The Rufford Foundation
Final Report

Congratulations on the completion of your project that was supported by The Rufford 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.

Thank you for your help.

Josh Cole, Grants Director

Grant Recipient Details	
Your name	Gifty Anane-Taabeah
Project title	Genetic diversity and conservation of natural populations of Nile tilapia (*Oreochromis niloticus*) in Ghana
RSG reference	22083-1
Reporting period	May 2017 – October 2018
Amount of grant	£4,994
Your email address	ananetaabeah@gmail.com
Date of this report	October 31, 2018

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
To determine the genetic variability within *Oreochromis niloticus* populations in different drainage basins in Ghana				
To assess the effect of aquaculture on the genetic diversity of natural populations of *O. niloticus* in Ghana				

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

As part of our sampling protocol, we anticipated the need to purchase fish samples from distribution centres of known farms in case we faced difficulties in obtaining samples from fish farmers. We did not expect any challenges with sample collection at the distribution centres and markets since we only needed fish fin clips, which were usually discarded. However, we faced significant resistance in our quest to obtain fish samples from distribution and market centres. Explaining the research objectives created needless suspicions and sometimes led to outright refusal to provide samples. We therefore resorted to purchasing several kg of whole fish because we needed defensible sample sizes.

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

1. We sampled Nile tilapia *Oreochromis niloticus* from nine new sites representing five major rivers and one lagoon (Pra, Ankobra, Tano, Black Volta, and Lower Volta rivers, and Juen Lagoon). We used eight nuclear microsatellite DNA markers to characterise *O. niloticus* from these basins together with samples obtained in 2015 from three rivers (the Afram, White Volta, and Oti rivers). Our results showed moderate to high genetic diversity within *O. niloticus* across sites. However, we found that several populations across all basins have recently experienced demographic bottlenecks and population decline, evident by loss of genetic diversity and heterozygosity excess, and low effective population size respectively. We also found moderate to high population genetic differentiation among the nine basins studied, suggesting minimal to no gene flow among *O. niloticus* populations across basins. In particular, populations in the Black Volta River and the Tano River at Asuhyea appeared isolated from all other populations and were highly distinct genetically. Given these findings, we recommend that each basin be designated a management unit (MU) and that their respective fisheries be managed separately to curtail population decline and loss of genetic diversity. Furthermore, the Black Volta River and the Tano River at

Asuhyea populations may potentially represent evolutionary significant units (EUs) of *O. niloticus* in Ghana and should be prioritized for management and conservation actions.

2. Our analyses, using a combination of mitochondrial and nuclear DNA data, revealed that at least two aquaculture facilities on Volta Lake were growing genetically improved farmed tilapia (GIFT) strains of *O. niloticus* in 2017. We also found two individuals that were genetically identical to the GIFT strains in the wild samples from the Lower Volta River, suggesting one or more escapes of GIFT-strain fish into the wild. Furthermore, we found varying levels of genetic admixture between local *O. niloticus* populations and the GIFT strain on some farms in Ghana.

3. We produced a report detailing our preliminary findings that the GIFT strains of *O. niloticus* were being farmed in Ghana. A copy of the report was submitted to the Fisheries Commission of Ghana and other stakeholders in February 2018. A stakeholder workshop organised at the end of October 2018 brought together aquaculture stakeholders including fish farmers, feed producers, representatives from the Fisheries Commission, and scientists to discuss the implications of the GIFT strains in Ghana and how to protect the genetic purity of local populations of *O. niloticus*.

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

Local communities contributed significantly to the successful completion of the project's field sampling. We are deeply indebted to all the fishers and boat operators who willingly worked with us. Some fishers went over and beyond our expectation. They conducted sampling in our absence, sent us photos to confirm the species, commenced fishing, and kept fish alive ahead of our visits.

We also received immense support from local contacts such as chiefs, opinion leaders, and local volunteers, including a fish farmer in Elubo (Western Region), who readily provided samples from his farm, helped obtain samples from another farmer, and worked with local fishers to provide wild samples. The locals served in many capacities and can truly be described as "citizen scientists."

Even though the locals who assisted us received monetary compensation, it is my opinion that the true benefit that these individuals and their communities received was the knowledge and empowerment they gained regarding the conservation of important fish resources. Overall, we interacted with nearly 50 individuals in the various communities, excluding all the fish traders and marketers that we encountered.

5. Are there any plans to continue this work?

Yes, the results from this project serve as a foundation for important follow-up research, which is contingent on future funding availability. Given the significant

genetic differentiation observed among the wild *O. niloticus* populations studied and the fact that several populations have declined, I would like to further characterise the more isolated populations, in order to identify possible local adaptions to environmental conditions, which would help prioritise them for conservation action.

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

- In addition to sharing our preliminary results with the Fisheries Commission of Ghana, we have also shared our research findings at two scientific meetings.
    - The first presentation entitled "The potential effect of aquaculture on the genetic purity of natural populations of Nile tilapia *Oreochromis niloticus* population in Ghana" was given at the World Aquaculture Society Conference in Las Vegas, Nevada, USA in February 2018.
    - The second presentation entitled "The effect of aquaculture on the genetic purity of natural populations of Nile tilapia Oreochromis niloticus population in Ghana" was given at the Interfaces of Global Change Graduate Research Symposium in Virginia Tech, Blacksburg, USA in April 2018.
- Results from this project, which form a significant part of my Ph.D. dissertation, were presented in a public seminar on September 18, 2018 at Virginia Tech. I also plan to publish the results in peer-reviewed journals.

- I also shared key research findings related to the inferred presence of the genetically improved farmed tilapia (GIFT) strains of Nile tilapia in Ghana at a one-day aquaculture stakeholder workshop on October 29th 2018.

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

Most of the Rufford Foundation grant was used within the first 4 months of the project from May 19th 2017 to August 31st 2018. This period covered the field sampling and DNA extraction phases of the project. The project was anticipated to be completed within 12 months. However, due to logistical constraints, the project was extended by five months and was completed on October 29th 2018.

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
Vehicle hire	1443	1415	+28	I used £28 less than the budgeted amount. I was loaned a research vehicle for majority of the field season.

				The actual expenses were drivers' allowances, vehicle maintenance and repairs, and road tolls. When the vehicle was not available, taxis and other forms of public transportation were used for sampling.
Fuel	481	662	-181	I used £181 more than the budgeted amount because fuel prices were higher than estimated and I undertook more return trips than originally planned.
Communication cards	50	71	-21	I used £21 more than the budgeted amount because I sampled more sites than I anticipated.
Overnight lodging during field sampling research and 1 field assistant	840	266	+574	I used £574 less than the amount budgeted. This is due to two factors; 1) it was cheaper to conduct some reconnaissance surveys using return trips, and 2) hiring reliable local contacts reduced the need for overnight stays and ensured that we undertook sampling trips only when we were assured of the actual sampling days. The total cost for overnight accommodation = average of £14/night x 10 nights (for researcher) + (14/night for 3 nights x 3 field assistants). The difference was used to offset the additional costs including fuel, communication, and allowance for local contacts and purchasing of fish samples.
Fishing cost and canoe hire	858	838	+20	I used £20 less than the budgeted amount because I negotiated for lower fees with fishers who also served as local contacts because they were paid additional allowances.
Stipend for field assistant 1	200	57	+143	I used £143 less than the budgeted amount because the number of overnight trips were reduced. Instead, I opted to pay a flat daily rate in the local currency (GHC) for the three nights in the field.
Stipend for field assistant 2	150	57	+93	I used £93 less than the budgeted amount because the number of overnight trips were reduced. Instead, I opted to pay a flat daily rate in the local currency (GHC) for the three

				nights in the field.
Stipend for field assistant 3		57	-57	I hired an additional field assistant and paid the same rate as the other assistants.
Meals for field assistants		190	-190	This additional amount was used to pay for food and incidentals for field assistants as compensation for work done during return trips and for sampling when I travelled to South Africa for a scientific conference during the field season.
Allowance for local contacts		286	-286	This additional amount was used to pay the local contacts who assisted with fish sampling in the various regions.
Cost of fish		189	-189	This additional amount was used to purchase whole fish samples at some farms and fish distribution centres.
Packaging and postage fees		55	-55	This additional amount was the cost incurred by local contacts to send samples to me when it was not cost effective to undertake additional trips for extra samples. The costs include transportation to fishing sites, packaging, and overnight postage (bus services).
DNA extraction kit	552	532	+20	I used £20 less than the budgeted amount because I received an institutional discount since I purchased the extraction kit as a Virginia Tech affiliate.
One-day stakeholder workshop for 20 participants	420	1140	-720	I used £720 more than the budgeted amount for the stakeholder workshop because the announcement of the workshop generated high interest among stakeholders. Since funding was a constraint, some private stakeholders provided funding to support a larger venue, and catering for 60 participants. Forty out of the 60 invited participants were in attendance.
Totals	**4994**	**5815**	**-821**	

The local exchange rates used were £1 = GHC 5.25, and £1 = $1.25

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

- To help reduce population decline and loss of genetic diversity within the wild *O. niloticus* populations studied, it would be important to engage local communities to develop management strategies aimed at reducing fishing pressure and increasing demographic recruitment within fish populations.

- It would be important to develop and implement management and conservation plans for *O. niloticus* genetic resources in Ghana, and for all economically important freshwater fish species.

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

Yes, I used the Rufford Foundation logo in all public presentations of the research findings including my dissertation defence and stakeholder workshop, to acknowledge the generous support from the Rufford Foundation. We acknowledged the Rufford Foundation's support in the tilapia genetics report submitted to the Fisheries Commission of Ghana. The Rufford Foundation also received publicity when my research was featured in Virginia Tech News in October 2017.

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

My team consisted of my dissertation research advisors, **Drs. Emmanuel A. Frimpong** and **Eric M. Hallerman**, who are co-supervisors of this project. Both Drs. Frimpong and Hallerman were involved in the conceptualization of the project, supervised the field work, and provided input in the data analysis and report writing. I acknowledge the support of the two other members of my Ph.D. dissertation research committee, **Drs. Jess Jones** and **Donald Orth**.

My core field crew consisted of three dynamic individuals with fisheries and aquaculture postgraduate training, who have assisted me in varying capacities on past projects. **Nathaniel G. Adjei** was instrumental in establishing the local contacts in Kantu and Talewona (Upper West Region) and assisted sample collection and packaging. Nathaniel also assisted with organizing the aquaculture stakeholder workshop organized at the end of the project.

Abigail E. Tarchie and **Anthony Aliebe** assisted with sample collection and packaging in the Elubo and Half-Assini (Western Region). Both Abigail and Tony worked as local language translators since they are natives of the region. Tony also assisted with English/French translation for fishers, who worked at the border between Ghana and Ivory Coast. Abigail and Tony also assisted with fish sampling when both Nathaniel and I travelled to South Africa to make presentations at the World Aquaculture Society Conference from June 26 – 30, 2017.

Clay Ferguson, formerly of the Department of Fish and Wildlife Conservation, Virginia Tech, assisted me with DNA extraction. **Miluska Olivera Hyde**, a Ph.D. student in the Department of Fish and Wildlife Conservation at Virginia Tech, provided useful suggestions and feedback during my laboratory and data analysis.

12. Any other comments?

My team and I are deeply grateful to the Rufford Foundation for supporting this project and providing the funds that made, especially, the field sampling possible. Through this project I have received several recognitions, including receiving the AquaFish/USAS Chapter Best Student Abstract Award in Las Vegas earlier this year.

The conservation awareness created through this project, though on a small scale, is the beginning of a long-term community involvement and partnership to help protect fish resources from unsustainable human activities.

Stakeholder workshop.