Project Update (August 2025): Identifying which native plant traits favor biotic resistance to shrub invasions in Patagonia to prevent future spread (ID 44748-1)

This study has been carried out, with the support of **The Rufford Foundation**, since January 2025 in the Nahuel Huapi National Park, province of Río Negro and Neuquén, Argentina.

The invasion of non-native species is one of the top five direct drivers of ecosystem deterioration and biodiversity loss, altering community structure and functioning. This work arises from the growing concern of managers of Patagonia's largest protected area, the Nahuel Huapi National Park, regarding invasive species and the limited information available on their ecology, management, and the restoration of affected ecosystems. In these ecosystems, two shrub species—rosehip (*Rosa rubiginosa*) and Scotch broom (*Cytisus scoparius*)—have become highly invasive. Both are especially effective colonizers after disturbances, forming dense stands that hinder native community recovery and act as foci for further invasion. However, their advance into less disturbed shrublands is not homogeneous, suggesting that differences in community structure and plant functional traits influence biotic resistance (i.e., the ability of native communities to limit invasion). Understanding which traits enhance biotic resistance will help predict which communities are less susceptible to invasion and inform restoration strategies to design resilient native communities. With this project, we aim to identify functional traits that promote biotic resistance in order to guide future management and restoration efforts in Patagonian shrublands.

Activities and Progress:

We selected a total of 9 sites across the Nahuel Huapi National Park where the focal species have become invasive. In each plot we recorded vegetation species composition, cover and origin (native vs. introduced).

At each site, a block design was implemented, consisting of t**hree to six blocks per site**, including:

- One invaded plot (10 m × 10 m), located in areas invaded by at least one focal invasive species.
- One non-invaded plot (10 m × 10 m), located 25–100 meters from the invaded plot, in areas free of invasive species but with similar environmental conditions.
- In some sites, an additional plot to survey invasion foci (10 m × 10 m) was also established.

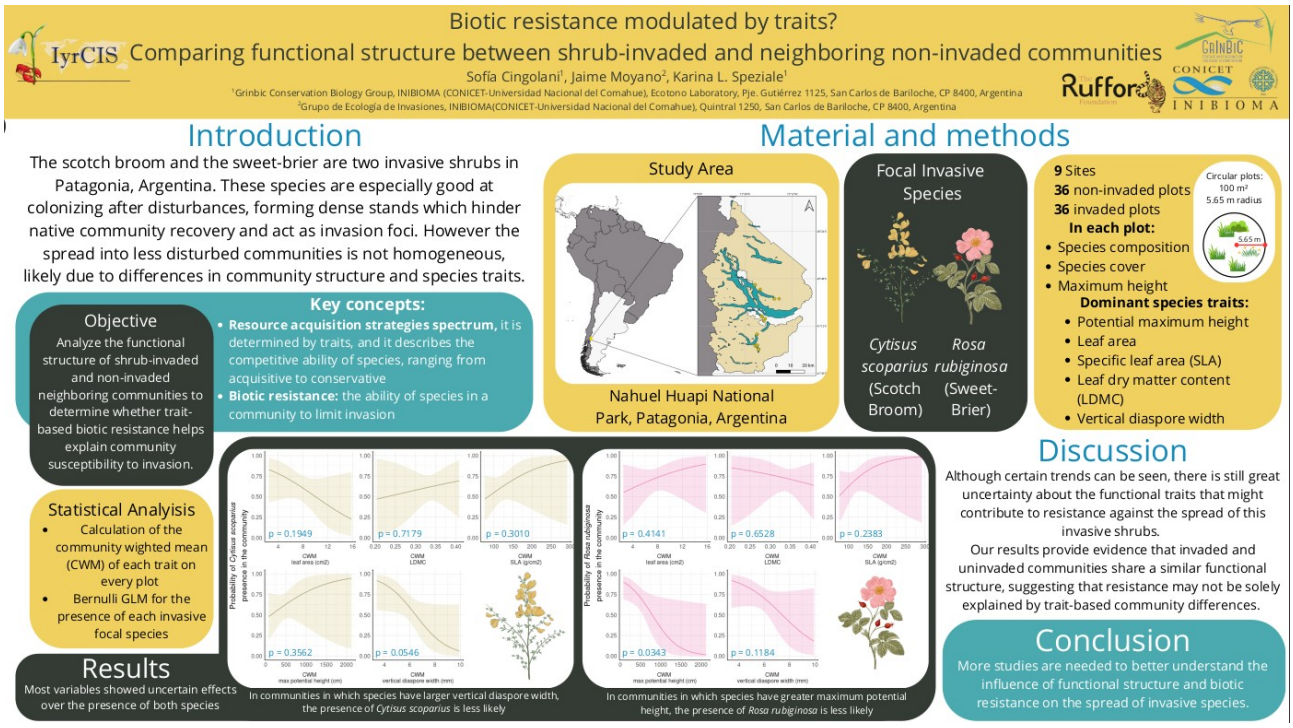
So far, 36 blocks have been surveyed, corresponding to 36 invaded plots and 36 control plots, 9 of which also included a plot of the invasion foci. This means that there were 81 plots in total. In each plot, a vegetation and structural survey was carried out: all species present were recorded, and their cover and maximum height within the plot were measured. Additionally in each plot we recorded latitude, longitude and altitude, canopy cover, slope, slope orientation, herbivores load, mean annual temperature and mean annual precipitation.

We collected leave samples from the most frequent species in the plots to measure their functional traits related to resource acquisition strategies (plant maximum height, leaf area, leaf dry matter content, specific leaf area, N, C and P leaf content). In total, we collected leaves and measured traits for 41 species (list below). We carried out the functional trait measurements in the laboratory, using a precision scale, scanner, and drying oven. Traits measured were: fresh weight, dry weight and leaf area. With this information we calculated SLA (Specific Leaf Area) and LDMC (Leaf Dry Matter Content). For the chemical traits, the leaf samples were sent to a specialized laboratory in the University of Comahue, Bariloche. Results expected in November. We also made literature and herbarium searches to complement field trait data with additional species trait information.

We also initiated preliminary statistical analyses with the data obtained so far. These analyses allowed us to generate early results and present them in the form of a poster at a virtual conference.

Result Communication

I attended the IyrCIS'2025 Conference held online on May 6th - 7th, 2025 and presented a poster communication entitled: **"Biotic resistance modulated by traits? Comparing functional structure between shrub-invaded and neighboring non-invaded communities"**. Authored by Sofía Cingolani, Jaime Moyano and Karina Speziale



Figuere 1. Poster presented at the V International Young Researchers Conference on Invasive Species. See at: https://iyrcis.webs.uvigo.es/page22.html

Educational game

With my group and other collaborators we are in the process of creating an ecology themed board game for children. It is called “Jardineros de Ecosistemas” (Ecosystem gardeners) and its main objective is that players create a healthy ecosystem, earning points for completing objectives related to biodiversity of native plants and animals, restoration, control of invasive species, good practices for recreational activities in nature, ethnobiology, agroecology, national parks and protected areas, among other topics.

Figure 2. Educational boardgame in progress. Line art made by Sofia Cingolani.

List of species with measured functional traits

Cytisus_scoparius
Rosa_rubiginosa
Lomatia_hirsuta
Maytenus_boaria
Aristotelia_chilensis
Nothofagus_dombeyi
Schinus_patagonica
Nothofagus_antarctica
Austrocedrus_chilensis
Nothofagus_pumilio
Diostea_juncea
Discaria_chacaye
Maytenus_chubutensis
Gaultheria_mucronata
Myoschilos_oblongum
Ribes_magellanicum
Ribes_cucullatum
Mutisia_spinosa
Alstroemeria_aurea
Acaena_pinnatifida
Acaena_ovalifolia
Escallonia_rubra
Haplopappus_glutinosus
Sorbus_aucuparia
Berberis_darwinii
Berberis_microphylla
Solidago_chilensis
Fragaria_chiloensis
Mutisia_decurrens
Chusquea_culeou
Vicia_nigricans
Dactylis_glomerata
Equisetum_bogotense
Holcus_lanatus
Mulinum_spinosum
Carex_andina
Baccharis_salicifolia
Osmorhiza_berteroi
Rumex_acetosella
Viola_maculata
Balbisia_gracilis

Additional project goal

Following the completion of the vegetation surveys, we identified a priority area within the park that presented the opportunity to carry out invasive shrub control and for continuing our research. Park rangers and technicians expressed strong interest in advancing applied research on invasive species management in the selected area, due to being an area of high public use of great conservation value. The preliminary results from the trait-based surveys enabled us to select native species with known functional traits to plan an applied restoration and biotic resistance experiment. Furthermore, since priority was given to the most frequent or representative species (more than 1% cover) the number of samples sent for leaf nutrient chemical analysis wereless than originally planned (41 species) and because we succeeded in gathering a group of motivated volunteers to support the installation of a new experiment, we were able to allocate part of the grant budget to an additional field experiment.

The following experiment was made possible thanks to the collaboration of multiple stakeholders, including Nahuel Huapi National Park technicians and rangers, Circuito Verde volunteers, and INIBIOMA researchers and technicians, as well as the financial support provided by **The Rufford Foundation**.

Ecological restoration seeks to recover the structure and functioning of a degraded ecosystem. In the case of exotic species control, the goal is to return the system to a state as close as possible to its pre-invasion condition. One promising approach is to restore by planting native communities that are resistant to new invasions. However, there is still little experimental evidence regarding the effectiveness of this strategy. Understanding the mechanisms of biotic resistance—the ability of native species to limit invasion—may be key to guiding future restoration strategies. Such knowledge will allow the design of more stable and resilient communities, thereby contributing to biodiversity conservation.

Objectives:

1. Evaluate the effect of different mechanical removal treatments on the survival of focal invasive plants and on the subsequent assembly of the plant community.

2. Analyze whether the introduction of native species enhances biotic resistance and facilitates restoration.

3. Assess the effort and cost associated with different mechanical removal treatments.

Activities and Progress:

An experiment was initiated in early 2025 in Nahuel Huapi National Park, which will be monitored over the next two years. The experiment was established in a total of 60 plots where five treatments of rosehip and scotch broom removal were applied (cutting every

spring month, cutting once a year, root removal, root removal + planting of native species, and control (no remotion); n = 12).

In the root removal + native planting treatment, 10 individuals were planted per plot—two of each of the selected native species:

- **Retamo –** *Diostea juncea*
- **Maqui –** *Aristotelia chilensis*
- **Laura –** *Schinus patagonica*
- **Maitén –** *Maytenus boaria*
- **Coihue –** *Nothofagus dombeyi*

In total, 120 saplings were planted, 24 of each species.

To assess costs and efforts of invasion control, in each plot, we measured the treatment application time, the number and gender of volunteers involved, and the tools used. So far, we were able to carry out two vegetation surveys in the plots, one before the treatment and one immediately after applying the treatment. The surveys involved recording all the species present in the plot, their cover and maximum height. We are planning two additional surveys at six-month intervals.

A. Two volunteers carrying out the invasive shrub root-removal treatment. **B.** Volunteers assisting in the installation of the invasive species removal experiment. **C.** Native saplings donated by Nahuel Huapi National Park. **D.** Experimental plot where invasive shrubs were removed from the root and native species were subsequently planted.

Use of the Rufford Grant so far:

The Rufford grant was used to support key activities during the 2025 summer field campaign, including:

- Transportation, vehicle maintenance, and fuel costs for accessing remote sites within the park.

- We hired a field assistant, including personal insurance coverage.
- We purchased materials for storing plant samples (leaves and whole plant for herbarium).
- We sent leaf samples from 41 species—the most represented in the vegetation surveys—for analysis of leaf nitrogen, carbon, and phosphorus content. Payment will be made upon completion of the analysis in November 2025.
- We purchased tools to extract manually invasive species: 1 shovel, 2 pulaski axes, 6 curved-blade saws, 1 sharpening stone, 1 pruning shears.
- Transportation with volunteers for invasive plant removal.
- Transportation with volunteers and CONICET field technicians for native plant planting.
- Native saplings (we purchased pots and tools for the National Park nursery, and they provided us with native saplings in return).
- We hired a photographer to document our work, particularly a day when we planted native saplings after invasion removal as part of an experiment.
- We purchase color laminated prints to put together an educational board game based on Patagonian ecology, conservation and environmental hazards (biological invasions, contamination, deforestation, wildfires, etc).