The Rufford Foundation
Preliminary Report

Congratulations on the completion of your project that was supported by The Rufford Foundation.

We ask all grant recipients to complete a Final Report Form that helps us to gauge the success of our grant giving. The Final Report must be sent in **word format** and not PDF format or any other format. We understand that projects often do not follow the predicted course but knowledge of your experiences is valuable to us and others who may be undertaking similar work. Please be as honest as you can in answering the questions – remember that negative experiences are just as valuable as positive ones if they help others to learn from them.

Please complete the form in English and be as clear and concise as you can. Please note that the information may be edited for clarity. We will ask for further information if required. If you have any other materials produced by the project, particularly a few relevant photographs, please send these to us separately.

Please submit your final report to jane@rufford.org.

Thank you for your help.

Josh Cole, Grants Director

Grant Recipient Details	
Your name	Paulina Bahamonde
Project title	The war of a hundred years: Assessing the effects of introduced salmonids on native fishes at small streams in Patagonian freshwater systems
RSG reference	18782-1
Reporting period	October 2016 to July 2017
Amount of grant	$5,000
Your email address	p.bahamondec@gmail.com
Date of this report	September 2017

1. Please indicate the level of achievement of the project's original objectives and include any relevant comments on factors affecting this.

Objective	Not achieved	Partially achieved	Fully achieved	Comments
To determine fish biodiversity in two different features streams, the Colonos River and Marchant River				We used several fishing arts and equipment in a try out to assess the ichthyofauna. We succeed on the lower parts of both rivers, but we need to go further upstream, to fully understand the spatial and temporal impact of the salmon and trout.
To determine the habitat overlap and competition of exotic invasive species				Despite the success on the lower parts of the basin, we are eager to extend the research upstream and locate the spawning areas of native and exotic fish, in order to fully understand the habitat overlap and competition/predation relationship
To explore management decisions related to the freshwater system microhabitats to enhance native fish reproduction and survival				Partially archived. Today, we are currently part of the INVASAL, a millennial project supported by Chile and government, to study invasive salmonids. The multidisciplinary group will explore national management decisions.
To study length frequency of fish species				Fortunately, we collected a high number of one native fish species (*Galaxias maculatus*), and we were able to assess the length frequency for both spring and fall seasons, but we need to make a more intensive field collection effort to assess the other species size frequency study for the seasons.
To explore macroinvertebrates biodiversity				Again, we were successful, but we need to expand upstream this topic, to fully understand the possible impacts at a basin level.
To determinate fish nesting places				The difficulties to explore the area in addition to the challenging of the remote sites made us difficult to be able to carry out this goal. We believe, spawning areas for salmonids and some of the native

				species might be further upstream.
To assess the interaction between native and invasive species				We are currently analysing the stable isotopes to evaluate the depredatory interaction between natives and invasive fishes. Initial data from field observations: we evidenced a very high number of native fish (Puye, <90% in numbers and almost 100 in biomass) as prey items in stomach contents of brown trout. We have to finish the stomach content and stable isotope analysis to fully answer this topic.

2. Please explain any unforeseen difficulties that arose during the project and how these were tackled (if relevant).

- Since the project got the funds, my team and I started to buy the equipment necessary to develop the fieldwork. We obtained a quote for the electrofishing backpack in December 2015. Sadly, the electrofishing backpack and some nets were harder to get that we thought, due to customs. We had to delay the fieldwork by one season, been the first one on October 2016 and the second during April 2017.
- In addition, due by the difficulties of the access (harder than we expected), it was not possible to explore nesting places of the fish species collected, further upstream.
- The access to the rivers is harder than we expected. Canoes and kayaks were not enough to get to the sites. We are evaluating the use of helicopters to access the sites upstream and assess those sites and possible spawning areas.
- We have not been able to finish by this date the analysis of carbon and nitrogen stable isotopes in order to assess the trophic dynamics in the freshwater systems. The samples are currently being analysed and we expect to have the results in a couple months.

3. Briefly describe the three most important outcomes of your project.

A total of five sites were sampled using different fishing techniques (Figure 1), summarised at the project methodology. The summaries of the species found are in Figure 2 and the number of individuals obtain by fishing techniques by sites are in Table 1.

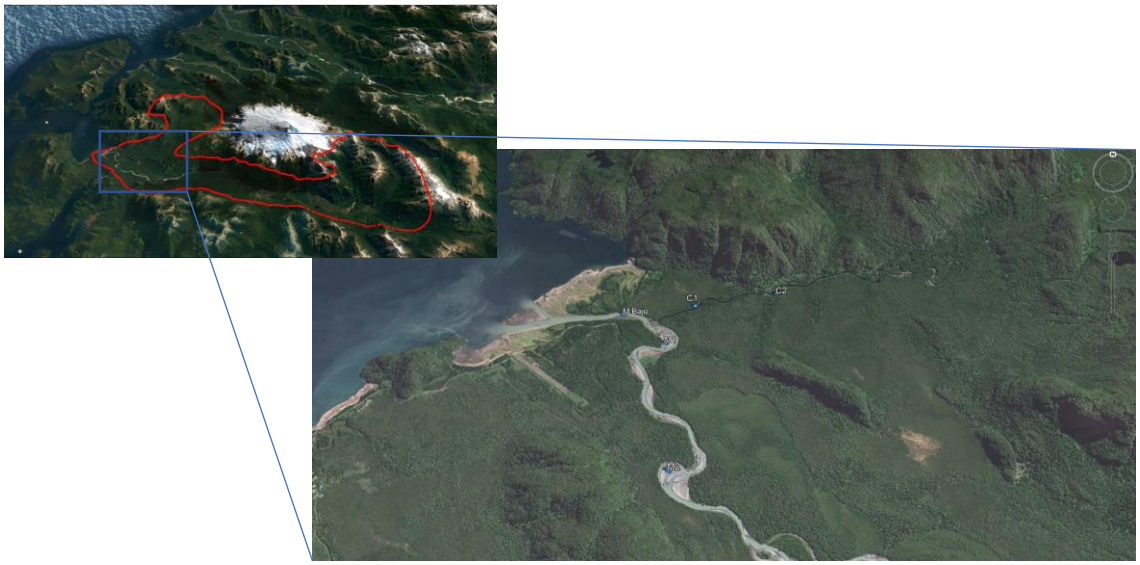

Figure 1. Study site. Red line shows the boundaries of the Marchant River Basin. Blue box shows the sampling sites in the Colonos River (Colonos 1: C1; Colonos 2: C2) and in the Marchant River (Marchant bajo: M Bajo; Marchant 1: M1; Marchant 2: M2).

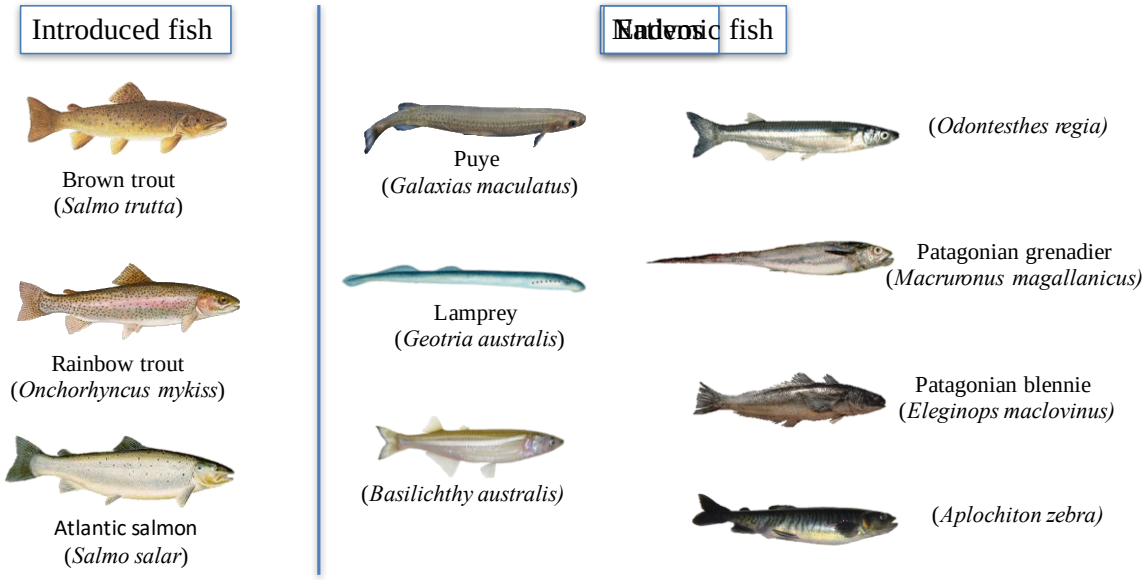

Figure 2: Fish species identify during the field work developed in October, 2016 and April, 2017 at the lower end of the Marchant River Basin (Colonos River and Marchant River), Aysen Region, Chile

Table 1: Summary of the number of fish species collected by site during Southern Hemisphere spring (2016) and fall (2017).

Site	*Year*	*S.trutta*	*O.mykiss*	*S.salar*	*G.maculatus*	*B.australis*	*O.regia*	*G.australis*	*E.maclovinus*	*A.zebra*	*M.magallanicus*	*Total*
Colonos 1	**2016**	0	0	2	44	0	0	0	0	12	0	58
	2017	4	0	1	22	0	0	4	0	0	0	31
Colonos 2	**2016**	8	0	0	40	0	0	1	0	10	0	59
	2017	17	0	2	51	0	0	8	0	1	0	79
Marchant	**2016**	13	1	1	98	0	1	0	1	0	2	117
bajo	**2017**	2	0	2	117	0	0	0	20	0	0	141
Marchant 1	**2016**	1	0	0	84	0	0	0	0	0	0	85
	2017	11	0	0	29	1	0	1	0	0	0	42
Marchant 2	**2016**	7	0	0	23	0	0	0	0	0	0	30
	2017	17	11	0	0	0	0	0	0	0	0	28
Total	**2016**	**29**	**1**	**3**	**289**	**0**	**1**	**1**	**1**	**22**	**2**	**349**
	2017	**51**	**11**	**5**	**219**	**1**	**0**	**13**	**20**	**0**	**0**	**320**

In addition, the macroinvertebrates collected along the rivers are in table 2.

Table 2: Summary of the abundance of species collected by site each year.

				Colonos 1		Colonos 2		Marchant 1		Marchant 2		Marchant bajo	
PHYLUM	CLASS	ORDER	FAMILY	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Anellida	Oligochaeta	Anelida	Lumbriculidae	1		3	2	1					
Anellida	Oligochaeta	Anelida	Anelida pequeño				2						
Arthropoda	Insecta	Diptera	Athericidae					3		75			
Arthropoda	Insecta	Diptera	Blephareceridae					6		8			
Arthropoda	Insecta	Diptera	Chironomidae		4	8			54		1	1	
Arthropoda	Insecta	Diptera	Chironomidae pupa						3			1	
Arthropoda	Insecta	Diptera	Simulidae	1	2	4	2	53	266	224		1	
Arthropoda	Insecta	Diptera	Simulidae pupa					7	9	7			
Arthropoda	Insecta	Diptera	Tabanidae			1						1	
Arthropoda	Insecta	Ephemeroptera	Ameletopsidae								1		
Arthropoda	Insecta	Ephemeroptera	Baetidae	15		4		8	1	10			
Arthropoda	Insecta	Ephemeroptera	Coloburicidae					1		4			
Arthropoda	Insecta	Ephemeroptera	Leptophlaebidae	57	67	51		86	90	41	87	8	1
Arthropoda	Insecta	Plecoptera	Austroperlidae					1	2	6	4		
Arthropoda	Insecta	Plecoptera	Diamphipnoidea		1	2	3			4	1		
Arthropoda	Insecta	Plecoptera	Notonemuridae						3		1		1
Arthropoda	Insecta	Plecoptera	Grypopterigidae	15	3	6	3	24	9		4	35	8
Arthropoda	Insecta	Trichooptera	Glossosomatidae							1			
Arthropoda	Insecta	Trichooptera	Helicophidae	35		1				2			

Arthropoda	Insecta	Trichooptera	Hidrobiosidae	1		2				10		3	
Arthropoda	Insecta	Trichooptera	Leptoceridae	2		1	53						
Arthropoda	Insecta	Trichooptera	Ecnomidae		1		1				40+ 22		
Arthropoda	Insecta	Trichooptera	Polycentropodidae						1		1		1
Arthropoda	Insecta	Trichoptera	Limnophilidae				1						
Arthropoda	Insecta	Trichooptera	Trichoptera casita piedra	1									
Arthropoda	Insecta	Trichooptera	Trichoptera casita madera	5		8							
Arthropoda	Insecta	Trichooptera	Trichoptera pupa					14					
Arthropoda	Insecta	Coleoptera	Elmidae		1								
Arthropoda	Malacostrada	Decapoda	Aeglidae		5	12	3	5	2		2	1	1
Arthropoda	Malacostrada	Crustacea	Amphipoda										10
Arthropoda	Insecta	Chelicerata	Acaro						1				
Mollusca	Gastropoda		Chilinidae	139	53	21	28	2			12		
Mollusca	Gastropoda		Littoridina	3	1	1	5	1			5		

Table 3: Species richness *(S)*, number of individuals *(N)*, Shannon Index *(H´)*, maximun diversity *(H_{max})*, Pielou evenness Index *(J´)* and Simpson´s Dominance (D)

	Sitios	*S*	*N*	*H`*	*Hmax*	*J`*	*D*
2016	C1	3	58	0,652	1,609	0,405	0,595
	C2	4	59	0,903	1,609	0,561	0,439
	MB	7	117	0,624	1,946	0,321	0,679
	M1	2	85	0,064	1,099	0,058	0,942
	M2	2	30	0,543	1,099	0,494	0,506
2017	C1	3	30	0,765	1,609	0,475	0,525
	C2	5	79	0,994	1,609	0,617	0,383
	MB	4	141	0,553	1,946	0,284	0,716
	M1	4	42	0,785	1,099	0,714	0,286
	M2	2	28	0,670	1,099	0,610	0,390

The information that we previously know was:

- In continental Chilean waters, we find a total of 72 species of fish, where 27 are introduced to the country by government initiatives since 1900.
- The native ichthyofauna of inland waters is characterised by its low natural specific richness, small body size (<15 cm as adults) and highly endemic (about 80%).
- The family of salmonids are the most successful group in Chile (43% of introduced species), and generate serious ecological impacts.
- The rainbow trout and the brown trout represent more than 95% of the total biomass of the ichthyofauna in rivers of the south of Chile. They are among the 100 most harmful invasive alien species in the world.

According to the information provided, in addition to the field work observation, the preliminary findings that we can share are:

I. There is the habitat overlapping between alien's species and the natives in both, the Marchant River and Colonos River.
II. The most abundant species were Puye (*Galaxias maculatus*), representing 75.8% (n = 508) of the total sampled, followed by Brown trout (*Salmo trutta*) with 11.9%.
III. There is a strong depredation of Puye (*G.maculatus*) by juvenile brown trout (*S. trutta*).
IV. Stomach content evidenced a strong predation over Puye, from salmonids (ONE BROWN TROUT WITH ≈ 40 PUYE IN ONE DAY!).
V. The presence of wild Atlantic salmon and individuals escaped from farms at Marchant River. Salmon escaped could ESTABLISH ITSELF IN THE WILD.
VI. Size differences, reproductive success and salmonids escapees are A REAL THREAT TO AQUATIC BIODIVERSITY, both freshwater and marine

VII. The presence of a steelhead rainbow trout (*Oncorhynchus mykiss*) was detected at Marchant River. This is the first report of this life cycle for rainbow trout on this river system

VIII. The *Aplochiton zebra* or "peladilla" were found at the Colonos River, categorised as "critically endangered" Campos et. al., 1998. The size of the specimens found on the Colonos River are important, and we need to assess the possible habitat refuge for this specie.

IX. Salmonids exert negative effects on fish species in Chilean Patagonia due to predation, disease, niche modification or trophic changes. The most affected species are the galaxies by depredation and to *Aplochiton zebra* by food and area competition.

4. Briefly describe the involvement of local communities and how they have benefitted from the project (if relevant).

MERI Foundation is a non-profit organisation dedicated to "Protect the Natural Reserve Melimoyu and strengthen research and education for the conservation and sustainable management of terrestrial, freshwater, marine ecosystems and the cultural legacy of north Patagonia." Under the eaves of this mission, MERI Foundation has generated an Environmental Education Program oriented to one-teacher school's students from the local neighborhoods close to the Melimoyu Nature Reserve, Region of Aysen.

The names of the different schools are:

1. Madre de la Divina Providencia School, Puerto Gala, Cisnes commune.
2. Melimoyu School, Melimoyu, Cisnes commune.
3. Amanda Labarca Huberstone School, Puerto Raúl Marín, Cisnes commune.
4. Repollal School, Puerto Melinka, Las Guaitecas commune.

The general objective of this environmental education program of MERI Foundation is:

To awaken the sense of eco-systemic relevance from the assessment of the natural environment and its different components.
Generating awareness of the fundamental quality of nature as an interconnected system, in which our actions have consequences on the ecosystem and humans. In this way, it is intended to make a change of the general thinking that establishes nature as the environment that surrounds us, where the human being is implicitly posed as a domineering entity.

The general objective is to promote interest in the Freshwater ecosystem through the basic understanding of its functional dynamics.

Specific Objectives:

1. To give information about the basic understanding of the functional dynamics of the freshwater ecosystem.

2. To understand the ecological value of the freshwater ecosystem and to generate sensitivity and respect for it.
3. To discover the biological diversity of the freshwater ecosystem and to distinguish the interaction between native and introduced species.
4. To awake the interest and to apply good environmental practices that mitigate the impacts of climate change and introduced species.

Workshops:

1. The water: what is the water, where and how we can find it?
2. Knowing the freshwater system: glaziers, rivers, lakes, wetlands and fjords.
3. Discovering the Patagonia habitants: biodiversity.
4. A very particular animal: threats about the freshwater system.

The biodiversity information collected through this project will be essential to develop the programme.

At the same time, we have involved volunteers and graduate students working on site and on the analysis of the samples, developing qualified human resources that will improve the research and awareness of this topic at a regional and national level.

5. Are there any plans to continue this work?

Yes, we would like to keep the monitoring of this area with special focus on the interaction between the salmonids and the *Aplochiton zebra*. *A. zebra*, is a species of restricted distribution. It presents a shared distribution and habits with introduced salmonids that compete and depredate on this species. We evidenced a very high predation on *Galaxias maculatus*, and we would like to assess the extent of this interaction. At the same time, we would like to assess spawning areas for native and invasive species, and reproductive success in order to assess population sustainability within freshwater systems in Patagonia. The presence of Atlantic salmon escapees and steelhead rainbow trout will need a full assessment, especially at the mouth of the Marchant River (e.g. acoustic camera system (Aris)).

In addition, we want to keep monitoring the area under the INVASAL initiative to be able to influence stakeholders and community.

6. How do you plan to share the results of your work with others?

All the results will be share to the scientific community by conference, it has been already accepted for the IMPAC4, La Serena - Chile (International Marine Protected Areas Congress). In addition, MERI foundation has an environmental educational programme with local communities where all this information will be taught. We do have a close interaction with the regional Fisheries department of Chile (SERNAPESCA), with the regional and national Environmental Ministry, that are leading to regional (Aysen region) seminars and photographic expositions planned

for the end on 2017. An aquatic ecology and ecotoxicology summer course is planned for January 2017, where this topic will have a central scope.

7. Timescale: Over what period was The Rufford Foundation grant used? How does this compare to the anticipated or actual length of the project?

As we explained before, the whole project had to be delayed by one season because the field work equipment did not arrive on time. Since then, two field work seasons were developed: spring 2016 and fall 2017. The data showed are from those activities, however, there is still lab work ongoing.

Activity	**2016**	**2017**								
	Oct.+	April	May	June	July	Ago	Sept.	Oct.	Nov.	Dic.
Field work										
Literature										
Lab work										
Data analysis										
Manuscript preparation										

8. Budget: Please provide a breakdown of budgeted versus actual expenditure and the reasons for any differences. All figures should be in £ sterling, indicating the local exchange rate used.

Item	**Budgeted Amount**	**Actual Amount**	**Difference**	**Comments**
Field trip	373	200	173	
Travel allowance	1,800	927,35	872,65	
Supplies	950	809,44	140,56	
Undergrad help	560	480,93	79,7	
Fishing gear (fyke net–option 1)	300	-	300	
Fishing gear (fyke net–option 2)	330	-	330	
Modified minnow traps x10	130	-	130	
Total				

9. Looking ahead, what do you feel are the important next steps?

We plan to keep going with this monitoring. Since there is preliminary data about the presence of three invasive species, we want to:

1) Repeat the field work season this following spring (October 2017) and fall (April 2018) and apply.
2) To analyze age and stomach contents of individuals.

3) Environmental educational programs to local community to differentiate invasive from native freshwater species.
4) To expand our research further upstream and look for spawning areas of both, native and exotic fish, in order to assess the impact on reproduction.
5) To assess the total amount of salmonid species running upstream at the mouth of the river (e.g. acoustic camera system (Aris)) and so on the real number and biomass entering freshwater systems in Patagonia.

10. Did you use The Rufford Foundation logo in any materials produced in relation to this project? Did the RSGF receive any publicity during the course of your work?

Poster presentation at the 4th International Marine Protected Area Congress (IMPAC4) at La Serena, Chile. Titled: ALIEN SPECIES AT FRESHWATER AND MARINE FJORDS IN PATAGONIAN ECOSYSTEM: ASSESSING THE PRESSURES OVER THE ECOSYSTEM by PAULINA BAHAMONDE, Winfred Espejo, Elvira Vergara, Gabriela Mancilla, Andrea Fernández, Gustavo Chiang.

http://www.fundacionmeri.cl/2016/07/06/la-guerra-de-los-100-anos-evaluando-los-efectos-de-salmonidos-introducidos-sobre-los-peces-nativos-en-pequenos-arroyos-de-los-sistemas-dulceacuicolas-en-la-patagonia/

11. Any other comments?

In addition, the other highlights of the projects are:

- A master student from the University Andres Bello, Chile, is starting her project with the data and samples collected from this project.

- We are part of Millennium nucleus of Invasive Salmonids, evaluating the impacts of their presence on Chile's ecosystems and society, funding by Chilean government. The project recognizes Melimoyu sites as a strategic site to understand and to protect endemic fauna. **https://seeblab.files.wordpress.com/2017/06/invasal_final.pdf**