

## 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](mailto:jane@rufford.org).

Thank you for your help.

**Josh Cole, Grants Director**

Grant Recipient Details	
<b>Your name</b>	Rachael Carrie
<b>Project title</b>	The Development of Freshwater Bio-Monitoring in Belize, Central America
<b>RSG reference</b>	07.11.09
<b>Reporting period</b>	March 2010-August 2011
<b>Amount of grant</b>	£5985
<b>Your email address</b>	<a href="mailto:r.carrie@lancaster.ac.uk">r.carrie@lancaster.ac.uk</a>
<b>Date of this report</b>	September 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
<p><b>1. Identification of the Suitability of Evidence-Based Metrics</b></p>		X		<p>It was initially proposed to test the ability of metrics reflecting multiple taxon groups to distinguish anthropogenic impacts to riverine ecosystems. Macro-invertebrate and phytobenthos samples were collected along with environmental information (land-use, riparian and in-stream physicochemical) as planned from 21 sites during March-May 2010 (end dry season). Ornithological information was not sampled (see section 2 for more information). Macro-invertebrate samples were fully processed. However, constraints related to phytobenthos analysis prevented their assessment (see section 2 for more information). Instead a second survey of macro-invertebrates was undertaken at the same sites during Oct-Dec (beginning of dry season) to begin investigating temporal changes in community composition and the subsequent robustness of macro-invertebrate based metrics.</p>
<p><b>2. Determine the spatial and temporal pattern of macro-invertebrate diversity and community structure in the MMMC.</b></p>			X	<p>A total of 43,384 macro-invertebrate specimens were collected across seasons, belonging to 71 family groups. Ephemeroptera (mayflies), Diptera (flies), Gastropoda (snails) and Coleoptera (beetles) were the most abundant and Trichoptera (caddisflies), Coleoptera and Diptera the most diverse. Taxonomic groups were well represented during both seasons. Whilst seasonal fluctuations in presence and abundance were apparent, neither total abundance, family richness, diversity nor community composition was significantly different between seasons. Significant dissimilarity was observed in Coleopteran abundance between seasons and in metrics reflecting certain feeding groups. Cluster and ordination analysis revealed a number of distinct spatial groups. Whilst many taxon identified were distributed across groups, two key groups were distinguishable primarily based on the relative abundance of Gastropoda,</p>

				Decapoda (shrimp) and scraping Trichoptera in relation to filtering Diptera and Trichoptera. Considering the two groups separately revealed significant seasonal differences in community composition in group 1. Exploratory analysis suggests this to be due to changes in the abundance of Gastropoda, Odonata (dragon and damselflies) and Coleoptera (the latter also showed significant fluctuations in group 2), and in metrics reflecting feeding behaviour.
<b>3. Explore the relationship of environmental factors with macro-invertebrate communities</b>			X	Ordination analysis of reach scale environmental variables revealed similar spatial groupings confirming the importance of measured environmental variables in structuring the biological community. Of the measured variables a subset, reflecting the locally diverse lithology and its influence on water chemistry and substratum, were identified as significant in explaining biological community composition. Conductivity was the single most influential variable separating the two key biological groups. Sub-groups were further explained by substratum type (particularly bedrock, cobbles and gravel) and stream size.

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

Proposals to sample and assess multiple taxon groups were too ambitious given the challenges associated with undertaking such activities in Belize within limited timescales and budgets:

- 1 Staffing constraints and survey requirements presented difficulties in concurrent scheduling of ornithological and in-stream surveys. Team members with sufficient ornithological and freshwater expertise could not be available for all of the scheduled field surveys, resulting in patchy field data for ornithology.
- 2 Phytobenthos samples were collected concurrently with macro-invertebrate samples at each of the 21 field sites. It had been envisaged that a student would analyse these samples. However, such a student was not available within the time period of this project. Furthermore, phytobenthic samples require processing with equipment and expertise not widely available in Belize and it was thus decided to prioritise investigation of macro-invertebrate samples.

Following consideration of the points above, and given the extensive literature on the use of macro-invertebrate taxa for bio-assessment, the project focussed on new objectives necessary to progress the development to freshwater bio-monitoring and assessment tools in Belize: 1) Determine the spatial and temporal pattern of macro-invertebrate diversity and community structure in the watersheds of the Maya Mountain Marine Corridor and 2) Explore the relationship between environmental factors and macro-invertebrate communities.

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

**A. Increased understanding of local macro-invertebrate/environment relationships**

This project has provided key information regarding the importance of spatial and temporal environmental influences in structuring the community composition of macro-invertebrates within the watersheds of the study area. In particular it has highlighted the influence of natural features as a result of their affect on water chemistry and substratum. Understanding the nature and importance of natural influence is necessary before anthropogenic impact can be assessed. This is the first-time work of this kind has been undertaken with macro-invertebrates in Belize and provides evidence of local sensitivity to environmental factors, the potential usefulness of this taxon group for bio-monitoring and a strong foundation to direct its further development in the country.

**B. Increased taxonomic information.**

Previous surveys have recorded approx. 50 aquatic macro-invertebrate families in Belize. This survey recorded at least 71 family groups. These records include taxa previously unrecorded in the country and infrequently observed in the wider region (e.g. *Plectromacronema* sp.) and at least one taxa believed new to science: Juvenile Naucoridae (water bugs) resembling a subfamily uncommon in the Neotropics, and with features unique therein, were collected during this survey. Specimens are currently being analysed by a Hemipteran specialist. If and when appropriate the specimens will be described in the appropriate literature.

All taxonomic material collected during this project has been preserved and will continue to be analysed to obtain information at finer taxonomic resolution and contribute to a reference collection held in Belize.

**C. Increased Capacity for local freshwater bio-assessment.**

A core team of five staff from the Ya'axche Conservation Trust have received dedicated and experiential training in freshwater monitoring (biological and physicochemical), sample processing to a quality-controlled standard (macro-invertebrates) and beginner macro-invertebrate taxonomy. As a direct result of their experience the team proposed to continue their training and are currently collecting and analysing macro-invertebrate samples from a subset of the 21 sites on a regular basis, to further enhance understanding of seasonal variation and to progress their survey and taxonomy skills.

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

This project was undertaken in partnership with the Ya'axche Conservation Trust – a local community-oriented NGO. Staff involved with this project living in the rural communities of the MMMC have benefitted from the training and experience received which has enabled them to develop technical skills and expertise lacking locally.

A closely related study has involved ethnographic work with one community to explore locally held knowledge about rivers and water, providing valuable insight into culturally distinct human/environment relationships. It is hoped these two studies can inform each other to direct biologically robust and culturally sensitive watershed management in the future.

**5. Are there any plans to continue this work?**

It is intended to further explore spatial biological groupings in order that preliminary biological benchmarks can be characterised for different river typologies against which river condition can be assessed.

Currently held and newly collected taxonomic material will continue to be assessed with the intention of expanding knowledge of aquatic biodiversity and producing a locally meaningful macro-invertebrate identification guide.

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

Results will be discussed with interested associations in the UK (e.g. Freshwater Biological Association, Fauna and Flora International) during 2011.

Results will be presented to Ya'axche, interested Belizean conservation groups and local communities in January 2012, and shared with the University of Belize through the 'Field Methods' module of the Natural Resource Management Program.

Results will be shared with academia through journal publication and presentation at local (Belize and UK) and international conferences (e.g. Macroinvertebrados de agua dulce: su importancia en los ríos tropicales, being held in Costa Rica in February 2012).

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

The RSG grant was utilised in the field and laboratory as anticipated between March 2010 and April 2011. The wider project is due for completion in 2013. Reporting has been delayed whilst taxonomic identifications have been explored and verifications sought.

**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
Research Support (Ranger assistants) field	3450	3390	+60	There was a slightly lower resource requirement than expected due to the change in survey priorities
Operational Support –				
Utilities	937.50	1135.07	-197.57	Fuel costs for power generation were higher than expected. Due the unreliability of a local solar system it was necessary to purchase more fuel to guarantee power for lights and microscope work. Additionally, the opportunity arose to modify the field station to construct a basic wet laboratory. Funds from the utilities and the equipment line contributed
Permits	125	125	0	
Shipping	112.50	117.19	-4.69	

				to this.
Equipment	1360	1398.42	-38.42	
<b>Total</b>	5985	<b>6165.68</b>	-180.68	

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

Steps required before biological monitoring of rivers in the study area can be progressed include:

- a) Further exploration of preliminary findings to characterise aquatic biological benchmarks against which river condition can be assessed.
- b) Continued expansion of taxonomic knowledge and the related skill base locally.
- c) Developed partnerships with interested parties.

**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 press releases in Belize related to the project and on poster and PowerPoint presentations made in the UK and Belize. The RSGF will be acknowledged in forthcoming publications and presentations.

**11. Any other comments?**

This project represents a key step in facilitating river conservation in Belize, has contributed to the development of local capacity to monitor rivers and revealed important taxonomic information. This would not have been possible without the support of the RSGF, for which we are extremely grateful.