FINAL REPORT

MAB-UNESCO AWARD

Establishing the bases for a long term study about endemic biodiversity in Juan Fernández Archipelago, Chile

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Introduction

The Juan Fernandez Archipelago is located 650 km west of the Chilean Pacific coast and it is made up of three volcanic islands: Robinson Crusoe (48 km2), Alejandro Selkirk (50 km2), and Santa Clara (2.2 km2) that harbor a flora of remarkably high endemism (about 67%). In 1935, the Chilean Government declared these islands a National Park and in 1977 they became a UNESCO-approved Biosphere Reserve. Due to the extraordinary biotic endemism that characterizes these islands, they are considered to be one of two of the world's mini-hotspots (along with the Galapagos) (Mitterier et al. 1999). The JF Archipelago presents the highest plant species richness in the smallest area on the planet (Arroyo et al. 1999) and is considered by WWF/IUCN as a Center of Plant Biodiversity.

In July 2009 the researchers of this project traveled to Robinson Crusoe Island. In this travel the original project was discussed with the park-rangers and the environmental community of the island. Some modifications of the original project were suggested. It was requested we emphasizes our study in to undestand the invation dynamic of the major threatened to Juan Fernandez Archipelago biodiversity, that is the fast invation by the shrubs *Aristotelia chilensis* and *Rubus ulmifolius* and its relation with its unique disperser, *Turdus falcklandii*. Several aspects of this request can not develop in the Mab-Unesco project, but we found other finantial support from the Institute of Ecology and Biodiversity, Chile (IEB). With the Mab-Unesco support we developed one master thesis and two small student researches (not thesis). With the IEB additional support we are development other six thesis that were born in the Mab-Unesco project ideas. Afterwards, park-rangers show us valious information take by them about the new records of critically endangered endemic plants. They asked us collaboration to systematize and digitalize this information. Now this information has been systematized and a manuscript in which the park-rangers are the unique authors has been prepared.

Then the products of Mab-Unesco project are:

1.- Invasion dynamics in gap-forests in Robinson Crusoe Island, Juan Fernández Archipelago, Chile. Master thesis of Gisella Arellano. Universidad de Chile.

2.- Diet of *Turdus falcklandii* (Turdidade) in Robinson Crusoe, Juan Fernández Archipelago, Chile. Research of the students: Dafne Gho*, Juan Pablo Mora*, Francisco Muñoz and Gabriela Mendez. Universidad de Chile and Universidad Austral de Chile*.

3.- Gap-forests size age in the endemic forest of Robinson Crusoe island, Chile. Research from the student Hector Gutierrez. Universidad de Chile.

4.- Manuscript in preparation: New records from critically endangered plant species in Juan Fernandez Archipelago. Authors: Ivan leiva* and nine park-rangers. *Administrator of the Juan Fernandez National Park. It is shown in Annex I, in Spanish because is the first draft that park-rangers are developing.

Products with IEB and CASEB support:

1.- Genetic variation between *Turdus* from continent and Juan Fernandez Archipelago. Juan Francisco Gonzalez. Bachelor thesis. Universidad Católica de Chile.

2.- Biological interactions of *Turdus* in Juan Fernandez Archipelago. Javiera Zuñiga. Master student. Universidad Católica de Chile.

3.- Spatial cover changes of native and exotic vegetation in Robinson Crusoe Island during 1983, 2003 and 2010. Ignacio Díaz. Bachelor student. Universidad Católica de Chile.

4.- Priority areas to restore in Robinson Crusoe Island. María José Faundez. Bachelor thesis. Universidad de Chile.

5.- Willingness of the community to restore the endemic biodiversity of Robinson Crusoe island. Hector Gutierrez. Bachelor thesis. Universidad de Chile.

In this report we inform about product support by Unesco project.

I.

Invasion dynamics in gap-forests in Robinson Crusoe Island, Juan Fernández Archipelago, Chile.

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INTRODUCTION

Robinson Crusoe (RC) forest, defined as *Myrtysilva* formation (Danton, 2006), is composed exclusively by endemic tree species, giving to this plant community the value as a unique formation worldwide (Danton & Perrier, 2006).

At present, 75% of the endemic vascular flora of Juan Fernández Achipelago are critically endangered (Vargas & Reif. 2009), due to increasing expansion of invasive exotic plant species (Fellmann, 2004). This phenomenon is actually the mayor biological threatens to this insular ecosystem, which was the RC native flora is suffering increasingly replacement and displacement process (Cuevas & Van Leersum, 2001; Castro *et al,* 2007).

The main invasive exotic plant species are *Aristotelia chilensis* (maqui), *Rubus ulmifolius* (zarzamora) and *Ugni molinae* (murta) (Greimler *et al*, 2002; Fellmann, 2004; CONAF, 2009; Vargas & Reif, 2009). *Aristotelia chilensis* and *Rubus ulmifolius* are particularly dangerous to native forest conservation. Both are shade-intolerant shrub species: they requires direct light incidence to establish successfully. In RC forest high light incidence occurs on slopes and gap-forests, where these aggressive plant species find optimal conditions to establish. Gaps-forest are natural openings in forest canopy, caused principally by breaking or uprooting of trees and branches, allowing the direct incidence of sun light on substrate and encouraging the natural/exotic regeneration processes (Baret *et al*. 2008, Yamamoto, 2000).

To asses the exotic invasion process in Juan Fernandez Archipelago, we evaluated the rate of regeneration of exotic plant species inside gaps-forest in Robinson Crusoe Island.

The specific objectives were:

- Characterize gaps-forest disturbance regime on Robinson Crusoe Island.
- Determine the area of gaps-forest in native forests of RC.
- Determine the effect of spactial and structural variables over abundance of both invasive and native plant species in forest gaps.
- Determine the grade of exotic invasion; the occupation patterns in four demographic categories, for both endemic and alien plant species on a gap-forest gradient.
- Determinate the existence of specific regeneration microsites in gap forests.
- Generate a predictive model of native forest replacement pattern of invasive plant species.

Our hypotheses:

a) The abundance and density of invasive plant species should declines linearly from the center to the edge of the gaps-forest, and disappear under the native forest canopy.
b) The gaps-forest size should control the recruitment and success of invasive plant species.

METHODS

During February 2010 we identified, selected, and sampled 37 gaps-forest located at different slopes degree in one main area of RC Island (Plazoleta del Yunque, Fig. 1 MAPA). We considered slope degree as a determining factor on gaps-forest abundance. We selected only gaps-forest with presence of invasive plant species to develop our study.

II.1) Measuring the forest area currently on gap phase

Based on recent satellite images (*Quickbird* 2003) and Geographic Information Systems, we performed a spatial analysis to estimate the current gaps-forest area.

II.2) Characterizing gaps-forest disturbance regime

We used spatial and structural variables to characterize gaps-forest:

- Spatial variables: UTM coordinates, altitude, slope degree, and distance of the massive propagules source of *Aristotelia* and *Rubus* to invaded gap studied. Structural variables: origin and mechanism of canopy opening, gaps-forest size, characterization of 'gap-maker' trees (species, diameter at breast height or DBH) and micro-site conditions (cover percentage of different substrate components in one square meter samples).

II.3) Recording invasion stages in gap-forest gradient

We traced lineal transects every three meters, spreads throughout the long or the wide of each gap analyzed. The number of transects was a gap-size dependent factor, nevertheless, we tended to sample a standard surface on each gap. Each transect were divided in one square meter contiguous plots, folowing a gradient line from gap inside, passing through the gap edge, up to 5 meters perimeter under forest canopy (Pauchard *et al.* 2008).

Inside each plot we registered and classified all species abundances in four demographic stage classes: seedling (≤ 50 cm); juvenile 1 (≤ 50 cm), juvenile 2 (50 cm-2 m), and adult (> 2 m).

II.4) Plant regeneration on microsites above the 'gap-maker' trees

On each endogen originated gaps we sampled three specific microsites above the gapmaker tree: trunk, mound and `plato´. On each microsite, we quantify the regeneration of both native and alien plant species, by means of one square meter plots.

II.5) Data analysis

Statistical analyses were all developed with R-Project software (2.8.1 version, R Development Core Team, 2008). As well, we made unvaried analysis with generalized linear models (GLM), which considers some Poisson error type.

We worked with two data interpretations: a) *Relative density* (number of individuals of both alien and endemic plant species per surface unit (one square meter); and b) *Relative abundance* (percentage of alien plant species individuals regarding the total number of individuals).

It will makes relative density and relative abundance modeling to each species, following the recorded demographic stage classes, to evaluate the existence of significant effects of site of establishment (gap-edge-forest), as well as the descriptive variables of the gap disturbance regime (both spatial and estructural ones).

Respect to regeneration analysis, it will makes relative density and relative abundance modelings too, to evaluate the existence of significant effects of microsites of plant establishment (trunk-mound-plato), as well as the descriptive variables of microsites (DBH, specie and decomposition degree).

RESULTS

IV.1) Characterizing gaps-forest disturbance regime

Plazoleta del Yunque forest presents a gaps-forest generation dynamic associated principally to small-scale disturbances.

From a total of 37 gaps-forest observed, 33 gaps-forest (89%) were endogen-type (originated by tree falls), only 4 gaps-forest (11%) were exogen-type (originated by landslides). Principally the main canopy opening mechanism detected were tree falls, where 60.9% of the cases observed belong to *Myrceugenia fernandeziana*. Tree composition in gaps-forest edges was always dominated by *Myrceugenia fernandeziana* (84.3%).

We registered a gaps-forest size range between 13.03 to 368.1 m^2, with an average area of 88.7 m^2. (Table 1). More than 50% of the sampled gaps-forest presents frequency sizes in range between 15 to 100 m^2 (Figure 1)

Figure 1: Gap size structure dsitribution in Plazoleta el Yunque forest.

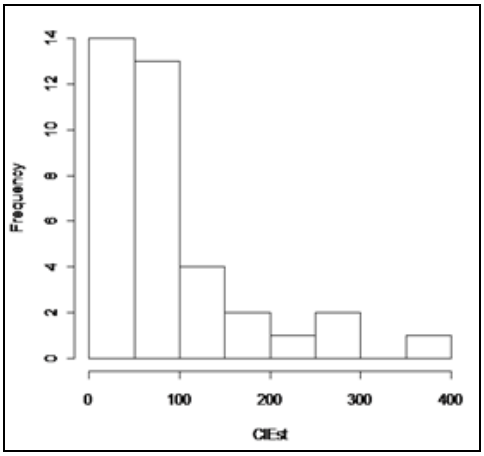


Table 1: Characterization of sampled gaps-forest near Plazoleta del Yunque.

Gaps (n=37)	
Average area (m^2 ± I.C)	88.7 ± 28.06
Surface range (m^2)	13.03 – 368.1
Endogen gaps	33 (89%)
Exogen gaps	4 (11%)
Canopy opening mechanism (%)	
Treefall	59.45
Multiple tree fall	16.21
Broked trunk	8.11
Uprooting	5.41
Landslide	10.82
Gaps with microsites	33 (89%)
Gaps with regeneration on microsites	23 (69.69%)

All 33 gaps-forest sampled showed endogen origin type; they may have microsites to regeneration: trunk, mound and platform for each gap-maker tree. Nevetheless, only 23 gaps showed regeneration of endemic and/or alien plant species on gap-maker trees.

IV.2) Invasion stage inside gaps-forest

32 gaps-forest (86.5%) in Plazoleta el Yunque present invasive plant species (*Aristotelia chilensis* and/or *Rubus ulmifolius*), principally represented by seedlings (66%, 2059 individuals). Their abundances are located principally inside the gaps and edges (68,7%), duplicating the endemic plant species abundances in the same sites (Table 2).

We observed high percentage of regeneration of invasive species (only seedling, 40.8%) surrounding the gaps-forest, compared with the endemic regeneration. However, they don't reach higher length classes (low representation of invasive species of juveniles 1, juveniles 2, and adult)

Myrceugenia fernandeziana was the only specie present in all sites evaluated and all demographic classes registered, reaching 100% of representation for adult stage in forest. *M. fernandeziana* is the dominant specie on Juan Fernandez forest canopy.

Table 2: Relative abundances according to demographic states and stablishment sites, in a gap-forest gradient for both endemic and invasive plant species.

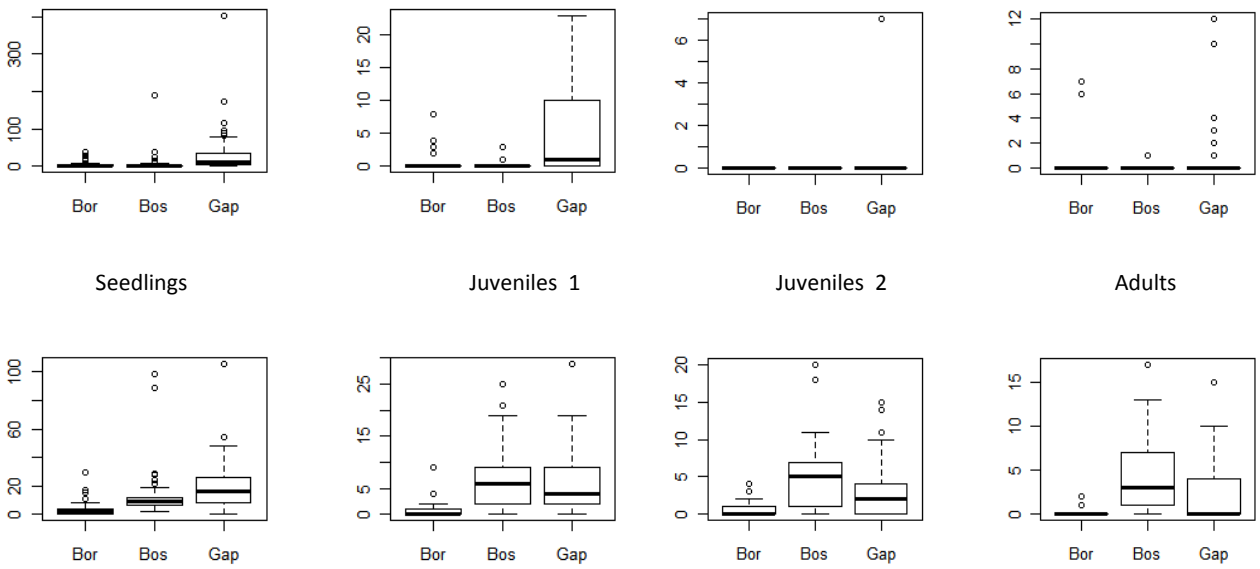
Relative abundance (%)	**Seedlings**			**Juveniles 1**			**Juveniles 2**			**Adults**		
	Gap	Edge	Forest	Gap	Edge	Forest	Gap	Edge	Forest	Gap	Edge	Forest
A. chilensis	36.25	45.57	22.72	11.69	18.37	-	4.93	-	-	12.28	15	-
R. ulmifolius	29.38	23.11	18.05	32.94	28.57	1.88	8.45	18.18	0.51	19.3	30	-
∑ Invasive sp.	**65.63**	**68.68**	**40.77**	**44.63**	**46.94**	**1.88**	**13.38**	**18.18**	**0.51**	**31.58**	**45**	**-**
Myrceugenia fernandeziana	22.24	19.65	39.38	50.84	51.02	84.96	78.87	78.79	96.41	59.65	55	91.86
Fragaria mayu	11.81	11.66	19	2.86	-	10.53	4.93	3.03	3.08	3.51	-	3.49
Drimys confertifolia	0.23	-	0.74	1.43	-	1.88	2.82	-	-	2.63	-	1.74
Boemeria excelsa	0.05	-	-	0.24	2.04	-	-	-	-	0.88	-	1.74
Raphithamnus venustus	0.05	-	0.11	-	-	0.75	-	-	-	1.75	-	1.16
∑ Endemic sp.	**34.37**	**31.31**	**59.23**	**55.37**	**53.06**	**98.12**	**86.62**	**81.82**	**99.49**	**68.42**	**55**	**100**

Generalized linear model shows the existence of significant differences ($p<0.001$) between the establishment of both invasive and endemic plant species in the evaluated sites (Figure 2).

We found significative effect for seedling establishment of invasive species in both gaps and forest environment, as well as for juvenile 1 of invasive species in gaps. We have not found significative effect for other length classes (juvenile 2 and adults) of invasive species in any site of establishment. For endemic species, instead, we found a significative effect for seedling and adults establishment in forest.

Therefore, the variables 'site' and 'specie type' show strong interactions, and explains significally the relative abundance of the species. Besides, the adjusted model explains a 74.6% of the variability of data.

Figure 2: Establishment preferences of endemic and invasive species, respect to four demographic classes on gap-edge-forest gradient. Notice: Bor=Edge, Bos=Forest, Gap. The invasive species are represented in top of figure; endemic species below and the.



IV.3) Evaluating the influence of gap descriptive variables over invasive species abundance

Trough generalized linear model (GLM) we analyze the existence of significative effects of gap descriptive variables (gap-size and gap-slope), according with relative abundances of four demographic states of invasive plant species. Our results show that gap-size and gap-slope causes a significative effect ($p<0.001$) above 'seedling' and 'juvenile 1' demographic classes, however for 'juvenile 2' and 'adults' there was not effect ($p<0.1$).

IV.4) Evaluating regeneration in microsites above 'gapmaker' tree

In 23 endogen originated gaps we found regeneration (69.69% of 33 endogen originated gaps sampled in the study area). Regeneration densities in each microsites are shown on Table 3.

The main microsite 'plato' with 42.17% of total regeneration (175 individuals), followed by 'mound' with 37.35% of total (155 individuals). Finally, the category 'trunk' with 20.48% of regeneration (85 individuals).

From a total of 415 individuals registered in three microsites (see table 3), 335 of them belong to invasive species (80.72%) and 80 to endemic species (19.28%).

The higher densities for invasive species were registered in the category 'plato', where 75.43% of registered individuals belong to an invasive plant specie (more specifically we found 132 individuals in those sites).

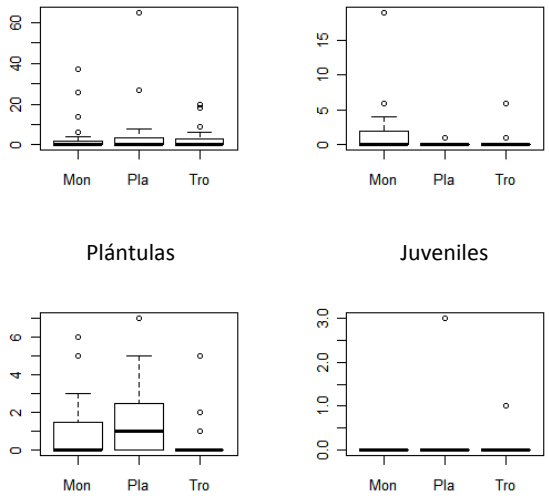
Table 3: Relative densities (seedlings in 1 m^2) in 'gapmakers' tree microsites, clasified under three categories: trunk, mound and plato.

Relative density (ind*m^{-2})	**Trunk**	**Mound**	**Plato**	**Total**
A. chilensis < 50cm	36	64	102	202
A. chilensis > 50cm	0	6	1	7
R. ulmifolius < 50cm	27	31	24	82
R. ulmifolius > 50cm	7	24	0	31
R. ulmifolius > 3m	0	8	5	13
F. mayu < 50cm	5	12	12	29
M. fernandeziana < 50cm	4	10	28	42
M. fernandeziana > 50cm	2	0	3	5
D. confertifolia < 50cm	4	0	0	4
Total	85	155	175	415

From GLM applied to evaluate the existence of significative effects between regeneration relative densities, species and gapmaker tree microsites (Figue 3), only the category 'plato' presents significative effect to invasive species regeneration ($p<0.0001$). Whereas, the cetegories 'mound' and 'plato' showed significative effect to endemic plant species ($p<0.001$).

Besides, we evaluate the influence exert by gapmaker tree descriptive variables (DBH, specie and decomposition degree) above detected regeneration. We found a positive correlation and a significative effect ($p<0.001$) of DBH, the three decomposition states and the gapmaker specie, *Myrceugenia fernandeziana*, with regard to regeneration density of invasive species.

Figure 3: Relative density regeneration of endemic and invasive species in gapmaker tree micorsites (trunk, mound and plato). Invasive species represented in top of figure; endemic species below.



DISCUSSION & CONCLUSIONS

Our demographic structure analysis in gap-edge-forest gradient, showed the main role of gaps-forest for invasive alien plant species regeneration on RC. Since the generation of a gap-forest in Plazoleta del Yunque, the environmental conditions for a successful establishment of invasive plant species are available. Those results support our first hypothesis, due to the existence of a linear decreasing of relative abundance of invasive species trough the forest gradient, with a peak inside gaps and a scarce presence under forest canopy.

Nevertheless, we found a high regeneration percentage of invasive species (40.7%) inside forest. Suggesting the existence of a supressed seedling bank of invasive species inside forest; supressed by the absence of the environmental conditions required by those shade-intolerant invasive plant species, to develope them to higher demographic stages. Therefore, this supressed bank for regeneration of invasive plant species inside forests could be waiting for canopy openings to grow at higher levels of its life cycle.

Regarding the variables that influence on relative abundances of both endemic and invasive plant species, gap-size and gap-slope has shown a positive correlation with the abundance of invasive species. Therefore, is predictable that at the higher gap size, the higher invasive species abundance inside, due to an effect of area. This conclusion supports our second hypothesis, since the gap-size regulates the invasive species abundance, probably by means of the control of the environmental conditions and, as a consequence, of the abiotic requirements for the successful establishment of the invasive plant species inside gaps.

Those results bring relevant information about occupation pattern of invaders on a gap-forest gradient, as well as about the regeneration preferences in specific microsites on gapmaker trees, and about the influence of spatial and structural variables of the gap forests over the invasion dynamics on Robinson Crusoe Island. This information will allow to propose concrete and specific actions of management and control of the invation processes on Juan Fernandez Islands, to channel the efforts into halt the progress of those agressive alien plant species and restore the original conditions of the Juan Fernandez forest ecosystem.

The hyphotesis related with SIG analysis and model to predict the invasive advance are development during the Master thesis of Gisella Arellano.

REFERENCES

BARET. S., L. COURNAC., C. THEBAUD., P. EDWARDS & D. STRASBERG. 2008. Effects of canopy gap size on recruitment and invasion on the non-indigenous Rubus alcelifolius in lowland tropical rain forest on Réunion. Journal of tropical ecology 24: 337-345.

CASTRO. SA., M. MUÑOZ & FM JAKSIC. 2007. Transit towards floristic homogenization on oceanic islands in the south-eastern Pacific: comparing pre-European and current floras. Journal of Biogeography 34: 213-222.

CONAF. 2009. Plan de manejo Parque Nacional Archipiélago de Juan Fernández. 294pp.

CUEVAS. JG & G. VAN LEERSUM. 2001. Project “conservation, restoration and development of the Juan Fernández Islands, Chile”. Revista Chilena de Historia Natural 74: 899-910.

DANTON. P. 2006. La "Myrtisylve" de l` archipel Juan Fernández (Chili). Une foret en voie de disparition rapide. Acta Bot. Gallica 153 (2): 179-199.

DANTON. P., C. PERRIER & G. MARTINEZ. 2006. Nouveau catalogue de la flore vasculaire de l'archipel Juan Fernandez (Chili) Nuevo catalogo de la flora vascular del Archipielago Juan Fernandez (Chile). Acta Botanica Gallica 153(4).

FELLMANN, M. 2004. Contribution à la mise en place d une stratégie de contrôle vis-à-vis des espèces exotiquez envahissantes en vue de la préservation et de la restauration des écosystèmes terrestres de l île Robinson Crusoé (Chili). Mémoire de fin d études, Formation des Ingénieurs Forestiers. Volume 1: Rapport. 116pp.

GREIMLER. J., TF. STUESSY., U. SWENSON., CM. BAEZA & O. MATTHEI. 2002. Plant invasions on an oceanic archipelago. Biological invasions 4: 73-85.

VARGAS. R & A. REIF. 2009. The structure, regeneration and dynamics of the original forest of Robinson Crusoe’s island (Juan Fernández Archipelago, Chile): baseline for its restoration. Presentation XVIII World Forest Congress, Argentina.

YAMAMOTO. SI. 2000. Forest gap dynamics and tree regeneration. Journal of forest research 5: 223-229.

II.

Diet of *Turdus falcklandii* (TURDIDAE) in Robinson Crusoe, Juan Fernández Archipelago, Chile. Preliminary report

Dafne Gho, Juan Pablo Mora, Francisco Muñoz, Gabriela Mendez and Cecilia Smith

INTRODUCTION

Juan Fernandez Archipielago (JFA) is one of the ecosystems with most endemism worldwide. Is has been declared National Park in Chile in 1935, and Biosfere Reserve by United Nations in 1977. Plant communities in JFA are extremely vulnerable, due to its high endemism, rounding 70% of the native species (CONAF, 1976). Although this, original forests coberture of JFA has decreased about two third between due to antropic activities and the effect of agressive alien plant species (CONAF, 1976; Dirnböck *et al.*, 2003). As a consequence of introduced plant and animal species, JFA actually has one of the most world's threatened biota. Under the current rates of forests decreasing, the invasion or replacement of 50% of the montane forest in the following 80 years, with over 60% of probability (Dirnböck *et al.*, 2003).

The total native flora consists of 209 plant species (including ferns), of wich 124 are endemic, whereas the number of introduced species is 227 (Swenson *et al.*, 1997; Dirnböck *et al.*, 2003; Cuevas *et al.*, 2004). Native vegetation on Robinson Crusoe has been severely affected mostly by four alien species: A*ristotelia chilensis* (maqui), *Rubus ulmifolius* (zarzamora), *Ugni molinae* (murta) and *Acaena argentea* (cadillo) (CONAF, 1976; Dirnböck *et al.*, 2003), of wich A. *chilensis* and *R. ulmifolius* are considered dangerous plagues for native flora persistance (CONAF, 1976).

A. chilensis, R. ulmifolius and *U. molinae* presents endozoochorous seed dispersal syndromes. Its fleshy fruits are consumed probably by animals, specially by birds. Endozoochorous seed dispersal by birds is a frequent mutualistic interaction between plants and animals, where birds obtain nutrients and water from the fruits, dispersing the seeds far away from the parental individuals, also increasing -in some cases- the probability of seed germination and/or germination rates (Traveset & Willson, 1997), and reducing the density-dependent mortality of seeds and seedlings by enabling escape from seed predators, herbivores, and other factors (Sekercioglu, 2006). Among JFA bird species, *Turdus falcklandii* (zorzal) is probably the unique seed disperser of fleshy fruits, since no

other disperser birds occur in JFA. Some studies in Spain shows the genus *Turdus* as a legitime disperser of *R. ulmifolius,* but the germination percentage of the seeds dispersed will depend of the field conditions.

T. falcklandii also is known as insectivorous bird. Empirical and experimental studies have shown that insectivorous birds in general can suppress populations of insect herbivores and reduce consequent plant damage (Sekercioglu, 2006). There are no studies of the effect of *Turdus* by the arthropoda fauna of JFA.

The main goal of this study is evaluate the diet of *Turdus falcklandii* (zorzal) in Robinson Crusoe Island, in order to evaluate its role as alien plant species seed disperser and arthropoda consumer. Our specific goals were (a) determine if *T. falcklandii* act as a legitimate seed disperser of *Aristotelia chilensis* and *Rubus ulmifolius*; (b) compare germination rates among seeds passed by bird digestive tract versus seeds unpassed; (c) identify species and geographical origin of insects taxa consumed by *T. falcklandii* in Robinson Crusoe Island.

METHODS

We collect 209 feces of *Turdus falcklandii* in Feburary 2010, along three transects near *Plazoleta el Yunque* in Robinson Crusoe Island, we collect fresh feces, every three days, on individual paper packets. 100 feces were annalized *in situ*, in SAG (Servicio Agrícola y Ganadero) laboratory, and conserved in alcohol (70%). Another 100 feces were refrigerated at 5°C and imbued on alcohol (90%) 30 days later.

From the first 100 feces we extract seeds of *A. chilensis* and *R. ulmifolius.* 240 seeds were sown under field conditions: 120 (4 replicates / 30 seeds) above forest gape and 120 (4 replicates / 30 seeds) above forest dossel. Another 120 seeds (4 replicates / 30 seeds) were put on petri plates under ambient conditions in Valdivia (39°S); and 120 seeds (4 replicates / 30 seeds) were put on petri plates under controled conditions (20°C, 12 day light hour cycles), in Universidad Austral de Chile seeds laboratory, also in Valdivia.

To compare germination rate of seeds passed by bird digestive tract versus unpassed seeds, we evaluate the same number of seeds extracted mannually from fruits, for each replicate, as control groups. Also, we sowed 120 intact fruits on field conditions.

The 100 feces remainders were send to Enthomology Departament of Natural History Museum, in Santiago de Chile (35°S), where were extracted and identified insect remains.

PRELIMINARY RESULTS

Plant species dispersed by *T. falcklandii.* 96.2% of seeds extracted from feces were (correspondieron) to alien plant species *A. chilensis* and *R. ulmifolius* (Table 1), while 3.8% corresponden to endemic native species *Drimys confertifolia* (canelo), *Berberis sp.* (michay) and *Azara sp* (corcolen).

Germination of alien plant species dispersed by *Turdus falcklandii*. Both under ambient conditions and under controled conditions, seeds dispersed by *T. falcklandii* show higher germination rates in case of *A. chilensis* (Figures 1 and 2) from day 30 and ahead. *R. ulmifolius* shows differencial germination rates from day 90 (Figure 3). Field experiments haven't shown germination yet.

Insect taxa on feces. We analyzed insect contents in 209 feces, of wich 61 had insect remains. We find 12 different species, of wich 55.7% were introduced species (Table 2).

Table 1. Seeds found in 100 feces of *T. falcklandii* in R. Crusoe Island. *Aristotelia chilensis*; *Rubus ulmifolius*; *Drimys confertifolia*; *Berberis sp*; *Azara sp*.

	A. ch	*R. ul*	*D. con*	*B. sp*	*A. sp*	unknown	total
Number of seeds	527	600	10	4	21	9	1171
Frequency	45.0%	51.2%	0.9%	0.3%	1.8%	0.8%	100%

Figure 1. Germination of *Aristotelia chilensis* under ambient conditions. Passed= seeds extracted form feces, that has passed the disperser digestive tract; unpassed= seeds extract mannually from fruits, without gut treatement.

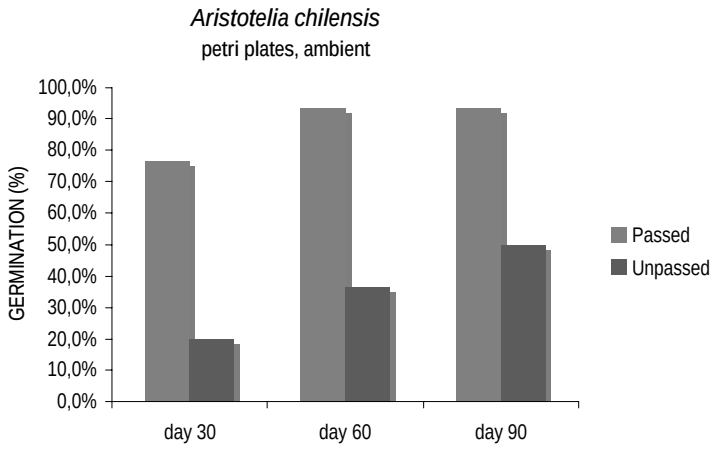


Figure 2. Germination in *Aristotelia chilensis* under controlled conditions. Passed= seeds extracted form feces, that has passed the disperser digestive tract; control= seeds extract mannually from fruits, without gut treatement.

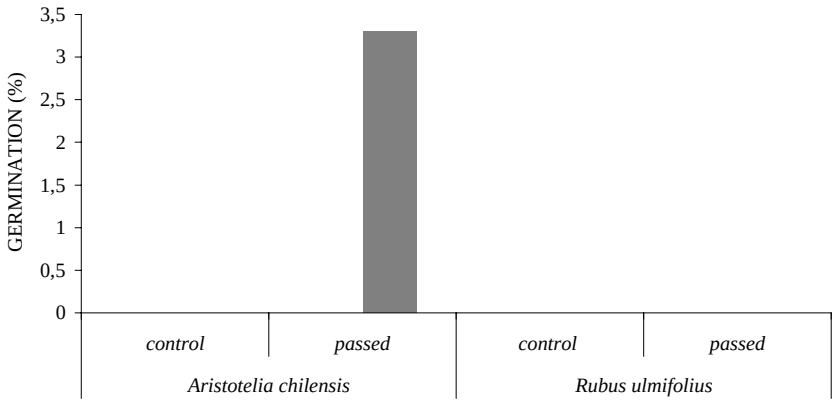


Figure 3. Germination in *Rubus ulmifolius* (zarzamora) under ambient conditions. Passed= seeds extracted form feces, that has passed the disperser digestive tract; unpassed= seeds extract mannually from fruits, without gut treatment.

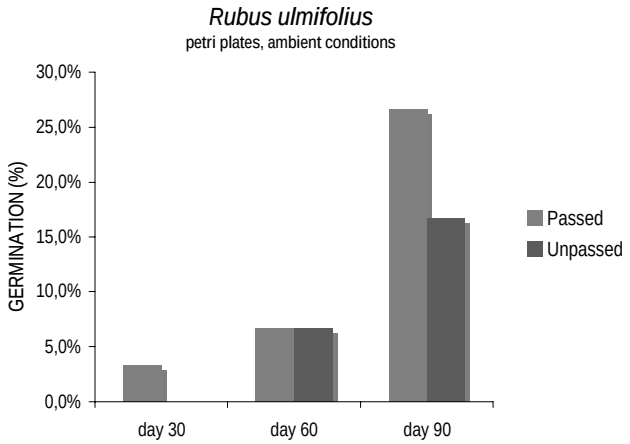


Table 2. Insect taxa found in 61 feces.

Species	Order: Family	Origin	Number of feces	Frequency
Kalotermes gracilignatus	*Isop: Kalotermitidae*	Endemic	2	
Strongylopterus ovatus	*Col: Curculionidae*	Native	6	
		Total feces with native species	**8**	**13.1%**
Otiorhynchus rugosostriatus	*Col: Curculionidae*	Introduced	27	
Naupactus xantographus	*Col: Curculionidae*	Introduced	11	
Vespula germanica	*Hym: Vespidae*	Introduced	5	
Asynonychus cervinus	*Col: Curculionidae*	Introduced	2	
Eryphus laetus	*Col: Cerambycidae*	Introduced	2	
Nycterinus abdominalis	*Col: Tenebrionidae*	Introduced	1	
Naupactus leucoloma	*Col: Curculionidae*	Introduced	1	
		Total feces with introduced species	**49**	**55.7%**
Araña sp	*Aracnida: Araenae*	Indetermined	2	
Milpiés	*Mirapod*	Indetermined	1	
sp	*Hym: Ichneumonoidea*	Indetermined	1	
		Total feces with indetermined species	**4**	**6.6%**

DISCUSSION

Our results evidence *Turdus falcklandii* as seed disperser both for native and alien fleshy-fruited plant species in Robinson Crusoe. More than 90% of the seeds found in it austral summer feces contain and disperse the exotic plant species *Aristotelia chilensis* and *Rubus ulmifolius*. The great fruit available of this extended species in summer, offers primary food source for *T. falcklandii* in study site. Preliminary results on germination tests, shows a possitive effect of dispersal proceses on seed germination rates, especially in *Aristotelia chilensis*. Insect analysis shows *Turdus falcklandii* as an active consumer of both native and introduced species, but shows higher percentage of introduced insect species consumed (more than 50%). Is necessary enhancer the knowledge about insect populations in Robinson Crusoe, to determine the importance of *T. falcklandii* as herbivorous population suppressor. Also, it turns necessary to evaluate feces contents in other areas in the island, in order to avoid possibly site effects, and in all four annual seasons, in order to evaluate diet of *T. falcklandii* while another fleshy fruit plant species are fructifing.

REFERENCES

Aizen, M.,A. D.P. Vásquez & Smith-Ramírez, C. (2002) Historia natural y conservación de los mutualismos planta-animal del bosque templado de Sudamérica austral. Revista Chilena de Historia Natural *75*: 79-97.

CONAF (1976) Plan de manejo del Parque Nacional Juan Fernández. FAO, Santiago de Chile. 61 p.

Cuevas, J.G., Marticorena, A. y Cavieres, L.A. (2004) New additions to the introduced flora of the Juan Fernández Islands: origin, distribution, life history traits, and potential of invasion. *Rev.Chil.Hist.Nat.* 77: 523-538.

Dirnböck, T., Greimler, J., Lopez, P. y Stuessy, T. (2003) Predicting Future Threats to the Native Vegetation of Robinson Crusoe Island, Juan Fernandez Archipielago, Chile. *Conservation Biology V.17, 6*: 1650-1659

Figueroa, J. (2000) Aspectos ecológicos de la germinación en especies del bosque templado-húmedo del sur de Chile. *Chloris Chilensis* N°2, Año 3. http:// www.chlorischile.cl/

Muñoz, A. & González, M. (2006) Aristotelia chilensis. En: Donoso Zegers, C. (ed.) Las especies arbóreas de los bosques templados de Chile y Argentina. Autoecología: 166-172. Marisa Cuneo Ediciones. Valdivia, Chile. 678 pp.

Riveros, M. & Smith-Ramírez, C. (1996) Patrones de floración y fructificación en bosques del sur de Chile. En: Armesto, J.J., Villagrán, C. & Arroyo, M.T.K. (eds) Ecología de los bosques nativos de Chile: 251-264. Editorial Universitaria, Santiago de Chile.

Sekercioglu, C.H. (2006) Increasing awareness of avian ecological function. *Trends in Ecology and Evolution*

Vol.21 No.8: 464-471

Skottsberg, C. (1953) The vegetation of the Juan Fernandez Islands. En: The Natural History of Juan Fernandez and Easter Island, Vol II Botany: 793-960. Almquist & Wiksells Boktryckery AB. Upsala, Suecia. 960+116 pp.

Swenson, U., Stuessy, T.F., Baeza, M. and Crawford, D. J. (1997) New and historical plant introductions, and potential pests in the Juan Fernández Islans, Chile. Pacific Science 51: 233-253

Traveset, A. & Willson, M.F. (1997) Effect of birds and bears on seed germination of fleshy-fruited plants on temperate rainforest of southeast Alaska. Oikos 80: 89-95

III.

Gap size age in the endemic forest of Robinson Crusoe island, Chile.

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INTRODUCTION

When one or more trees fall inside the forest, small or medium aperture of the cover will be created in this. This aperture are call gaps, where is possible the entrance of the light and the forest regeneration. The trees that remain in the borders of the gaps can grow in different rate due changes in light, humidity and temperature produced in the gap. The most waiting change is the diametral increasing in the rings of the border trees produced by the release of resources. If this increase is detected it is possible to detect the age when the gap was produced.

In this study we estimate the age of different gaps-forest in Plazoleta el Yunque, Robinson Crusoe Island, to determine the invasion rate by *Aristotelia chilensis* and *Rubus ulmifolius*. Specifically the objectives are: 1.- Determine the year of release of the growing rings in native trees in gaps borders, to know the age of gap origin. 2.- Determinate the age in which the shrubs, *Aristotelia chilensis* and *Rubus ulmifolius*, arrived at the gap forest. 3.- Determinate in how much time the invader shrubs are establish in a gap forests.

Hypothesis 1.- Immediate invation: The invation age occur in 1 or 2 years alter the formation of the gap forests. Hypothesis alternative: Delayed invation: The invation age is more than 3 years after creation of the gap forests.

Hypothesis 2.- The invation age is related with the gap area and with the distance at the source of propagules of *Aristotelia* and *Rubus*.

METHODOLOGY

We choose ten gaps-forest that had completely invaded, where the invaders shrubs had at least 10 cm of diameter. We choose forest gaps with different area. The area of forest gaps was determinate as the extrapolation from six transects that cross the gap throughout width and lenght. In the case of native trees the cores were taken at DBH, in the case of introduced shrubs the cores were taken at 30 cm from soil. In the border of each gap, we choose at least four native trees (*Fagara mayu*, *Drimys confertifolia* or *Myrceugenia fernandeziana*). At all this trees we extracted the increment cores.

Table 1. Number of cores by species sampled.

Species	**Number of cores**
Myrceugenia fernandeziana	44
Drimys confertifolia	6
Fagara mayu	4
Bohemeria excelsa	1
Rubus ulmifolius	5
Aristotelia chilensis	4
Total	**64**

The increment cores were sanded and its rings were calculated in Dendrocronology laboratory of Universidad Austral de Chile, Valdivia. *Myrceugenia fernandeziana* was the species that gave more clear rings to count for release ages. The data are been analysed to answer the objectives and hypothesis.

IV. PICTURES

Team group in Robinson Crusoe cabin to reserarchers from CONAF. Left to right. Claudio Almarza, Cecilia Smith, María José Faundez, Ana M. Abarzua, Hector Gutierrez, Dafne Gho Gisella Arellano and Juan Pablo Mora.

Team group in Plazoleta el Yunque, Robinson Crusoe Island.

Gisella Arellano take GPS data in Robinson Crusoe island.

Hector Gutierrez taken tree cores of *Myrceugenia fernandeziana*.

Tree increment cores from Robinson Crusoe Island.

Samples of arthropoda from the feces of *Turdus falcklandii*, analysed by Francisco Muñoz and Gabriela Mendez.

Ana M. Abarzúa happy in the fern soil of Robinson Crusoe Island.

Communitarian excursion with park-rangers from CONAF in Robinson Crusoe Island (leader Iván Leiva, National Park Administrator)

“Gap-maker” tree inside Robinson Crusoe Island (Plazoleta el Yunque)

Aristotelia chilensis and *Rubus ulmifolius* regenerations inside gap-forest

Turdus falcklandii, principal dippersor of exotic plants in Juan Fernández Archipelago

Sephanoides sephaniodes over a branch of *Aristotelia chilensis*.

ANNEX I

Nuevos registros y antecedentes de especies en Estado Crítico de Conservación de la flora de Robinson Crusoe y Santa Clara

Autores: Los guardaparques
Revista: Gayana Botánica

1. Título
2. Resumen (Abstract)
3. Introducción (El Plan de Conservación: Preguntas, Motivación, Objetivo, Conocimiento previo)
4. Metodologías
5. Resultados
6. Discusión
7. Figuras y Tablas
8. Agradecimientos
9. Referencias

2. Resumen

Es un texto resumido de alrededor 500 palabras donde se presenta el objetivo, los principales resultados y conclusiones.

3. Introducción

Introducir con el estado de conservación en el archipielago de Juan Fernandez y el Plan de Conservación actual.

Redefinir el concepto y criterios de evaluación del estado critico de las especies, de una población y una comunidad.

Objetivo: Exponer los nuevos antecedentes y registros para las 23 especies en estado critico que pertenecen al Plan de Conservación. Enriquecer el conocimiento de estas especies.

Explicitar la experiencia en terreno de los guardaparques.

Evaluar si incluimos Isla Selkirk.

4. Metodologías

Describir el área de estudio (las islas, su clima, su geografía, el impacto humano).

Descripción sintetizada de cada especie crítica. Como se eligieron las especies en concordancia con las definiciones de estado crítico, población y comunidad mencionados en la introducción.

Decir lo que se hizo y cómo durante el periodo de toma de datos y las especies asignadas a los guardaparques.

Explicitar que en esta publicación mostraremos los sectores donde se encuentran las especies, pero que ademas existe registro fotográfico y puntos GPS de cada especie en posesión de guardaparques en la Oficina de Conaf en JF.

Figura 1. Mapa del archipielago y los sectores registrados.

Tabla 1. Lista de sectores registrados y sus siglas correspondientes

5. Resultados

Mostrar los nuevos registros y antecedentes de las 23 especies que pertenecen al Plan de Conservación.

Describir la fenología y particularidades de cada especie.

Dar resultados anexos como la viverización y reproducción de ciertas especies, como por ejemplo que en Marzo 2007 se colecto la primera semilla viable de *D. gigantea* en A. Selkirk. (lo mejor es usar tablas y gráficos para resumir la información).

Tabla 2. 23 especies en estado crítico de conservación, su ubicación, número de individuos o poblaciones y fenología en el archipiélago de Juan Fernandez.

6. Discusión

Hacer un análisis crítico de los resultados, dando énfasis al objetivo planteado en la introducción

Interpretar los resultados, revisando cada especie y lo que conocemos de esta.

Mencionar las cosas que se podrían mejorar, como por ejemplo el sesgo que existe en la toma de datos y la falta de toma de datos en tiempo de verano. Un ejemplo: Solo una salida en enero y se encontró a Wahlenbergia en flor. En febrero solo hubo una salida.

Dar mucho énfasis al tema de las especies invasoras (maqui, zarzamora y zorzal) y su responsabilidad en la pérdida de biodversidad en el archipiélago.

Proponer al final estrategias para la recuperación y proyecciones de estudios futuros.

7. Figuras y Tablas

Figura 1. Mapa del Archipiélago de Juan Fernandez

Tabla 1. Lista de sectores registrados y sus siglas correspondientes

LUGAR SIGLA	LUGAR SIGLA
Cerro Alto CA	Los Alelies LA
Cordón del Centinela CC	Cordón atravesado CT
Damajuana DJ	Puerto Francés PF
Cordón Molina CM	El weste, Santa Clara EW
Salsipuedes SP	Isla Santa Clara SC
Camote C	Chifladores CH
Carbonera CAR	Mirador MI
La Piña LP	Cerro Agudo CG
Luma gacha LG	Cerro portezuelo CZ
Plazoleta PL	Mirador pistacho MP
Puerto Inglés PI	Morro Juanango MJ
Vaquería VA	Tierras Blancas TB
Campana CP	Quebrada La Matriz QLM
Villagra VL	Cerro Negro CN
Camino Villagra Campana VL-CP	La Torre LT
Tres Puntas TP	Quebrada El Lapiz QEL

Tabla 2. 23 especies en estado crítico de conservación, su ubicación, numero de individuos o poblaciones y fenología en el archipiélago de Juan Fernandez.

	Especie	N. Sec.	N. Ind.	Floración	Frutos	Nota
1	*Apium fernandezianum*	2	6			Regeneración natural
2	*Asplenium macrosorum*	10	110		JUL	Nuevo registro
3	*Asplenium obtusatum*	1	3 pob.		DIC	
4	*Asplenium stellatum*	8	687			
5	*Azara serrata*	14	44	MAR-ABR, OCT-NOV	MAR-AGO, OCT-NOV	Nuevo registro
6	*Centaurodendron dracaenoides*	6	51			
7	*Centaurodendron palmiforme*	1	14			
8	*Chenopodium crusoeanum*	4	468	JUL	MAY-AGO, DIC-FEB	Ataque de hongos, bacterias y roedores
9	*Chenopodium sanctae clarae*	3	21	SEP	SEP	Regeneración natural
10	*Colletia spartioides*	5	9		SEP	
11	*Cuminia eriantha*	19	215	FEB-JUN, AGO-NOV	FEB-AGO	Fenologia cambia con altitud (arriba no florece)
12	*Dendroseris berteroana*	8	33	FEB		2 muertas
13	*Dendroseris litoralis*	5	1109	FEB,JUL, NOV	FEB	Con urgencia fumigar. Regeneracion natural
14	*Dendroseris macrantha*	7	104	MAY-JUN		
15	*Dendroseris marginata*	2		MAR	MAR-ABR	
16	*Dendroseris pinnata*	17	80	FEB		Florece y luego muere
17	*Dendroseris neriifolia*	6	2			1 muerto en El lapiz
18	*Elaphoglossum squamatum*	1	1		ABR-JUN	UNICO ejemplar
19	*Grigia berteroii*	2	24			Mas de 15 años que no florce

20	*Haloragis sp*	1	39			Tienden a secarse en verano
21	*Margyricarpus diginus*	4	206			
22	*Nicotiana*	2	89			Ataque de hongos, bacterias
23	*Polypodium sp2*	2	45		MAY-JUL	
24	*Selkirkia berteroii*	7	35	JUN-AGO		
25	*Wahlenbergia larrainii*	2	10	ENE	MAR	

8. Agradecimientos

Deben estar mencionadas todas las personas e instituciones que han aportado al desarrollo del manuscrito (datos, texto, dinero, etc.).

9. Referencias

Danton, P. 2004. Plantas silvestres de la isla Robinson Crusoe. Guía de Reconocimiento. 1ra edición. CONAF. Viña del Mar. Chile, pp 194.

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