The Rufford Small Grants Foundation

Final Report

Congratulations on the completion of your project that was supported by The Rufford Small Grants 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	Taran Grant
Project title	Diagnosing spatial patterns of bullfrog invasion (Lithobates catesbeianus) in the Atlantic Forest of southern Brazil
RSG reference	34.09.09
Reporting period	Final report
Amount of grant	£5,823
Your email address	taran.gran@gmail.com
Date of this report	13.10.2011

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
Sampling of 90 sites within 3 study areas			X	The sites, half with bullfrog presence, half without bullfrogs, were sampled twice in each of three distinct regions. We collected data on bullfrog eggs, tadpoles, and post-metamorphic individuals, as well as other amphibians, macro-invertebrates, and environmental parameters (e.g., vegetation, land use, water pH)
Identification of sites most and least prone to bullfrog occupation			X	Based in our field data, we modelled the spatial pattern of species distribution (see comments bellow)
Assess the large scale distribution of bullfrogs in Brazil			X	We reviewed recent literature records, and consulted natural history collections for bullfrog's records in Brazil. With the result of this project and the record review we compiled the new species distribution map for Brazil.
Collection of testimonials and tissues for future studies			X	The samples collected will serve for future investigations.
Divulgation of the bullfrog invasive populations to general public			X	We met with land-owners in the areas of our study sites and discussed the potential negative impacts of invasive bullfrogs, produced an exhibit in the Museu de Ciências e Tecnologia in Porto Alegre on the diversity and importance of amphibians and the many threats they face (including a live bullfrog display with information on the bullfrog in Brazil), and we published a website summarising what is known about invasive bullfrogs in Brazil (http://www.ib.usp.br/grant/Ra-touro_no_Brasil/)

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

We encountered two unforeseen difficulties. The first was in effecting the transfer of funds to my bank account. The bank neglected to inform me that the funds had arrived and then tried to charge income tax. Although this slowed down our progress initially, we managed to prove to the bank that the funds were for research and eventually received the money.

The second problem was in gaining access to private property in one of the three study regions (encompassing the municipalities of Blumenau, Pomerode, and Indaial). Many landowners were wary of strangers and refused to grant access. Although it was more difficult to sample the 30 sites we planned for this region, we were able to overcome the problem by enlisting the help of supportive local residents who vouched for us in the local communities.

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

First, we discovered that the bullfrog is much more widely distributed in southern Brazil than was previously believed. Based in our samples, the literature, and Brazilian natural history collections, we compiled a new bullfrog distribution map (Fig.1) that more than doubles the number of municipalities with bullfrog records. Due to the lack of historical records for comparison, we are unable to determine if this is due to expansion of feral populations, increased bullfrog farming, or improved sampling. The species presents a widespread distribution, mainly in the Atlantic Forest Biome. These results have been published and are available at http://www.bioone.org/doi/full/10.2994/057.006.0203.

Second, we proposed an explanation for the distribution of the bullfrog in the three regions. We built a logistical regression model to test the importance of space, landscape, and waterbody descriptors in predicting bullfrog occurrence. Our results show that species occurrence is not spatially constrained. The logistic model showed that waterbody and landscape features can predict the presence of species. Sites that are most prone to invasive bullfrogs are dams with deeper water and fishes, are closer to roads, and occur outside protected areas. Our model correctly classified 89% of species-absence and 86% of species-presence.

We also found that bullfrogs are more likely to occur at localities that have greater anuran species richness than those with poorer communities. The implications of this finding are unclear. On one hand, the co-occurrence of bullfrogs and larger a rich native fauna suggests that the bullfrogs may simply adapt to local environments without negatively altering the local communities, i.e., competition and predation may have limited impacts. On the other hand, bullfrogs are vectors of emerging infectious diseases that are known to have caused devastating amphibian decline around the world, and the relative ease with which bullfrogs enter richer communities could bring bullfrogs into contact with a large number native species very quickly.

Most importantly, it is unknown when these invasive populations first arrived at these sites, and therefore we do not now if the current co-occurrence of bullfrogs and diverse native communities persists or not. Continued monitoring of the interactions of these species is necessary to evaluate the long-term impacts of the bullfrogs. Similarly, although the comparative, diagnostic approach employed in the present study provides many insights into the bullfrog invasion of Brazil, our experience in this project has convinced us of the importance of combining this approach with controlled experimental studies that directly test causal relation between bullfrog presence and alterations to native communities. The data and results from the present project will assist us in the designing the next phas in our research.

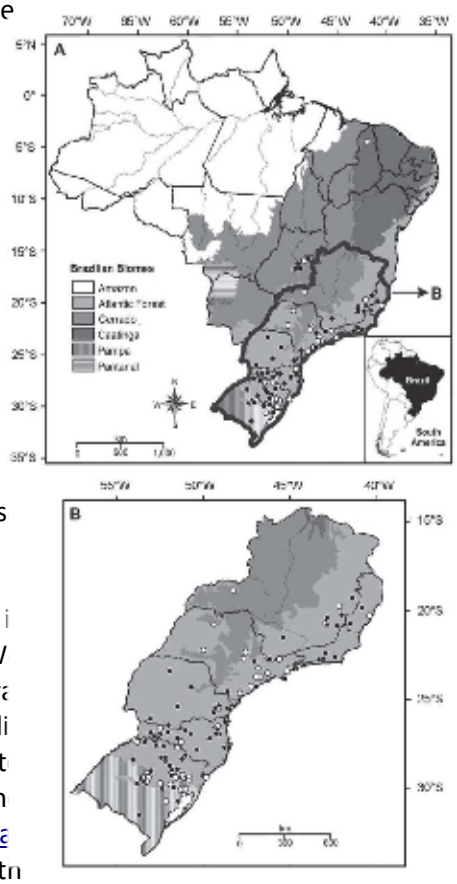

FIGURE 1. Spatial distribution of *Lithobates catesbeianus* invasive populations in Brazil (A). In B, the species distribution in south and southeastern regions appear in detail. White circles represent municipalities in which the bullfrog presence was already known in 2008 (Giovanelli *et al.* 2008), and the black circles represent the subsequent records reported herein.

Finally, one of the most important outcomes of our project i the increased awareness and interest we generated. W presented the project and preliminary results in severa academic and non-academic events, produced a publi exhibition in the Museu de Ciências e Tecnologia in Port Alegre, and published a website with information about th species in Brazil (http://www.ib.usp.br/grant/Ra touro_no_Brasil/). We have also worked closely with colleagues in the Ministry of the Environment (specifically the Instituto "Chico Mendes" de Conservação da Biodiversidade, ICMBio). On 17-22 October I will participate in an ICMBio workshop to develop a conservation plan for southern Brazil, and the results from the present study will be extremely important.

Source: Both, C., Lingnau, R., Santos-Jr., A, Madalozzo, B., Lima, L.P. and Grant, T. 2011. Widespread occurrence of the American Bullfrog, Lithobates catesbeianus (Shaw, 1802) (Anura: Ranidae), in Brazil. South American Journal of Herpetology, 6(2): 127-134.

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

The sampling activities took place in small properties and protected areas. The rural owners generally were very receptive and interested in the problem. They often knew the bullfrog, at least by their call, but they often believed it was a native species. Some local people expressed concern for the bullfrog's conservation, even describing how they had rescued bullfrogs and tadpoles from drying ponds. Some of them described having "won" tadpoles from fish farms. Through our interactions with local communities we were able to correct many errors, bring the potential impacts of bullfrog introduction to their attention, and discuss ways to prevent new introductions.

5. Are there any plans to continue this work?

Yes. This project was intended to provide an initial diagnosis of the extent of the bullfrog invasion. We intend to build on our initial findings in future studies (see below).

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

In addition to the efforts described above, the results will be included in scientific articles and a Ph.D. dissertation and, subsequently, will be shared on our website. The updated species distribution was published in a scientific journal. Simultaneously, we built a google map, which is now available on our website. Data analysis is ongoing, and we will publish our results as quickly as possible.

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

We concluded our field work within the anticipated time.

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.

Original budget

Item	Quantity	Unitary Value[1] (R$ / £)		Total (R$ / £)	
[2] Gasoline A1 (Nova Palma /Dona Francisca)	2	235	77.0491803278689	470	154.09836065573
[2] Gasoline A2 (Chapecó/ Joacaba)	2	435	142.622950819672	870	285.24590163934
[2] Gasoline A3 (Itajaí / Blumenau)	2	420	137.704918032787	840	275.40983606557
Highway toll A1	2	25	8.19672131147541	50	16.393442622950
Highway toll A2	2	80	26.2295081967213	160	52.459016393442
Highway toll A3	2	10	3.27868852459016	20	6.5573770491803
Vehicle rent	1008h 0m 0s	700	229.508196721311	4200	1377.0491803278
[3] Loading	84	50	16.3934426229508	4200	1377.0491803278
[3] Food	1008h 0m 0s	500	163.934426229508	3000	983.60655737704
Oxygen meter	1	700	229.508196721311	700	229.50819672131
Dip net (40 x 30 cm)	2	50	16.3934426229508	100	32.786885245901
Flashlights	2	40	13.1147540983607	80	26.229508196721
Waterproof overalls	2	150	49.1803278688525	300	98.360655737704
Digital camera	1	1300	426.229508196721	1300	426.22950819672
GPS	1	500	163.934426229508	500	163.93442622950
Camera bag	1	50	16.3934426229508	50	16.393442622950
Battery 9 volts	4	15	4.91803278688525	60	19.672131147541
Battery D	150	2.00	0.655737704918033	300	98.360655737704

Item	Quantity	Unitary Value[1] (R$ / £)		Total (R$ / £)	
Battery (AAA)	12	5	1.63934426229508	60	19.672131147541
[4] Bank fees	1	500	163.934426229508	500	163.93442622950
Total				17760	5822.9508196721

Actual expenditure

We were able to cover expenses for Gasoline and Highway toll from other sources, so we used those funds to purchase two digital audio recorders, which are fundamental to document anuran species.

Item	Quantity	Unitary Value[1] (R$ / £)		Total (R$ / £)	
Digital audio recorders	2	1200	393.44262295082	2400	786.88524590163
Vehicle rent	1008h 0m 0s	700	229.508196721311	4200	1377.0491803278
[3] Loading	84	50	16.3934426229508	4200	1377.0491803278
[3] Food	1008h 0m 0s	500	163.934426229508	3000	983.60655737704
Oxygen meter	1	700	229.508196721311	700	229.50819672131
Dip net (40 x 30 cm)	2	50	16.3934426229508	100	32.786885245901
Flashlights	2	40	13.1147540983607	80	26.229508196721
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GPS	1	500	163.934426229508	500	163.93442622950
Camera bag	1	50	16.3934426229508	50	16.393442622950
Battery 9 volts	4	15	4.91803278688525	60	19.672131147541
Battery D	150	2.00	0.655737704918033	300	98.360655737704
Battery (AAA)	12	5	1.63934426229508	60	19.672131147541
[4] Bank fees	1	500	163.934426229508	500	163.93442622950
Total				17750	5819.6721311475

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

Our experience in this project has pointed to many new questions about the bullfrog invasion. What are most lacking at present are (1) baseline data to determine the rate and causes of changes in bullfrog distribution and native anuran community structure and composition, (2) controlled experiments to directly identify the bullfrog as the cause of changes in native communities, and (3) assessment of the prevalence of infectious diseases in bullfrog farms and feral populations in Brazil. We also have many specific questions: i) how deep inside forest patches can bullfrogs be found in the Atlantic Forest? ii) Are the population dynamics different in this subtropical area than in other invaded areas around the world? iii) How genetically diverse are invasive populations?

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

The RSGF logo was used in public presentations (including two international congresses and presentations in local meetings) and on the project website.