Final Evaluation Report

Your Details	
Full Name	Laia Juliana Muñoz Abril
Project Title	Identifying the role of the Galapagos Marine Reserve in the tunas population from the Eastern Pacific Ocean
Application ID	40344-B
Date of this Report	24-06-2024

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
To provide accurate information about the population structure, movement patterns, mixing, and nursery areas			x	The project was successful, and the unexpected results are an important key to suggesting management regulations that promote tuna conservation

2. Describe the three most important outcomes of your project.

a) The microchemical signatures of Colombian yellowfin tuna were determined to show differences from equatorial waters (Galapagos Islands and equatorial waters). Likewise, the results suggested three possible origins of the tuna sampled (equatorial waters, Colombia and Mexico). This indicates that oceanographic conditions like currents, upwellings, winds, eddies, and rainfall likely influence these variations. While these changes are small, they give considerable insight into the environmental forces that determine a slight population differentiation and ecological dynamics. This may prompt consideration of stock assessments to avoid erroneous assumptions.

b) The current study's reporting was useful in filling the knowledge gap of spawning areas in the equatorial region. According to the last study and assessments (Schaefer and Fuller, 2022), the information about tuna spawning areas was unknown. Our results suggest the importance of the equatorial waters in tuna reproduction and its contribution to the tuna stock from the Eastern Pacific Ocean. Analysing the growth and reproduction of tunas is crucial for understanding their life history characteristics and population demographics (Schaefer 2001). Richards' model, described in the best way, revealed a biphasic growth pattern with two growth phases. The length at which 50% of the population (in the yellowfin tuna case) attains maturity (L50) was 102 cm. It was also observed that the spawning season occurs between November and January. This information is particularly useful in reproductive biology and management to point out specific critical periods or locations regarding conservation efforts.

c). The present study has shown that the Eastern Pacific Ocean yellowfin tuna population is a single stock with less genetic diversity, mainly between Colombian waters and the other study regions (equator and Mexico), through an analysis of single nucleotide polymorphism (SNP). Less diversity within a fish population often indicates reduced connectivity among different subpopulations.

3. Explain any unforeseen difficulties that arose during the project and how these were tackled.

Initially, the project encountered an unforeseen overhead cost due to the university's funding restrictions. This overhead amounted to $1,016 USD, which was initially designated for other expenses. However, I obtained an additional grant through the Smithsonian Institution, allowing us to proceed with our experimental design and analyses without any modifications.

4. Describe the involvement of local communities and how they have benefitted from the project.

The community was integrally involved throughout the project, with all samples derived from fishery-dependent surveys. Local fishermen were actively engaged, acquiring skills in otolith extraction and participating in educational workshops. These workshops emphasised the critical role of fisheries science in sustainable management, highlighting the importance of identifying spawning areas, understanding population growth patterns, and maintaining regional connectivity to prevent overfishing.

The educational benefits to the community were substantial, fostering an appreciation for the role of scientific data in management plans. In regions like the Galapagos, prolonged collaborative efforts have equipped local stakeholders with the tools to initiate their management strategies.

Cross-national collaboration facilitated mutual learning, as exemplified by interactions between Colombian and Ecuadorian communities. While fisheries research in Colombia is less developed than in Ecuador, this partnership has accelerated the recognition of fisheries science's importance in Colombia, promoting the exchange of knowledge and experiences to address shared challenges effectively.

5. Are there any plans to continue this work?

Absolutely, the plan is to extend this research, which has had a remarkable beginning and yielded significant results for the tunas across the Eastern Pacific Ocean. The ongoing work will address new research questions that emerged from our initial analyses, ensuring continued progress in understanding and managing tuna populations.

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

We have been conducting workshops with local communities to communicate the results in Spanish, ensuring thorough understanding. For government stakeholders, we are organising workshops and meetings to present our findings and propose management strategies based on our results. Additionally, we will disseminate our

findings to the scientific community through a research paper and presentations at scientific conferences. Part of the results were already presented at the World Fisheries Congress 2024.

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

With the current research results, we aim to address two key questions. The first question concerns establishing the baseline geochemistry in each area of the Eastern Pacific Ocean. To achieve this, we will conduct sampling and geochemistry analyses focused on fish under 40 cm in length, likely near their natal spawning areas.

The second question involves identifying tuna spawning areas in Colombia by supporting geochemical analyses with histological examinations and comparing these findings with histological data from equatorial waters.

Lastly, we will initiate a tagging programme in Colombia to understand why the population prefers Colombian waters.

8. 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, I used the foundation's logo in all my presentations during the workshops and at scientific conferences.

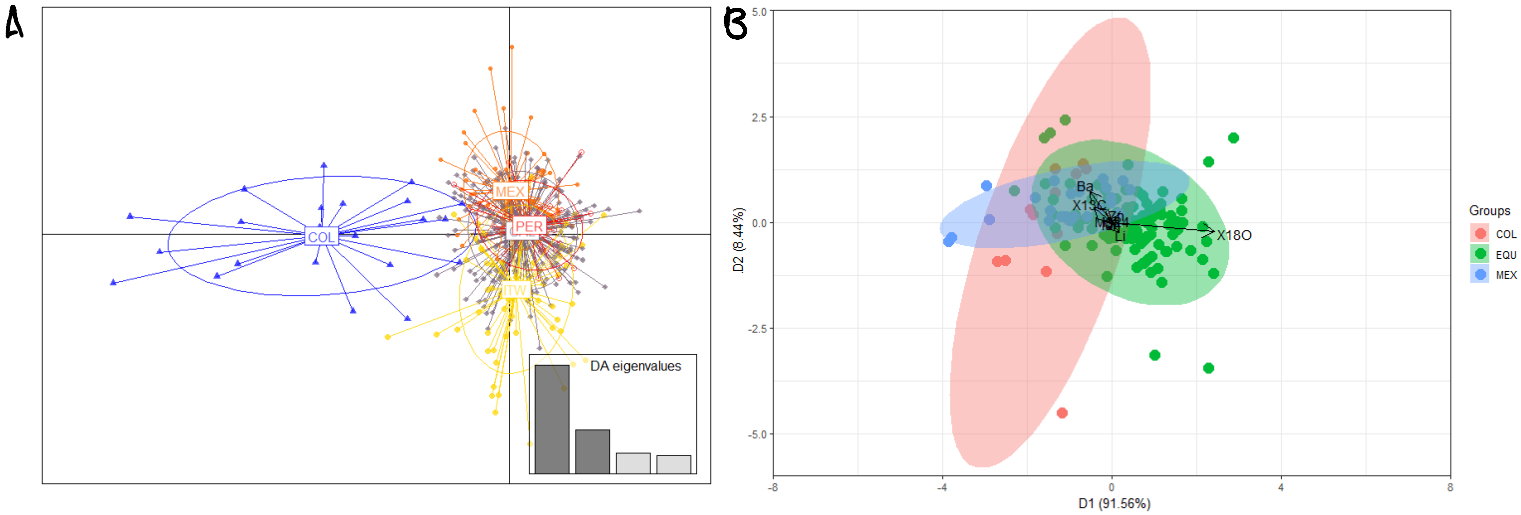
9. Provide a full list of all the members of your team and their role in the project.

Steve Canty: Experimental design, result analyses, and conceptualization.
Barbara Block: Experimental design, result analyses, and conceptualization.
Jay Rooker: Experimental design and result analyses.
Michelle Sluis: Experimental design and result analyses.
Nancy Brown-Peterson: Reproduction analyses.
Pilar Solis: Fieldwork coordination in Ecuador and bridge with equatorial government.
Ashley Pacicco: Growth Analyses
Sean Powers: Results conceptualization and funding search.
Alex Hearn: Results conceptualization

10. Any other comments?

I would like to extend my heartfelt thanks to The Rufford Foundation for its unwavering support. Our new findings are crucial for the conservation of tuna populations, and The Rufford Foundation has been a key sponsor contributing to the development of this research since I received my first Rufford grant.

The following figure resumes one of the most important results of this research.



A. Discriminant Analysis of Principal Components of yellowfin tuna within the Eastern Pacific Ocean and the Gulf of Mexico, using 10 531 markers grouping samples by sampling site. Colombia (n = 22)(COL), Galápagos Islands (n = 209)(GAL), Ecuador, Peru (n = 31)(PER), International Waters (n = 69)(ITW), and the Gulf of Mexico (n=5)(GOM).

B Quadratic discriminant analyses otolith element: Ca concentrations and $\delta_{13}C$ and $\delta_{18}O$ of yellow-fin tuna (*Thunnus albacares*) captured in the Eastern Pacific Ocean. Regions are denoted as COL (Colombia), GAL (Galapagos), GOM (Gulf of Mexico), INT (International Waters), MEX (Mexico), and YOY