Final Evaluation Report

Your Details	
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Project Title	Fish Community structure and its function in an aquatic hot spot Mexican Subtropical Lake
Application ID	29446-1
Grant Amount	6,000 £
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1. 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
Evaluate the fish structure fish in the Lake				The fish community of the lake was evaluated through field sampling for 2 years, the evaluation was completed, and a scientific article was written and sent to a scientific journal for its possible publication.
Make the limnological characterization of the lake				The limnological characterisation was evaluated over 2 years at the lake; the data was used in the evaluation of the biological communities.
Evaluate the trophic ecology of the species				The diet and trophic structure of species in the lake was evaluated, and a scientific article is in draft, it will send for publication when it is ready.
Evaluate the dynamics of the communities (invertebrates, phytoplankton, zooplankton, and fish)				The communities of the food web of the lake were evaluated and the results are used in the general characterisation of the lake.
Compare the previous and current populations in the lake				The fish community was evaluated and compared with the historical data of the lake; a scientific paper was sent for publication.
Evaluate the reproduction aspects of the species of the lake				The reproduction of the viviparous species of the lake was evaluated, and a scientific article was published. Also, one bachelor thesis was created by a student about the reproduction of one ovoviviparous species from the lake.
Establish an environmental education program in Zacapu city				Local actors have been identified in the Zacapu area. Diagnoses were carried out in conjunction with environment secretary from the state and the municipal ecology secretary to see the environmental education actions that have been developed at the state level around Lake Zacapu. A series of meetings have been held with

				different local actors and the government to work in the agenda for 2022 and 2023.
Zacapu Lake, diagnosis of the socio-environmental perception				The lack of knowledge of the people about the species of the lake and the resources has been detected, we created illustrated guides with the taxonomic groups of the lake. We are going to carry out a series of workshops with local actors and the citizens, to determine the problems of the lake and determine the actions to establish a medium and long-term action plan, in conjunction with the oriented to the direction of ecology of the municipality. All this information will be part of the management plan of the lake.

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

We had difficulties in the environmental education part, unfortunately in Mexico the Covid 19 pandemic began in March 2020, and until now it continues with many restrictions. However, we are trying to work using all the possible media, as online meetings.

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

1. We determined the temporal variation (seasons and decades) in the fish community structure in terms of composition, abundance, diversity, and dominance and sought the patterns of association between the species and water quality. Our results showed spatial homogeneity of most physicochemical variables and they remained in the same range after decades, but some nutrients increased recently (NO_3). All species that were detected in early samples remained present in the recent surveys (11 native and two non-native species), indicating that the fish community composition had significant qualitative stability. However, the diversity and abundance of sensible fish decreased in recent samplings. Consequently, the current status of critically endangered species is supported by some restricted and micro-endemic fish.

2. We conducted a comprehensive investigation to evaluate the annual reproductive cycle of viviparous fish species (goodeines; splitfins), and the diet of the fish community and its trophic structure. Our result shows that populations of goodeines presented different tactics (fertility rates, sex ratio, reproductive period) and strategies (viviparity-matrotrophy) favour reproductive success in this environmentally stable subtropical lake in the highlands of Mexico. The diet of the fish consisted mainly of aquatic

macroinvertebrates and most of the species were positioned as secondary consumers, being mainly trophic generalists. Our results suggest a higher position of native species in terms of spatial trophic niche and niche width conservation of Lake Zacapu as adaptative centre for fished and other groups, as a system with water regulation thought the lake, and as important resource for human communities.

3. Diagnoses were carried out with the state environment secretary (municipally and statal) to detect all the environmental education actions that have been developed around Lake Zacapu. A series of meetings have been held with different local actors and the government to generate the agenda for 2022 and 2023. Based on the results of these diagnoses, we are going to carry out a series of workshops with local actors and citizen to determine the problems of the lake and determine the actions to establish a medium and long-term action plan, with this strategy will be useful for the management plan of the lake. Studies of the perception of the habitants of Zacapu were carried out through surveys. The crowed areas for visitors of the lake were detected, to develop workshops in that location. An environmental workshop will be held on 3rd and 4th June 2022, to show the lake as a centre of biodiversity. Artistic and scientific workshops, training will be carried out for the participants. Murals will be created through citizen participation. Finally, the Secretary of the Environment is reviewing the current situation of the management plan to later start updating it, with the information that we have generated (in the social part and the scientific part) we are going to collaborate and participate in updating the management plan of the lake.

4. What do you consider to be the most significant achievement of this work?

5. Briefly describe the involvement of local communities and how they have benefitted from the project.

The local fisherman of lake Zacapu were collaborating in all the field sampling as well as the Government of Zacapu.

The secretary of the environment at the state level is reviewing the current situation of the management plan, which is a complex and time-consuming process. Once the current situation is established, the update will begin. With the information that we have generated, we will collaborate and participate in updating it.

An environmental workshop will be on 3rd and 4th June 2022 to show the lake as a centre of biodiversity. Artistic and scientific workshops will be presented and we are going to train the participants of the workshops to focus on the native fauna and flora of the lake. Also, murals will be created through citizen participation around the Zacapu city.

6. Are there any plans to continue this work?

Yes, we are planning to continue this project, especially with the part of environmental education and dissemination of knowledge to the citizens of Zacapu,

including children and adults and the updating of the management plan of the lake.

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

We published a paper in the scientific journal (Neotropical Ichthyology), we have another submitted to Ecology freshwater fish, and a third article is in draft. In addition, we have published four articles in national and international magazines. We created illustrated guides of taxonomic groups of the lake. All the documents are attached in the email.

We created a web page so that anyone can consult our generated information, link: https://bioumich.wixsite.com/proyectozacapu

We have participated with conferences in national and international congresses, just to mention some of them:

- Conference "Conservation of native fish of Central Mexico" in the framework of the summer course PAUTA (Adopt a Talent Program). Institute of Nuclear Sciences, UNAM. Mexico City. Date July 2020.

- Conference "Native and endemic species of a small lake in Central Mexico" at the virtual meeting of the international Goodeid Working Group, in celebration of the International Day for Biological Diversity. Online modality. Date May 2021

- Conference "A hotspot in Central Mexico, Laguna de Zacapu Natural Protected Area", held at the online event "Celebration of Natural Protected Areas in Latin America and the Caribbean". Date October 2020

- Oral presentation in Virtual meeting Dialogues on Ecology: facing the challenges of global change: lessons, advances, and opportunities. Participated with two investigations in oral presentations, online mode. Date April 2021.

- Oral presentation in VII National Congress of Native Fauna in Anthropized Environments, through the Biology, Management and Conservation of Native Fauna in Anthropized Environments Thematic Network and the Mexican Scientific Society of Ecology. Online. Date September 2021

- Oral presentation in the V Congress of Macroinvertebrates and Aquatic Ecosystems. In Panama. Online. Date October 2021

In addition, the information generate with this study will be imparted through conferences and workshops to the citizens of Zacapu. The Secretary of the Environment is reviewing the current situation of the management, with the information that we have generated, we are going to collaborate and participate in updating it.

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

The grant was used since January 2020 to December 2021. The planned objectives were achieved from the subsidy granted. And we are still working on the environmental education activities and the updating of the management plan of the lake.

9. Budget: 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. It is important that you retain the management accounts and all paid invoices relating to the project for at least 2 years as these may be required for inspection at our discretion. Average exchange rate: 1 sterling pound = 27.59 Mexican pesos.

Item	Budgeted Amount	Actual Amount	Difference	Comments
Laboratory material: formalin, analytic balance, test tube rack, petri dish, agate mortar	1500	1500		
Environmental education materials supplies (sheets, copies, markers, Scotch tape, scissors, coloured pencils)	1000	500	-500	
Stables isotopes/ analysis: sample to isotope stable, 800 samples	2000	2000		
Nets and traps (Chinchorro net 25 meters) 5 Traps naza type	500	500		
Transportation to the field work. Fuel for Field Truck	1000	1000		
Sub-total	**6000**	**5500**	**-500**	
Stable isotopes/materials: Microtube Type Eppendorf Pcr 0.5 Ml Pq C / 1000		50		paid with another grant
Laboratory materials 500 blank Microscope Slides + 1000 square cover slips		300		paid with another grant
Translations, publication fees		1500		paid with another grant
3 Vadeador		360		paid with another grant
5 fishermen per day, three days per campaign, 4 campaigns per year.		1800		paid with another grant
TOTAL	**6000**	**9510**	**+3510**	

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

The next steps are to continue with the work of environmental education in order to establish a sustainable local group that can take charge of the long-term environmental agenda, as well as protecting the lake and its species.

Contribute and participate with our information to the update of the management plan of the lake, to be conserved the lake in the long term.

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

Yes, we used the logo in all the national and international conferences, divulgation material and acknowledgment in all the paper published.

Papers and material published are attached to this email.

12. Please provide a full list of all the members of your team and briefly what was their role in the project.

Arely Ramírez García: leader of the project, coordinate the field work, laboratory analysis, statistics analysis, conceptualization, funding acquisition, investigation, methodology, project administration, resources, Software, supervision, validation, visualization, writing-original papers, writing-review and editing papers.

Omar Domínguez Domínguez: adviser of the project, supervision the field work, conceptualization, funding acquisition, investigation, methodology, project administration, resources, validation, visualization, writing-original papers, writing-review and editing papers.

Rodrigo Moncayo Estrada: adviser of the project, supervision the field work, conceptualization, statistics analysis, investigation, methodology, validation, visualization, writing-original papers, writing-review and editing papers.

Federico Hernandez Valencia, and **Martín Mejía,** both environmental educator researchers, are designing the strategy for environmental education plan, including the workshops, all this together with the supervision of Paul Bamford from Chester Zoo (England).

The local fisherman from Zacapu, collaborated in the field work.

Government from Zacapu, gave us the permission to do the field work in the area.
All the local actors and the different secretaries of government of the municipally and state level who participated in the education program and environmental strategy.

13. Any other comments?