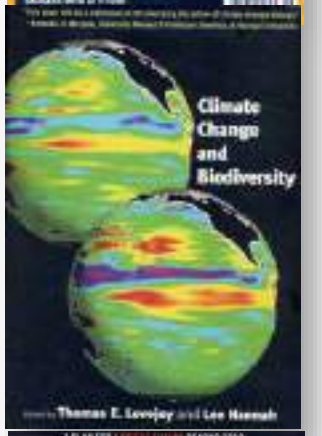

NT
2007
2023
Rao's Q Index
0
2
4
6
8
10
1800
2000
2200
2400
2600
2800
3000
3200
3400
3600
Elevation (m a.s.l.)

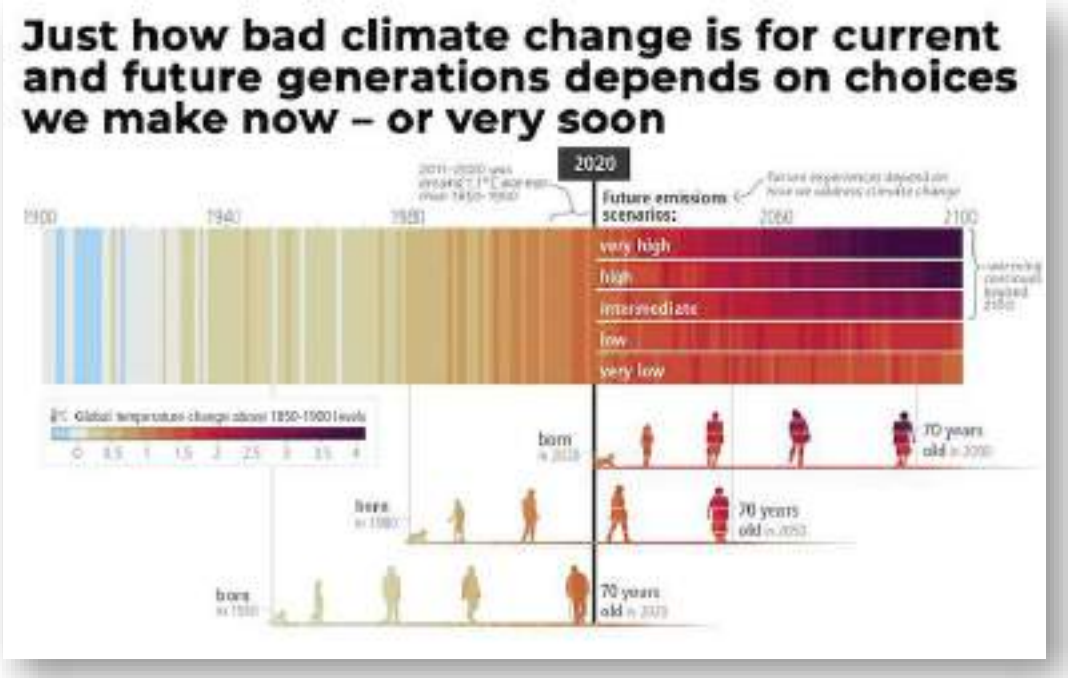
1990

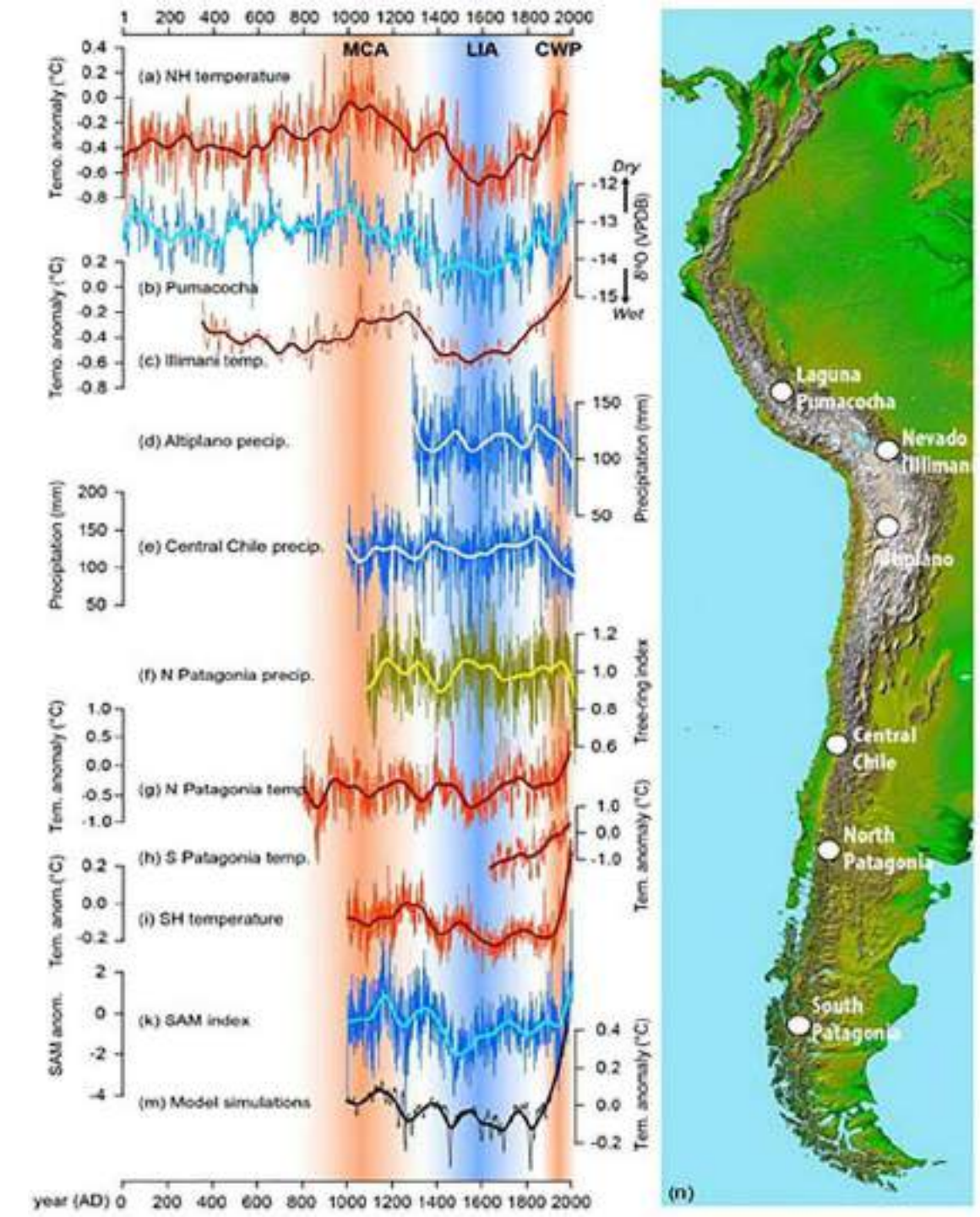


Global Warming Is Changing the World

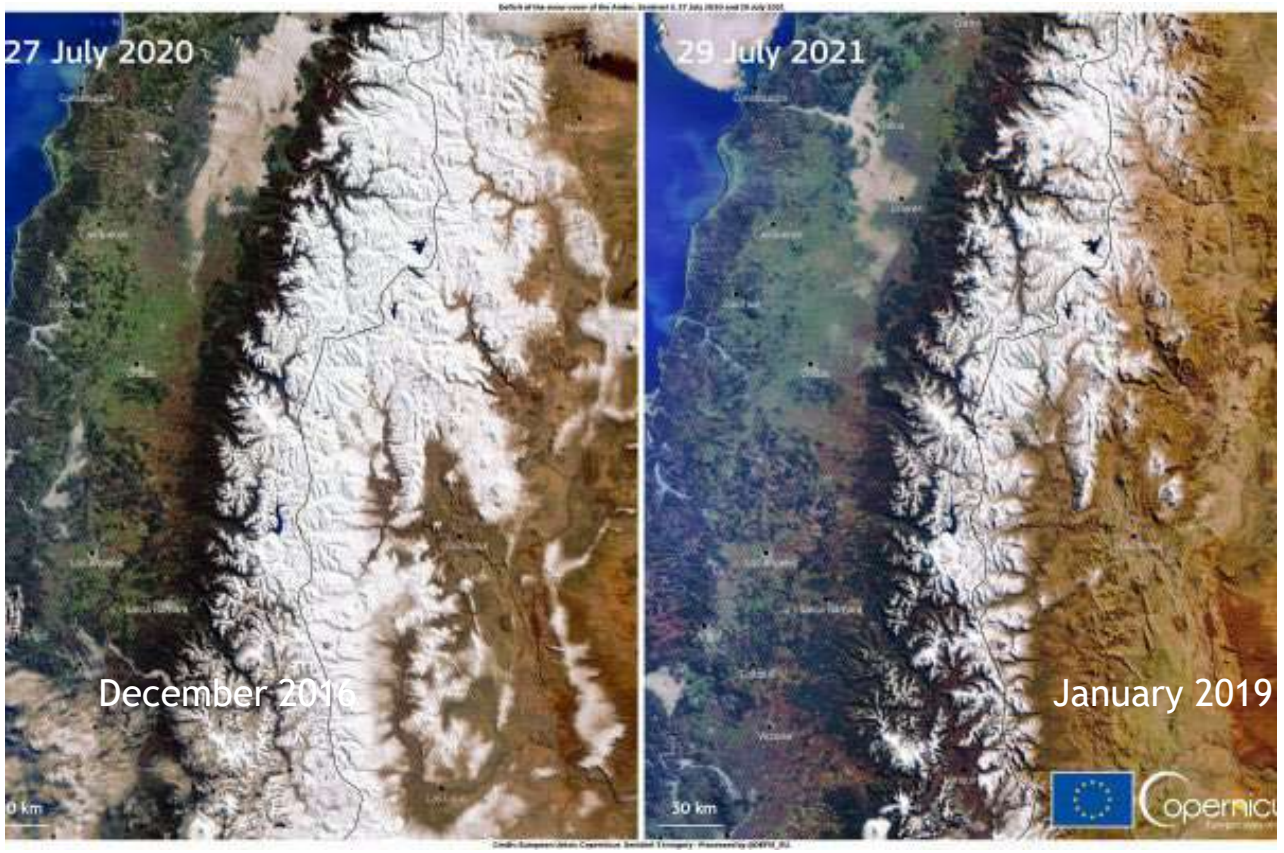
An international climate assessment finds for the first time that humans are altering their world and the life in it by altering climate; looking ahead, global warming's impacts will only worsen





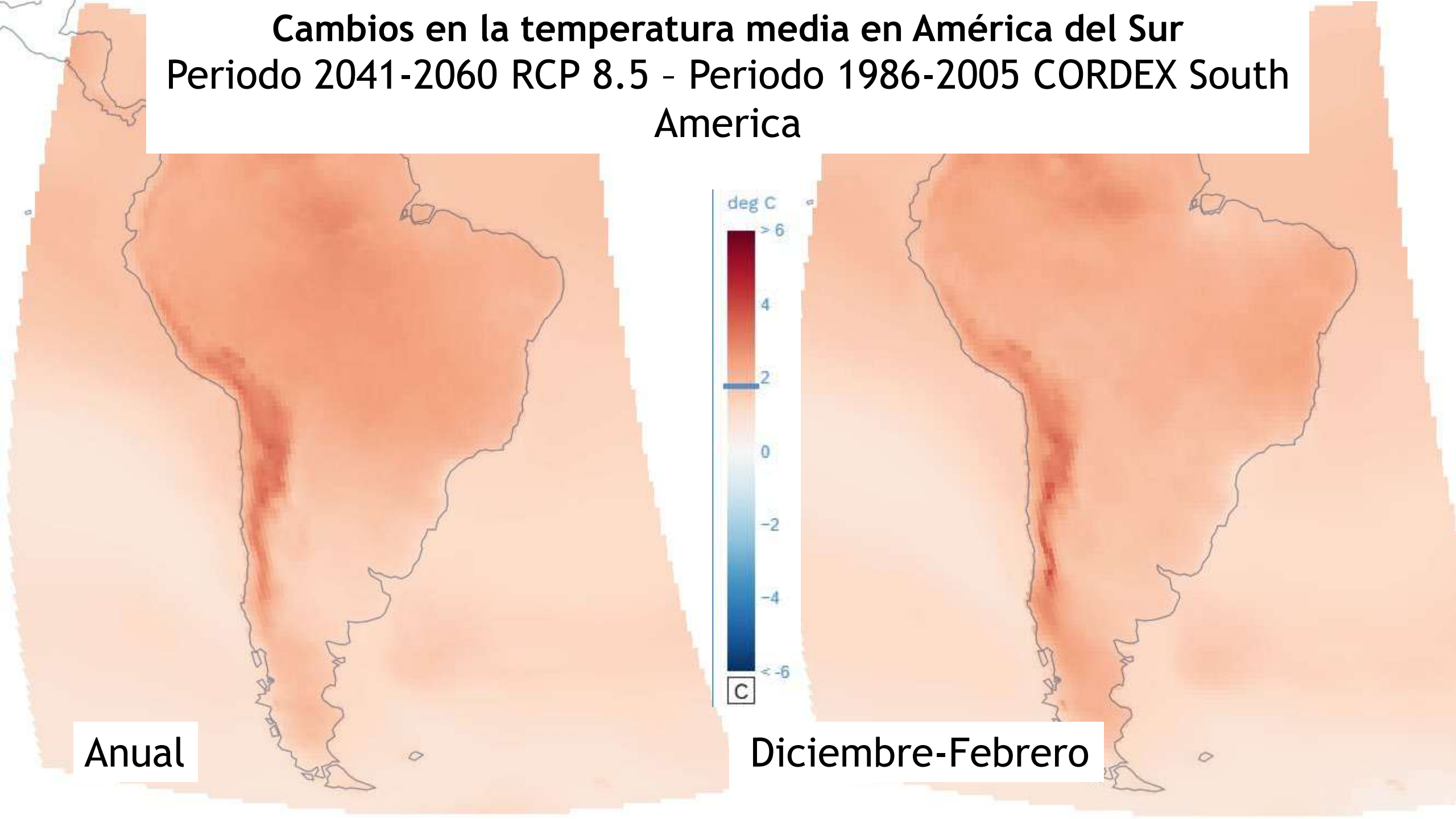

MCA
LIA
CWP
(a) NH temperature
(b) Pumacocha
(c) Illimani temp.
(d) Altiplano precip.
(e) Central Chile precip.
(f) N Patagonia precip.
(g) N Patagonia temp.
(h) S Patagonia temp.
(i) SH temperature
(k) SAM index
(m) Model simulations
Dry
Wet
δ18O (VPDB)
Precipitation (mm)
Tree-ring index
Tem. anomaly (°C)
SAM anom.
year (AD)

Laguna Pumacocha
Nevado Illimani
Altiplano
Central Chile
North Patagonia
South Patagonia
(n)


27 July 2020
29 July 2021
December 2016
January 2019
30 km

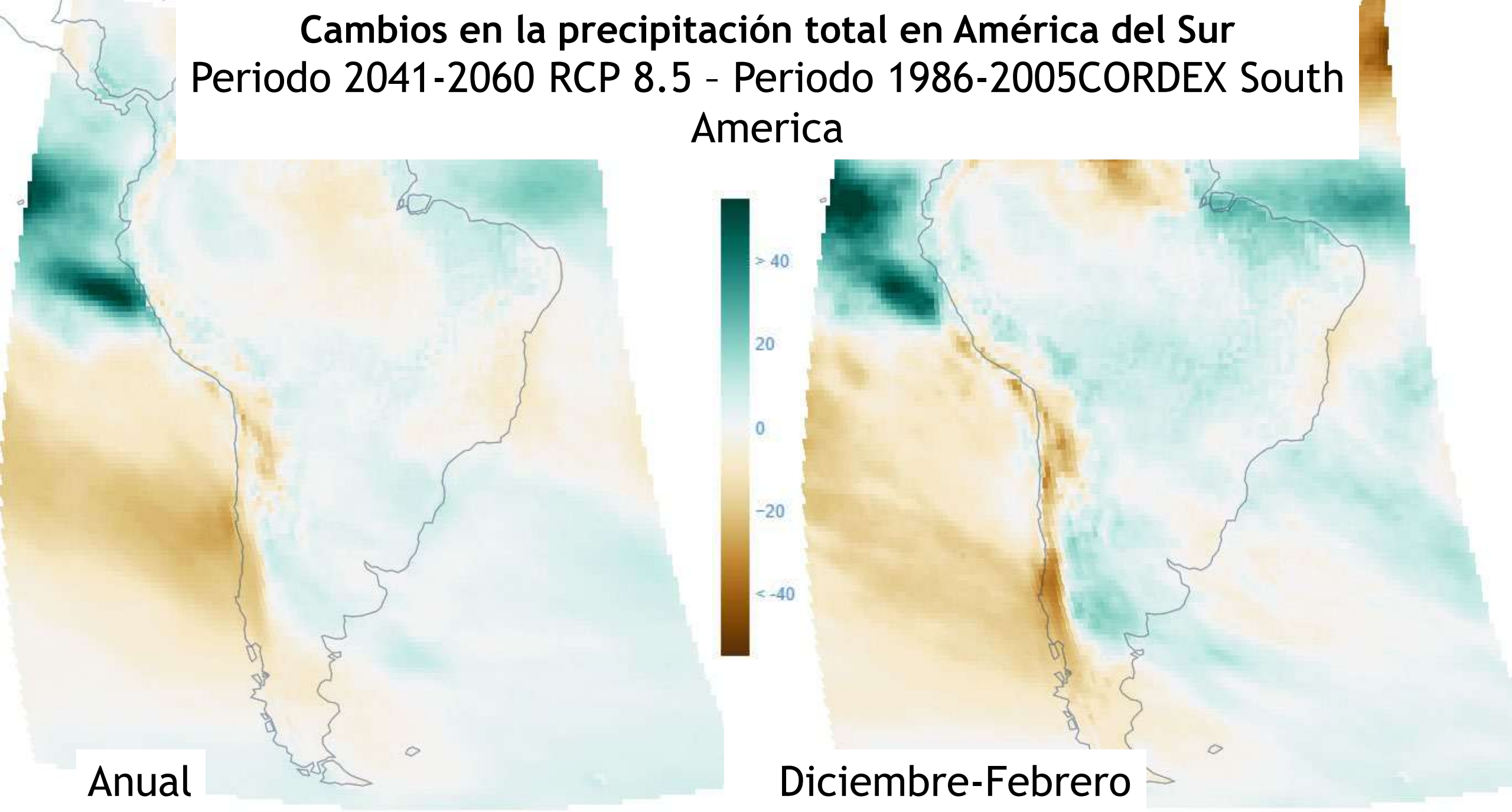
Cambios en la temperatura media en América del Sur

Periodo 2041-2060 RCP 8.5 – Periodo 1986-2005 CORDEX South America



Cambios en la precipitación total en América del Sur

Periodo 2041-2060 RCP 8.5 – Periodo 1986-2005CORDEX South America



Anual

Diciembre-Febrero

Modelos de Distribución Presente y Futura

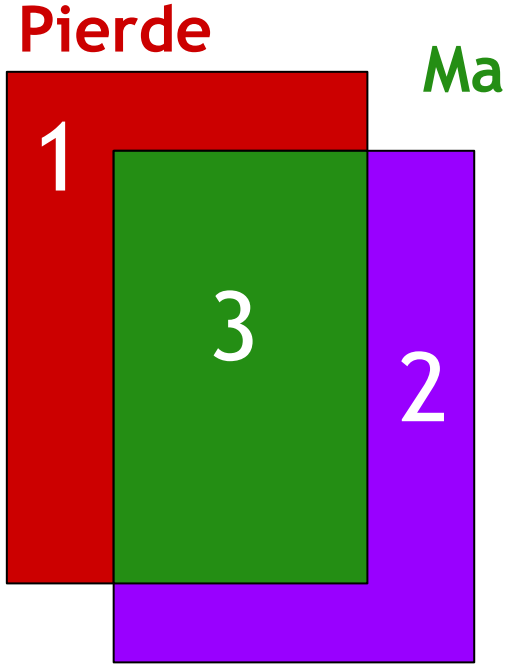
biomod2

20 escenarios:

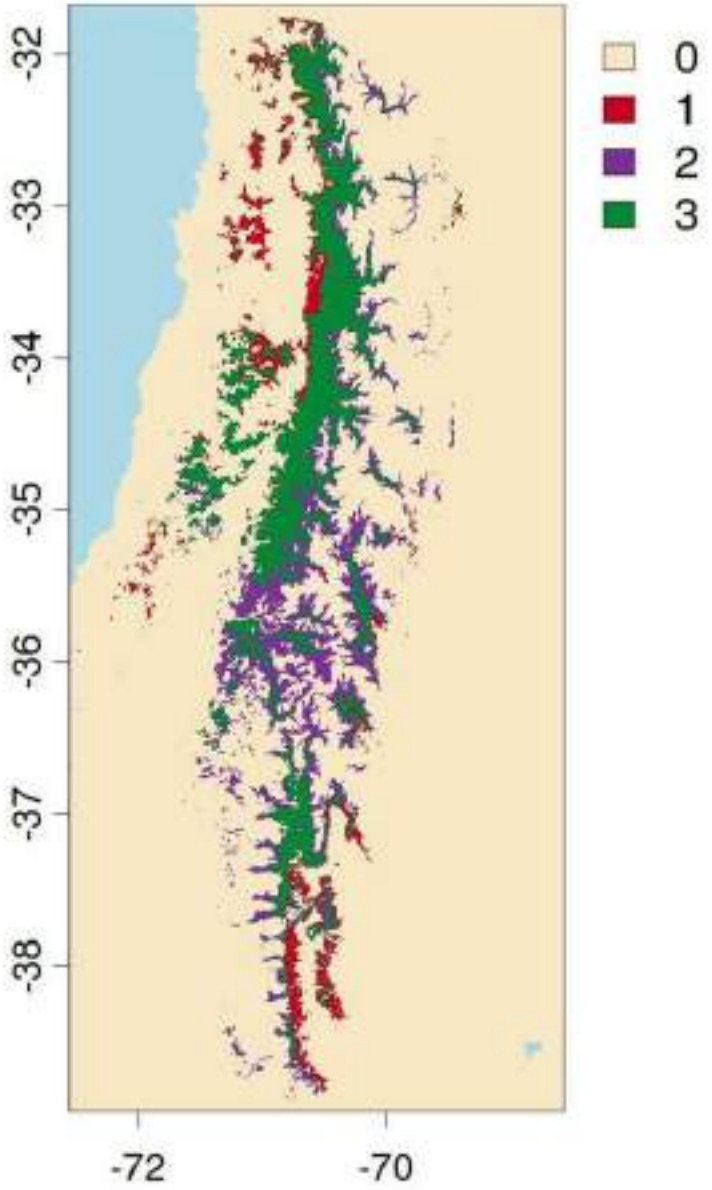
2 Futuros: 2055, 2085

5 Modelos:

- GFDLESM4 (USA)
- UKESM1-0-LL (UK)
- MPIESM1-2-HR (DE)
- IPSLCM6A-LR (FR)
- MRIESM2-0 (JP)



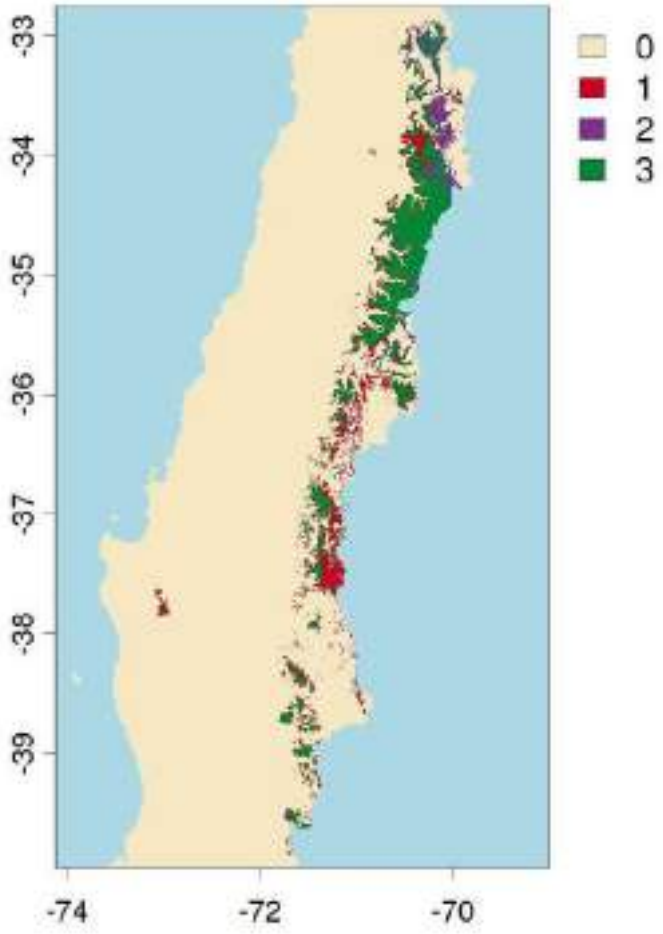
Gana
(según Migración)



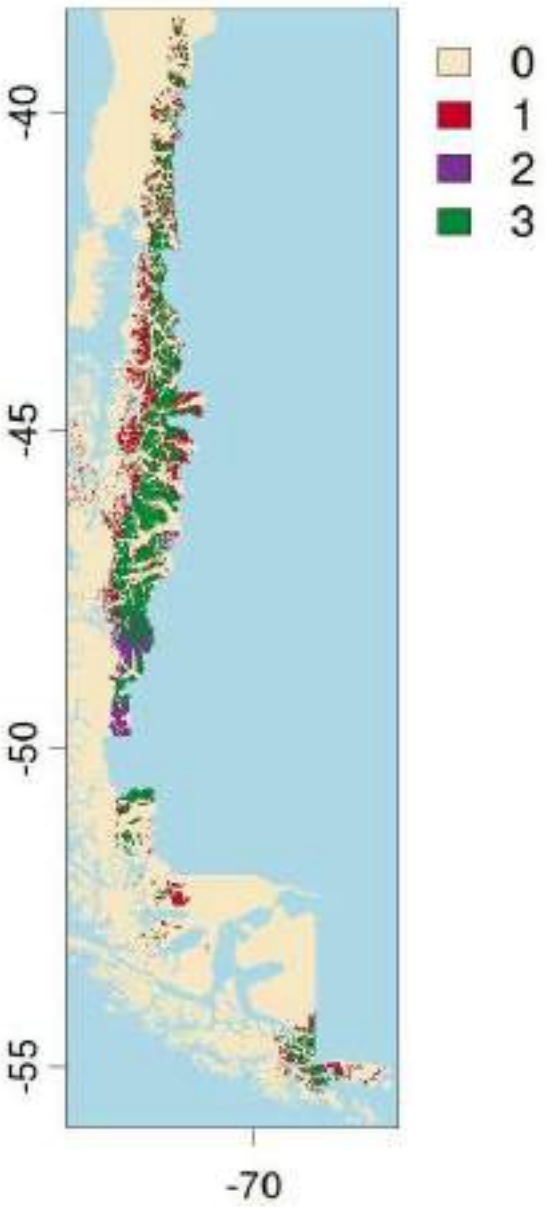
Quechua

Cuyano

Nothoandino-norte

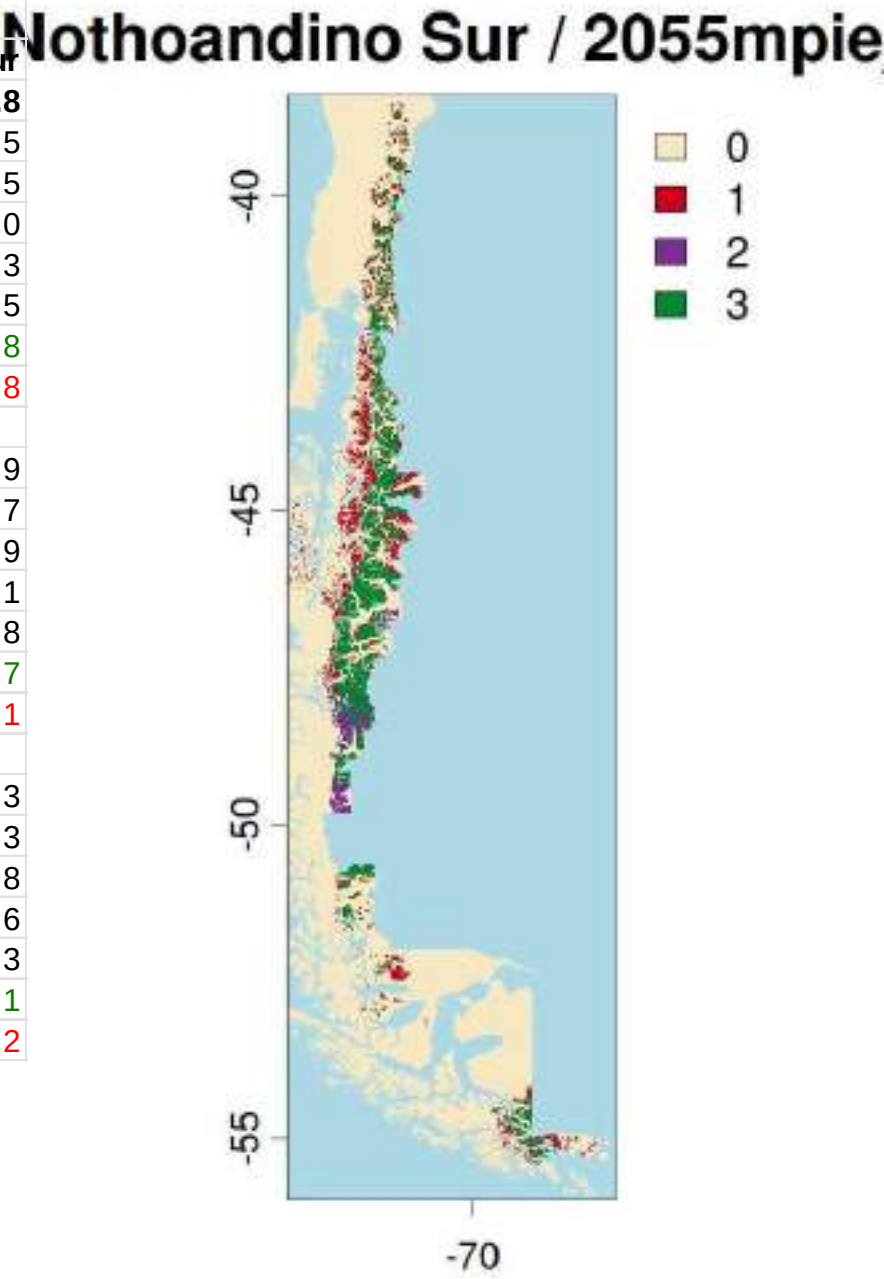


Nothoandino-sur



Loss **Manteinance** **Gain**

Superficies Modelos por Distritos Altoandinos (km2)								
Escenario	I	Marca	Model*	Scenario	**Quechua**	**Cuyano Pikumche**	**Nothoandino Norte**	**Nothoandino Sur**
Presente	I	-	-	-	**23098.4**	**39062.4**	**14141.7**	**54655.8**
1. Pérdida a Futuro	f	2055	GFDL	126	7302.9	5698.0	5092.0	26076.5
1. Pérdida a Futuro	f	2055	UKES	126	10919.7	6464.3	11930.1	26475.5
1. Pérdida a Futuro	f	2055	MPIE	126	5818.1	8685.9	1756.5	21011.0
1. Pérdida a Futuro	f	2055	IPSL	126	6114.8	5546.5	3852.0	23205.3
1. Pérdida a Futuro	f	2055	MRIE	126	6037.6	3274.6	7486.4	25735.5
prom					7238.6	5933.9	6023.4	24500.8
%					31.3	15.2	42.6	44.8
2. Ganancia Potencial	f	2055	GFDL	126	1476.4	2285.2	1972.1	4555.9
2. Ganancia Potencial	f	2055	UKES	126	2700.8	4989.2	607.7	5224.7
2. Ganancia Potencial	f	2055	MPIE	126	1965.6	2690.1	7893.5	5765.9
2. Ganancia Potencial	f	2055	IPSL	126	2318.6	3540.5	4465.6	4812.1
2. Ganancia Potencial	f	2055	MRIE	126	2059.3	4019.1	2646.7	4574.8
					2104.2	3504.8	3517.1	4986.7
					9.1	9.0	24.9	9.1
3. Mantención a Futuro	f	2055	GFDL	126	15795.5	33364.5	9049.7	28579.3
3. Mantención a Futuro	f	2055	UKES	126	12178.7	32598.1	2211.6	28180.3
3. Mantención a Futuro	f	2055	MPIE	126	17280.2	30376.5	12385.3	33644.8
3. Mantención a Futuro	f	2055	IPSL	126	16983.6	33515.9	10289.7	31450.6
3. Mantención a Futuro	f	2055	MRIE	126	17060.8	35787.9	6655.4	28920.3
					15859.8	33128.6	8118.3	30155.1
					68.7	84.8	57.4	55.2

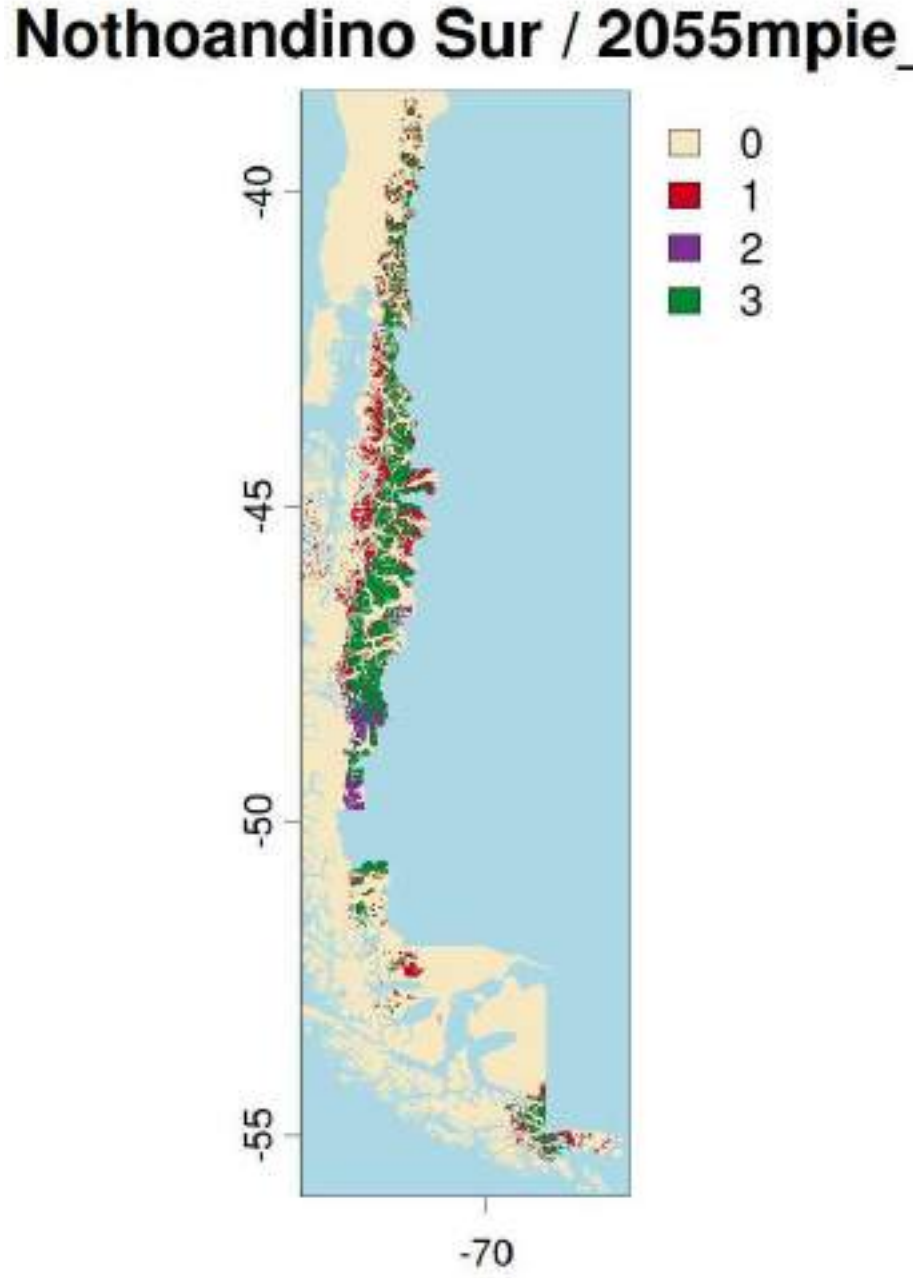


Resultados de Modelos para Escenarios Futuros

Color en cifra: Verdes Especies Ganadoras

Rojas Especies Perdedoras

	Grupo	Especie	2055
1	centro	*Adesmia exilis*	46.5%
2	centro	*Anarthrophyllum cumingii*	58.0%
3	centro	*Azorella madreporica*	96.5%
4	centro	*Azorella monantha*	28.7%
5	centro	*Azorella ruizii*	97.0%
6	centro	*Chuquiraga oppositifolia*	71.0%
7	centro	*Erigeron andicola*	78.0%
8	centro	*Galium eriocarpum*	115.5%
9	centro	*Haplopappus anthylloides*	137.9%
10	centro	*Haplopappus schumannii*	79.5%
11	centro	*Leucheria gayana*	120.6%
12	centro	*Montiopsis cistiflora*	95.0%
13	centro	*Nassauvia looseri*	82.3%
14	centro	*Oxalis squamata*	44.8%
15	centro	*Pozoa coriacea*	31.6%
16	centro	*Senecio bustillosianus*	52.5%
17	centro	*Senecio pentaphyllus*	2.9%
18	centro	*Viola subandina*	108.2%
19	patagonia	*Acaena lucida*	137.7%
20	patagonia	*Adesmia lotoides*	0.0%
21	patagonia	*Adesmia pumila*	12.5%
22	patagonia	*Adesmia villosa*	0.3%
23	patagonia	*Anarthrophyllum desideratum*	0.0%
24	patagonia	*Bolax gummifera*	114.9%
25	patagonia	*Calceolaria uniflora*	1.9%
26	patagonia	*Festuca gracillima*	102.4%
27	patagonia	*Hamadryas delfinii*	213.1%
28	patagonia	*Hypochaeris incana*	61.4%
29	patagonia	*Leucheria purpurea*	271.3%
30	patagonia	*Nardophyllum bryoides*	3.7%
31	patagonia	*Oxalis enneaphylla*	0.4%
32	patagonia	*Poa alopecurus*	0.0%
33	patagonia	*Scutellaria nummulariifolia*	56.0%
34	patagonia	*Senecio argyreus*	36.9%
35	patagonia	*Senecio magellanicus*	133.7%
36	patagonia	*Senecio miser*	897.4%
37	altiplano	*Astragalus arequipensis*	50.5%
38	altiplano	*Azorella compacta*	92.7%
39	altiplano	*Baccharis tola*	144.0%
40	altiplano	*Cinnagrostis velutina*	85.8%
41	altiplano	*Descurainia myriophylla*	573.5%
42	altiplano	*Gomphrena meyeniana*	415.4%
43	altiplano	*Parastrephia lucida*	725.4%
44	altiplano	*Parastrephia quadrangularis*	43.5%
45	altiplano	*Perezia atacamensis*	0.1%
46	altiplano	*Pycnophyllum bryoides*	51.2%
47	altiplano	*Senecio nutans*	156.7%
48	altiplano	*Senecio puchei*	246.1%
49	altiplano	*Werneria aretioides*	80.2%
50	altiplano	*Xenophyllum incisum*	60.5%



Conclusiones

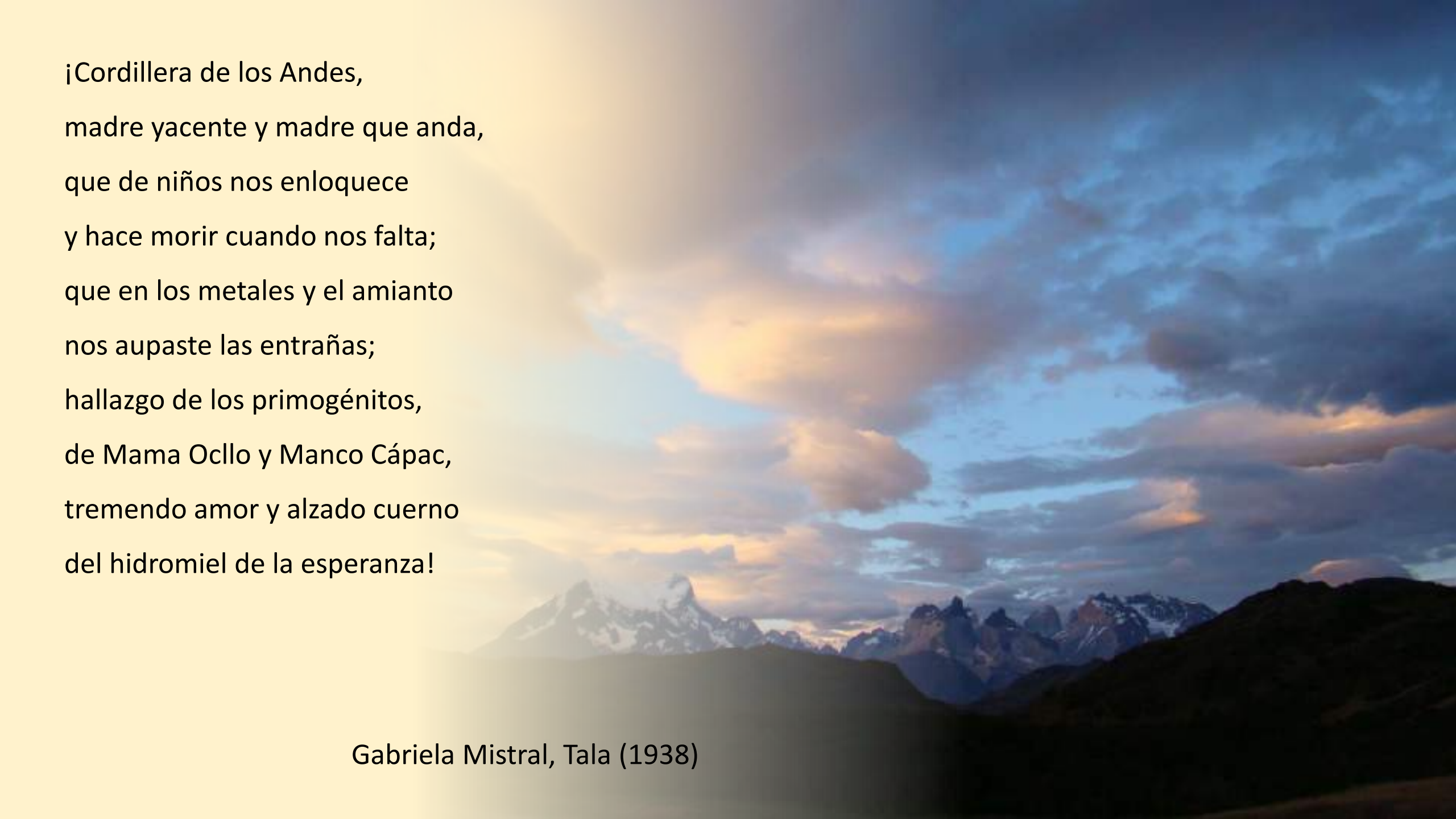
La flora alto-andina de Chile es particularmente rica en especies considerando su extención territorial (14% territorio contiene ca. 22% de nuestra flora).

Mayor riqueza y abundancia de especies no-nativas en las elevaciones bajas, esto último ha ido aumentando en el tiempo…aún no hay mucho cambio en los límites, pero parece ser cosa de tiempo.

La presencia de especies no-nativas afecta la riqueza de especies y la diversidad funcional en bajas altitudes. Algunas no nativas (*T. parthenium y T. officinale*) tienen efectos competitivos en el campo.

En alta elevación efectos negativos sobre indicadores del funcionamiento del ecosistema a nivel del suelo.

Los modelos predicen que en general la zona de vegetación alto-andina va a disminuir, especialmente la Patagonia.



¡Cordillera de los Andes,
madre yacente y madre que anda,
que de niños nos enloquece
y hace morir cuando nos falta;
que en los metales y el amianto
nos aupaste las entrañas;
hallazgo de los primogénitos,
de Mama Ocllo y Manco Cápac,
tremendo amor y alzado cuerno
del hidromiel de la esperanza!

Gabriela Mistral, Tala (1938)