

## Final Evaluation Report

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Your Details	
<b>Full Name</b>	Dalia Carolina Barragán Barrera
<b>Project Title</b>	Studying the physiological response of bottlenose dolphins to anthropogenic stressors related to boat traffic in the Archipelago of Bocas del Toro, Panama.
<b>Application ID</b>	29151-C
<b>Date of this Report</b>	September 11 <sup>th</sup> , 2023

**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
<p>Conduct outreach activities in different local Institutions for engaging local stakeholders in management steps.</p>				<p>Several outreach activities have been conducted in Bocas del Toro under the frame of this project. Therefore, for this last subvention, outreach activities were conducted mainly with stakeholders in Panama City. Some talks were conducted with Panamanian students from Universidad Marítima Internacional de Panamá, to engage more local students in studying the bottlenose dolphin population from Bocas del Toro. Additionally, the most important outreach activity was conducted with the Ministerio de Ambiente de Panamá (Panamanian Environmental Ministry), in which we presented to officials the scientific data that the Panacetacea team, led by Dr. Laura May-Collado, have collected during last 15 years about biological, ecological, genetic, and conservation status of bottlenose dolphins in Bocas del Toro. This meeting has been the key to government is still discussing the possibility of extending the local marine protected area to Dolphin Bay, where the resident bottlenose dolphin population is concentrated.</p>
<p>Quantify the concentration of the stress hormone cortisol on individuals of the bottlenose dolphin population from the Bocas del Toro Archipelago, Panama.</p>				<p>Two stress hormones (cortisol and corticosterone), as well as two reproductive ones (progesterone and testosterone), have been successfully quantified in blubber samples of bottlenose dolphins from Bocas del Toro. The hormones were modelled in relation to site, reproductive status, time of day, and tourism season with the goal of assessing metabolic and reproductive steroid hormones differences between two populations living in areas with different levels of boat traffic (Bocas del Toro (high boat traffic) vs Cayo Zapatilla and Chiriqui Lagoon (low boat traffic)). In general, findings showed that although stress</p>

			hormones increase in the area with high traffic, reproductive hormones did not appear to be affected. Currently, a manuscript is being prepared with these results, which are very relevant for conservation of this bottlenose dolphin population, since we are providing evidence that dolphins in Bocas del Toro are suffering stress in relation to the high tourist-boat traffic.
As a contingency measure derived of COVID-19, a passive acoustic monitoring was conducted in the Archipelago of Bocas del Toro before and during lockdowns, in order to assess dolphin stress level based on the hypothesis that dolphins increase in whistle frequency modulation as an indicator of stress.			The COVID-19 lockdown resulted in the closing of tourism infrastructure and limited mobility in both land and coastal areas. This “natural experiment” was used as an opportunity to study the impact of tour-boat activities on dolphin communication in the Bocas del Toro Archipelago. Therefore, we requested permission to the authorities to go and install a hydrophone in three different sites in the archipelago in July and September 2020 to evaluate the soundscape and dolphin's vocalisation in the absence or reduced ambient noise. During the lockdown, dolphin whistles were longer in duration and less modulated than pre-lockdown, which means that effectively boat traffic is affecting dolphin communication. This study, which was published in <i>Frontiers in Remote Sensing</i> ( <a href="https://doi.org/10.3389/frsen.2022.934608">https://doi.org/10.3389/frsen.2022.934608</a> ), was a result of a contingency plan to determine successfully the previous goal related to assess stress in dolphins.
Study the degree of Inbreeding on individuals of the bottlenose dolphin population from the Bocas del Toro Archipelago, Panama.			By July 2022, we have collected 102 samples from bottlenose dolphins in Bocas del Toro using the RSG funds. Currently, microsatellite analyses have been conducted on around 75% of samples, and remaining analyses are currently ongoing. Because COVID-19 lockdown and restrictions, laboratory analyses have been delayed. Additionally, we have found a high inbreeding among individuals, we have repeated some analyses several times and included more microsatellite loci. For this reason, laboratory work is currently ongoing, and kinship analyses will be conducted soon.

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

**a). Community outreach:** Involvement of local communities during this project has been crucial for its success. For this reason, in this last grant we focused more on the main stakeholder, the Ministerio de Ambiente de Panamá (Panamanian Environmental Ministry). Thus, the most important outreach activity was conducted with this ministry, since they are discussing the possibility of extending the local Marine Protected Area until Dolphin Bay, where the resident bottlenose dolphin population is concentrated. For this, ministry officials needed the scientific data about conservation status of bottlenose dolphins in Bocas del Toro, in order they can present evidence to demonstrate the vulnerability of this population, and we presented these data to them. Thus, scientific data that we have generated with RSG support, has been the key to conserve the bottlenose dolphin population in Bocas del Toro.

**b). Hormone analyses:** We provided evidence that high boat traffic is impacting on stress of bottlenose dolphins in Bocas del Toro through hormones concentration, since cortisol and corticosterone (stress hormones) in dolphins are high in areas with high boat traffic. Although stress can affect dolphin reproductive success, we didn't find evidence that suggest reproductive hormones (progesterone and testosterone) were affected by boat traffic. Despite of this, our findings are very relevant for conservation of this bottlenose dolphin population, since we are providing evidence that dolphins are suffering stress in relation to the high tourist-boats traffic in Bocas del Toro.

**c). Acoustic environment:** As a contingency measure of COVID-19 lockdown, we also provided evidence that boat traffic in Bocas del Toro change the environmental noise levels, which affect dolphin communication, since they have to change their acoustic structure and diversity. Thus, during lockdown (with no boat traffic), the environment was quieter, and dolphin sounds were more frequent, as well as their whistle repertoire being more diverse. Thus, in a noisy environment due to non-regulated boat traffic, dolphins are affecting their communication signals, which may affect dolphin health. We really expect our findings, which were published in the *Frontiers in Remote Sensing Journal* (<https://doi.org/10.3389/frsen.2022.934608>), will help to local stakeholders as the needed evidence that support the importance of mitigating noise by regulating boat traffic within the Archipelago, mainly in Dolphin Bay where dolphin-watching activities are concentrated.

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

The main difficulty was related with COVID-19 lockdown. Initially, we had planned to conduct two fieldtrips, but unfortunately, the first one was made a couple of days before COVID-19 was detected in Panama. For this reason, trip had to be cancelled. However, because we wanted to assess the stress level on dolphins related to noise generated by boat traffic, we found the COVID-19 lockdown as a “natural experiment” to assess how acoustic environment affects dolphin communication. Therefore, we decided to use some RSG funds to conduct one

short fieldwork to install a hydrophone to record noise within the Archipelago. For this, we had to request permission to Panamanian Government, and we were supported by local researchers. Later, the hydrophone was picked up but for this, other funds were used. Thus, we used RSG funds to cover some expenses for this acoustic monitoring, and we conducted only one fieldtrip to collect more dolphins' samples.

The COVID-19 lockdown also affected our lab work, since we couldn't access to the laboratory even after lockdown finished, due the laboratory-maintained access restrictions for several months. For this reason, once we could access to the laboratory, we tried to optimise the work to get some results. However, despite we collected new samples, the individuals inbreeding detected was high, so we had to conduct several repetitions. For this reason, microsatellite analyses are still ongoing.

Similarly, the COVID-19 affected the mail shipping of dolphins' blubber samples to the endocrinology laboratory of the University of Alaska Fairbanks, Juneau Center, where hormonal analyses were conducted. For this reason, we requested permission to Smithsonian (STRI) during COVID-19 lockdown to storage the samples in a -80 fridge, while mail service was later reactivated.

Despite of all these issues derived COVID-19, we finally could achieve the main goals of this project, and even we found an opportunity to assess how noise is affecting dolphin communication. At the end, all our results together are providing the evidence needed to demonstrate that noise derived of boat traffic is affecting and stressing to dolphins in Bocas del Toro.

#### **4. Describe the involvement of local communities and how they have benefited from the project.**

Involvement of local community for successfully dolphin conservation in the Bocas del Toro Archipelago is one of the most important outcomes of our project. A long-term plan has been established with the local NGO Panacetacea as well as with the local College, Universidad Marítima Internacional de Panamá, so Panamanian students are involving in research in Bocas del Toro. Additionally, local dolphin-watching operators have shown their concern about the dolphin situation, so they have participated actively in meetings to regulate the tourism in the archipelago. And the most relevant outcome in our outreach activities have been the involvement of Environmental Ministry, since they are the authority in charge of extending the Marine Protected Area until Dolphin Bay, where the resident bottlenose dolphin population is concentrated. Although the ministry is still discussing this extension with local communities, their involvement as a link in this project has been crucial to guarantee dolphins conservation through local communities' involvement.

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

Absolutely! To date, we have achieved several scientific and conservation outcomes, but our previous findings have generated new questions to address in relation to biology and conservation status of this bottlenose dolphin population.

However, one of my main goals when we started this project was involving Panamanian students and researchers in this project. For this reason, dolphin monitoring will continue with students enrolled with local institutions (e.g., Universidad Marítima Internacional de Panamá, NGO Panacetacea). In my particular case, I am preparing a proposal to apply several Postdocs calls in order we can continue with kinship analyses as well as other social studies like male-alliances, which can be conducted with both genetic and photo-ID data already collected. Thus, we expect to still generate biological, ecological, and conservation data about these dolphins with data that we already collected thanks to previous RSG support.

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

The main source to share our results have been the outreach activities with local communities and stakeholders, which is a mandatory activity in our project since we started. Additionally, we have presented our findings in scientific events like International and local Congress (e.g., the 2nd World Marine Mammal Science Conference (Barcelona, Spain), the Primer Congreso Centroamericano de Cetáceos (Panama City, Panama), the Rufford Small Grant Conference 2020 (La Paz, Baja California), and 24th Biennial Conference on the Biology of Marine Mammals (Miami, FL, USA)). Furthermore, a manuscript in which evidence about how boat traffic is affecting dolphin communication through acoustic monitoring during COVID-19 lockdown was published in the *Frontiers in Remote Sensing Journal* (<https://doi.org/10.3389/frsen.2022.934608>). Additionally, a manuscript about how boat traffic appears to increase stress hormones in dolphins has been currently in preparation.

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

Despite generating data to demonstrate how boat traffic is affecting dolphin communication and is generating stress on individuals, we recognise that we need to generate abundance data to establish if population has increase or not in order to IUCN and local government change the conservation status of this population. Therefore, next steps within the archipelago include maintaining the long-term monitoring with students to generate more biological information that include:

- Population estimation to assess number of individuals present in Bocas del Toro.
- Reproductive parameters to determine reproductive success and calf mortality in Bocas del Toro.
- Finally, maintaining good links with Environmental Ministry in order they can extend the Marine Protected Area to Dolphin Bay, where dolphins are concentrated.

#### **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?**

The RF logo was displayed in all presentations that we have showed to local stakeholders. Furthermore, the RF logo was posted in our social media. The logo was

also displayed in poster and oral presentations in four scientific events: the 2nd World Marine Mammal Science Conference (Barcelona, Spain), the Primer Congreso Centroamericano de Cetáceos (Panama City, Panama), the Rufford Small Grant Conference 2020 (La Paz, Baja California), and 24th Biennial Conference on the Biology of Marine Mammals (Miami, FL, USA). Additionally, the RSG was mentioned in the acknowledgment sections of the manuscript "Dolphin communication during widespread systematic noise reduction-a natural experiment amid COVID-19 lockdowns" published on August 17, 2022, in the Frontiers in Remote Sensing journal, as well as in manuscripts that we are currently preparing.

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

**Dalia C. Barragán-Barrera.** I was working in the field collecting data and lab work. My role in the project was focused on conducting genetic and parental analyses.

**Betzi Pérez-Ortega.** She worked in the field collecting dolphins' samples. She also established links with Environmental Ministry and local Universities to conduct talks and outreach activities. Additionally, she conducted hormone analyses, and participated in the acoustic monitoring during COVID-19 lockdown.

**Chelina Batista.** Although she was not included in our initial proposal, she supported us actively collecting data in the field trips, particularly during COVID-19 lockdown.

**Emma Gagne.** Although she was not included in our initial proposal, she supported us actively collecting data in the field trips and analysing acoustic data.

**Manali Rege Colt.** Although she was not included in our initial proposal, she supported us actively collecting data in the field trips and analysing acoustic data.

**Demetrio Georget and Rene Georget.** Although they were not included in our initial proposal, their support as boat captains is very important to collect samples and in the acoustic monitoring during COVID-19 lockdown, since they have a lot of experience working with dolphins.

#### **10. Any other comments?**

As I mentioned in previous reports, the support that generously the Rufford Small Grants has allowed the generation of relevant data for conservation of bottlenose dolphins in the Bocas del Toro Archipelago in Panama. Therefore, we are really grateful for all the support and confidence that the RSG board committee has given us to achieve the most important outcomes in our project. We really appreciate your support in conservation projects in developing countries, since you are contributing to conservation of many species and ecosystems in our continent, and also you are empowering young Latin American researchers to follow their careers and promote conservation issues in developing countries. ¡Gracias Totales! 😊



