Final Evaluation Report

Your Details	
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Project Title	Advancing conservation of Elasmoblanchs, rays and management of future supply chain disruptions caused by outbreaks of the pandemic diseases
Application ID	35423-2
Date of this Report	20/12/2022

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 assess the current genetic status of ray fish from different landing sites along the Tanzania mainland and Zanzibar coastal line			■	In total, 114 samples from the ray species *Pateobatis Jenknsii*, *Himantura gerrardi*, *Himantura fai*, and *Bathytoshia centroura* were sequenced. The *H. gerrardi* ray species was the most abundant on the Tanzanian fish landing sites. This species is designated by IUCN as Endangered. The IUCN Red List of Threatened Species for the other studied species indicates that they are all Vulnerable. A population genetic structure analysis was carried out for the species *H. gerrardi*. According to the results, there is limited gene flow between fish from Mafia and Tanga, Dar es Salaam, Mtwara, and Unguja. Mafia Island subpopulation had the largest genetic diversity and Unguja Island subpopulation had the lowest. The samples taken at Tanga had the largest effective population size, but those taken at Mtwara had the lowest.
To Identify the obstacles that COVID-19 has caused to important fisheries value chain nodes			■	Social survey results show that the COVID-19 had little effect on fishing activity, fish landings, and revenue. The COVID-19 had also little impact on market disruptions. It did lead into little increased health risk for fisher's communities, illegal, unreported and unregulated fishing. Because some fishermen were warring of social interaction, fishing efforts slightly decreased. This presented a challenge because a certain number of people had to cooperate to set up fish nets in the water and haul them in with fish aboard the fishing vessel. Therefore, the decreased efforts brought on by COVID-19 also resulted in decreased fisheries and income. However, records show that COVID-19 had small impact because Tanzania's Government did not impose a

				lockdown, allowing fishing operations to continue. Fishermen just needed to abide by the rules that had been established, such as avoiding crowded areas, routinely washing their hands, and using hand sanitiser. According to the fishermen and traders, the fish supply chains would have suffered if the government had imposed a lockdown during which no one was allowed to go outside of their base area. Additionally, it would be challenging to obtain enough fish, which would have resulted in lower income.

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

a) The research project has resulted in increased awareness among the local community on the importance of gene flow between and among subpopulations of a ray fish species. However, the knowledge on the importance of genetic diversity and effective population size of a ray species among the fisher's communities has been enhanced**.**

b) This is the first time that the genetic structure of *Himantura gerrardi* along Tanzania's mainland and Zanzibar Island to be reported. The genetic makeup of the *H. gerrardi* ray along Tanzania's western Indian Ocean coastline has never been documented. The results show that there is less genetic exchange across the groups, and the mafia subpopulation is distinct from others due to its high genetic diversity. This suggests that this subpopulation should be managed as a single stock. Unguja Island subpopulation had the lowest genetic diversity compared to other subpopulations studied, which indicates the necessity for conservation efforts to protect this unique stock that could be threatened by environmental changes. Although there is reduced gene flow, the Mafia, Mtwara, Tanga, Dar es Salaam, and Unguja subpopulations are still genetically connected (See Fig. 1). A manuscript that will be submitted to the international journal for publication is now being prepared. When making plans for conservation of the endangered ray fish species along the western Indian Ocean, the scientific community will find the publication to be helpful. The outcomes will include improved livelihoods, increased awareness, and improved ecosystem management capacity.

Based on *Pateobatis jenknsii's* Vulnerable (Matsumoto et al. 2020) and *H. gerrardi's* Endangered status (Sherman 2020) on the IUCN Red List of Threatened Species, we anticipated that *P. jenknsii* would be more abundant on fish landing sites. The *P. jenknsii* and other ray fish, which are also included on the IUCN Red List of Threatened Species as Vulnerable (Carlson et al. 2020; Matsumoto et al 2016), were found to be scarce in comparison to the *H. gerrardi*. This may indicate the need for a new evaluation of these species to determine whether

their ICUN red list status has altered or remained the same because of on-going conservation activities that may have aided in population recovery.

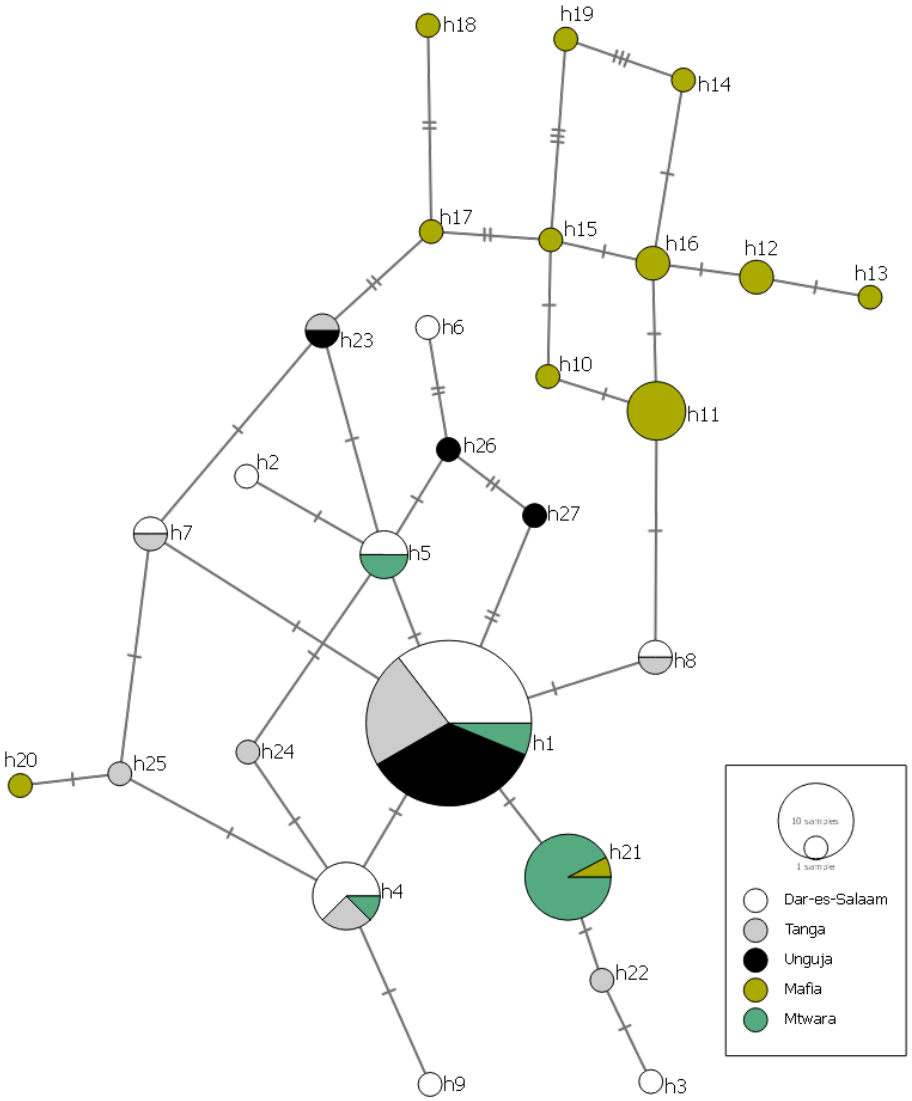

Figure 1: The haplotype distribution of *Himantura gerrardi* shows a simple spinning network based on the cytochrome oxidase subunit I sequences. The haplotype network displays the percentage of haplotypes from Dar es Salaam (white), Tanga (grey), Unguja (black), Mafia (yellow), and Mtwara (green) subpopulations. The large haplotype consists of 48 individuals in total (h1). The size of the other circles corresponds to the number of individuals, as indicated by the numbers in the bottom right of the haplotype network.

c. With the help of this research project, people will have a better understanding of how to make decisions when faced with pandemic diseases. The Government of Tanzania decided against imposing complete lockdowns, allowing fishermen to continue their work. Because fishermen could still acquire ray fish in the landing sites and marketplaces, the impact of COVID-19 had no strong negative

effects on the supply chain of rays and other fish species. This suggests that it may be wise to make judgments that take the well-being of the communities into account when there is a pandemic disease. Therefore, the government should try to make it possible for people to interact to meet their needs. To ensure that the benefit would outweigh the loss, however, prior assessments on cost-benefit analyses will be necessary. Otherwise, the government would be better to institute the total local down if there is more death of people.

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

The inability to find the species targeted for population genetic molecular structure around the Indian Ocean has proven to be the project's biggest obstacle. We intended to use *Pateobatis jenknsii* as a model species at the start of the research in order to evaluate the population genetic status of ray species along the Tanzanian mainland and Zanzibar Island. We were unable to gather the necessary number of samples (ray species' fin tissues) during the initial field campaign. As a result, we prepared for a second fieldwork trip and asked The Rufford Foundation for an extension on the deadline for submitting our final report. Although it was listed as a vulnerable species on the IUCN Red List, *P. jenknsii* was frequently absent from the landing sites and fish markets during the second fieldwork. We were surprised to see that *P. jenknsii* was less common than the endangered *Himantura gerrardi*. Our capacity to assess the population genetic status of ray species along the Tanzanian mainland and Zanzibar Island using *H. gerrardi* as a model species was made possible by its presence on the landing sites.

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

The local community which was mainly composed of fishermen, fish traders, students and other residents along the landing sites and fish markets (Fig; 2) was important to this project. They responded to questions during the social survey and participated in physical interviews. The fishermen also assisted in sample tissue collection of ray species, and they were organising the fishermen to make sure that we obtain enough samples for genetic molecular analysis. While gathering samples, a student worked alongside the team's researchers and participated in DNA extraction and polymerase chain reactions (PCR). The local communities benefited from the knowledge provided during the feedback regarding the conservation of *Himantura gerrardi* to avoid their possible future extinction. This species is endangered due to the rapid decline in its population size due to incidental catches and their habitat destruction. Therefore, it requires effective measures to ensure their population recovery. However, the fishermen benefited also from the cash that we exchanged with them when we were buying the fish for samples.

Figure 2: a) A research team taking a photo while holding a whip ray species, at Dar es Salaam ferry fish market, b) a research team taking a photo after discussion with fishermen during social survey at Dar es Salaam ferry fish market, c) a master's student taking a photo with two ray species (*Himantura gerrardi)* at Mafia Island, d) a master's student taking photo holding *H. gerrardi* at Tanga landing site and e) a master's student working with his colleagues to conduct a genetic molecular analysis at Biosciences Molecular Genetics lab of Biosciences Department-Sokoine University of Agriculture.

5. Are there any plans to continue this work?

Yes, we intend to confirm the genetic status discovered for *Himantura gerrardi* using sensitive markers like microsatellites. Additionally, we want to add other sampling locations, including Pemba Island. However, we also intend to concentrate on other fish species, like sharks, which are currently in danger due to incidental catches and the loss of their habitats along the Tanzanian mainland and Zanzibar Island.

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

We are currently preparing a manuscript to submit to the international pear reviewer journal. The results of this research will also be posted on the website of the Sokoine University of Agriculture. However, all four species' sequences will be deposited on GenBank and made accessible to other researchers. We intend to include our data in the WCS mobile app. This will help the fisheries officers and fishermen in identifying

fish species that are threatened or endangered. Additionally, planning management initiatives and establishing regulations will benefit from it. The DNA sequences uploaded in the WCS mobile app will support effective conservation, the development of fisheries policy, decision-making, and the sustainable management of ray species. This will boost the market value chain for both threatened and non-threatened ray species.

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

We intend to expand our efforts to improve the conservation of ray species and other fish species. Due to a lack of resources and knowledge, especially money, it is still unknown how the ray species in Tanzania are doing genetically. Future conservation studies of threatened ray species will build on the insights from this research study. We also have the plan to generate extensive data about the marine fauna along the Tanzanian coast and to develop an interactive system that anybody can use to acquire, store, and disseminate genetic and species data from the Tanzanian mainland and Island's coastal 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, over the 2 days of the workshop on "Navigating through academics for early career researchers - Funding acquisition and Equipping new scientists with molecular and research skills," the Rufford Foundation log was used during the presentation. The logo was also used in the questionnaires that were given to nearby communities during the fieldwork for the sociological survey. Additionally, it will be utilised in conference presentations, and The Rufford Foundation will be acknowledged in the paper that is intended to be published.

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

I, the principal investigator, was responsible for supervising every aspect of the research, which also included conducting sociological surveys, collecting tissue samples of rays' species, molecular laboratory analysis, holding meetings to discuss the results, producing reports, and preparing manuscripts. Ms. Catherine Mangare, a specialist in software development, particularly mobile phone applications, was also a member of the project team. She is in charge of coordinating with fisheries officers and the Tanzania program of the Wildlife Conservation Society (WCS) to make sure the DNA sequences gathered for this study are incorporated into the mobile phone application. She also participated in other project tasks like sample collection and data processing. Additionally, one postgraduate student assisted with the collecting of samples and DNA molecular laboratory analysis. However, during sample collection, there were participation from fisheries officers, fishermen, students, and fish traders.

10. Any other comments?

We would like to express our gratitude to The Rufford Foundation for providing the funds for this project, which allowed the research team to visit Zanzibar Island and the coastline of Tanzania mainland. We learned through DNA sequences for the samples collected in the fish landing sites that the assessment status given by IUCN on the Red List of Threatened Species may not always be a reliable indicator of fish availability at a fish landing site. While the vulnerable fish species may not be present, endangered species might be present at that landing site. The *Himantura gerrardi*, an endangered ray species was available on the majority of fish landing sites, but a vulnerable species *Pateobatis jenknsii* and other ray species collected during the fieldwork were not available in most fish landing sites.