DETAILED FINAL PROJECT REPORT

Understanding Community Perception on Threatened Fish Species Conservation and Promoting Sustainable Aquaculture in White Volta Basin's Fishing Villages, Ghana

Rufford Small Grant_43601-1

By

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May 2025

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1. Introduction

Aquatic ecosystems serve as vital reservoirs of biodiversity and foundational pillars for livelihoods and food security across West Africa. In Ghana, the White Volta River (WVR) exemplifies this dual role, sustaining fishing communities in its basin through its rich fish diversity and socio-economic contributions. For generations, these communities have relied on the river's resources for nutrition, income, and cultural practices, with fish constituting over 60% of dietary animal protein and supporting local economies (Ahmed et al., 2022; Yeboah, 2014). However, escalating anthropogenic pressures including overfishing, habitat degradation, pollution, and climate change now threaten both the river's ecological balance and the resilience of its dependent populations. Urgent conservation action, coupled with sustainable livelihood alternatives, is critical to avert irreversible biodiversity loss and socio-economic collapse. The WVR's aquatic ecosystems harbor diverse fish species, many of which remain unassessed for their conservation status. Globally, freshwater fish face alarming extinction rates, with West Africa experiencing declines in endemic species such as *Dasyatis garouaensis* and *Chrysichthys nigrodigitatus*, now classified as Critically Endangered on the IUCN Red List due to overexploitation (Emmanuel et al., 2016). In Ghana, similar trends are emerging. For instance, traditional fishing communities along the WVR report dwindling catches of once-abundant species like the African catfish (*Clarias gariepinus*) and Nile tilapia (*Oreochromis niloticus*), signaling ecosystem-wide stress (Yeboah, 2014). These declines are compounded by habitat fragmentation from sand mining, agricultural runoff, and untreated waste discharge, which degrade water quality and disrupt breeding grounds. Fishing, a cornerstone of local economies in villages, now faces existential threats. Catches have declined by an estimated 40% over the past decade, forcing fishers to adopt destructive practices like fine-mesh nets and chemical fishing to meet demand (Ahmed et al., 2022). This short-term survival strategy exacerbates long-term risks, pushing species toward local extinction and undermining food security. Women and youth, who dominate post-harvest activities like fish smoking and trading, face heightened vulnerability as resource scarcity deepens poverty cycles. Concurrently, limited awareness of conservation needs among fishers and policymakers perpetuates unsustainable practices. In this context, the current project titled "Understanding Community Perception on Threatened Fish Species Conservation and Promoting Sustainable Aquaculture in White Volta Basin's Fishing Villages, Ghana" has been developed and funded by the Rufford Foundation, with the aim of conserving and sustainably managing Ghana's endangered freshwater fish species. This project focused on the white volta river in the northern region of Ghana using three main fishing communities (Nuwuni, Adayili, and Dapali) in northern region of the country. This document is the final detailed report of the implementation of this project over a period of 12 months from June 2024 to May 2025.

2. Objectives

The specific objectives of this project were to:

1. Assess threats to endangered fish species and the knowledge level of fishing communities on threatened fish species conservation;

2. Determine factors influencing fishing communities' perceptions towards sustainable aquaculture development;

3. Identify suitable sites for pond aquaculture development;

4. Create awareness of fishpond farming adoption for livelihood diversification; and

5. Train fishing communities on approaches to developing pond aquaculture without interfering with biodiversity.

3. Methodology

The implementation of the project started with conducting field reconnaissance and community entry meetings at the project sites: Nawuni, Adayili, and Dapali along the White Volta River. These meetings were vital in establishing trust with local communities by introducing the project to leaders and key influencers in each village. The primary objective was to inform community leaders about the project's aims, with a focus on the potential benefits, including long-term improvements in fish biodiversity, food security, and economic opportunities for fishing communities as well as their role in the succus of our project.

The methodology we used are described bellow

3.1. Objective 1: Assess threats to endangered fish species and the knowledge level of fishing communities on threatened fish species conservation

To achieve this objective, we conducted a study entitled "knowledge level of fishing communities and threats to endangered fish species in the white volta basin fishing villages in Northern Ghana. A survey questionnaire, was designed, digitized using KoboCollect and deployed on mobile phone tablets by enumerators recruited for the data collection. The enumerators were trained in the concepts behind the questions in order to be able to translate them into the local languages without losing their meaning. Supervisors monitored the surveys in the fields to ensure discipline and motivation and, ultimately, the completion of activities within the stipulated timeframe and production of high-quality data. The questionnaire used for the data collection contained information on: Socio-demographic and economic characteristics of the respondent, Awareness level of fishing communities endangered fish species, Anthropogenic activities threatening fish Biodiversity in White volta basin in Northern Ghana, as well as Involvement activities, motivations and main barriers to participating in conservation activities. A pictorial checklist of local and global endangered and critically endangered was created in order to capture the full extent of the fish species threatened in the white volta basin (Annex).

The data collection was done in three fishing communities along the white Volta River in the norther part of Ghana, including Nuwuni, Adayili, and Dapali. Additionally, we included the fish markets (main embarkment point) within those communities. A total of 240 respondents, were surveyed including fishermen, fishmongers, local authorities, and fisheries managers (Table 1). After data collection, the generated data were verified, cleaned, curated and exported in Excel and loaded into SPSS version 26 for descriptive statistics and charts/diagrams.

Prior recruitment of the study participants, respondents were taken trough the informed consent process by fully explaining the objectives of the study, risk involved, and their right of withdrawal at any time they feel uneasy. Written consent was obtained from all respondents.

3.2. Objective 2: Determine factors influencing fishing communities' perceptions towards sustainable aquaculture development.

To identify the factors shaping fishing communities' views on sustainable aquaculture development in the White Volta Basin, we carried out a mixed-method study titled "Determinant of Fishing Communities' Perceptions towards Sustainable Aquaculture Development in White Volta Basin in Northern Ghana." For that a survey questionnaire couple with focus group discussion were used. This study aimed to assess factors influencing white volta's fishing communities' perception on the feasibility of pond aquaculture development in white volta basin. Survey questionnaire was developed using kobotool box and administered using android table by recruited enumerators. The enumerators were trained in the concepts behind the questions in order to be able to translate them into the local languages without losing their meaning. Supervisors monitored the surveys in the fields to ensure discipline and motivation and, ultimately, the completion of activities within the stipulated timeframe and production of high-quality data. A total of 200 respondents from Nuwuni, Adayili, and Dapali fishing communities including mainly fishermen and fishmongers took part of the quantitative part of the study. The questionnaire was designed to collect data on six groups of factors:

- Socio-demographic factors
- Economic and Livelihood Factors
- Cultural and traditional factors
- Social and community collaboration factors
- Environmental and biodiversity factors
- Institutional and support factors

After data collection, the data were retrieved in excel format from kobo toolbox server, cleaned and loaded into SPSS version 26 for statistical analysis. To determine the factors, a univariate analysis using Chi-square test with feasibility of pond aquaculture development as dependent variable. Then a binary logistic regression was performed to uncover factors and come up with a best model explaining the feasibility perception of fishing communities toward sustainable pond aquaculture development in the white volta basin.

Concerning the qualitative part of the study, focus group discussions were conducted with two categories of respondents (fishermen (Male group) and Fishmonger (Female group)) in each of the fishing communities using an interview guide. Each focused groups comprised eight (08) participants. All focus group discussion were recorded using a recording device, downloaded in a laptop, transcribed and analysed using thematic analysis.

Prior recruitment, respondents were taken trough the informed consent process by fully explaining the objectives of the study, risk involved, and their right of withdrawal at any time they feel uneasy. Every respondent provided their written consent.

3.3. Objectives 3: Identification of suitable sites for pond aquaculture development

We obtained digital elevation model (DEM) data for the study area from the United States Geological Survey (USGS) at a spatial resolution of 30 m. FAO digital soil map was used to map the soil quality for the two target districts of the project. Since land use data was not available for the project sites, we performed a land use and land cover classification of the two-district using Semi-Automatic Classification Program (SCP) in QGIS 3.36 with an overall accuracy of 93.48 and Kappa of 0.81. All digital data were processed within the GIS software, QGIS for windows (version 3.36), All map layers are converted into WGS 84 / UTM zone 30N coordinates projection, following the FAO Soil Map coordinates projection. All the layers are converted in raster with the size of 30 m before analysis. For the distance scale, the unit meter was used and defined in the software system.

Four steps were used in the suitability modelling. First was setting the objective, which is to determine suitable sites for earthen pond aquaculture activity. The second involved identifying criteria and constraints to use in selecting aquaculture sites. Soil quality indicators (organic matter, soil texture and pH) were sourced from the FAO Soil Map of the World, while slope and elevation were obtained from the SRTM 30 m DEM. Land use data was obtained from our own land use and land cover classification as mentioned earlier which was then used to extract the water bodies, road, residential area and protected region. Although there are many criteria to be considered in aquaculture site selection, due to data limitation, we used nine (9) essential criteria were chosen (soil pH, soil texture, soil organic matter, soil slope, soil elevation, water bodies, road, protected areas, and residential areas). In the third stage, the suitability scores for all criteria were normalized. Following the FAO guideline (Cardia et al., 2017), a score of 1 was allocated to pixels considered not suitable, 2 for moderately suitable pixels, and 3 for the most suitable pixels. The study employed Equation (1) for the suitability analysis.

$$S = \sum_{i=1}^{n} wici$$

where S represents the overall suitability score, wi is the weight assigned to each criterion, ci is the individual criterion score, and n (which equals 9 in this study) is the total number of criteria. This equation integrates the trade-offs among different factors to compute a comprehensive weighted suitability score for each evaluation unit.

In the fourth step, the weights for each criterion were determined through interviews with three academicians specializing in aquaculture practices. These experts provided their input using a pairwise comparison matrix with a scoring range from 1/9 (least important) to 9 (most important). Their responses were consolidated by calculating the median values, which defined the final pairwise comparison matrix. The resulting consistency ratios (CR) for soil quality, infrastructural facilities, and overall criteria were 0.07, 0.048, and 0.014, respectively. Since all CR values were below the 10% threshold recommended by Saaty (1990), this suggests that the weights were not assigned by chance.

Before performing the weighted analysis, all data layers were prepared. A Euclidean distance map was created for water bodies, roads, residential areas, and protected areas to enable proximity analysis. Data standardization was applied to facilitate comparisons across the various map layers. This process resulted in a final suitability map for potential earthen pond aquaculture sites, with scores ranging from 1 to 3 where a higher score indicates greater suitability and a lower score indicates lesser suitability. Each layer was multiplied by its respective weight, and the weighted values were summed using the weighted overlay process to produce the final suitability map based on Equation (1).

The application of Equation (1) is demonstrated for the soil quality, soil condition and infrastructure suitability maps as shown below.

$$\boldsymbol{Suitability\ Soil\ Quality} = (\text{SoilpH x } 0.33) + (SoilTexture\ x\ 0.14) + (SoilOM\ x\ O.52)$$

$$\boldsymbol{Suitability\ Soil\ Condition} = (\text{SoilSlope x } 0.67) + (SoilElevation\ x\ 0.33)$$

$$\begin{aligned}\boldsymbol{Infrastucture\ Suitability} \\ &= (\text{Distance to water bodies x } 0.46) + (Distance\ to\ Road\ x\ 0.3) \\ &+ (Distannce\ to\ Forest\ x\ O.15) + (Distnce\ to\ Resiential\ x\ 0.15)\end{aligned}$$

Finally, overlay techniques in QGIS were used to merge all the criteria, resulting in the final suitability map based on Equation (1) above resulting in the subsequent equation.

$$\begin{aligned} \mathit{Final\ Suitability} \\ &= (\mathit{Suitability\ Soil\ Quality}\ \mathrm{x}\ 0.18) + (\mathit{Suitability\ Soil\ Condition}\ x\ 0.2) \\ &+ (\mathit{Infrastucture\ Suitability}\ x\ O.2) + (\mathit{Land\ Use}\ x\ 0.43) \end{aligned}$$

Prior to the map generation, a consultative workshop was organized with local fishermen associations to discuss and identify key factors that should be considered in the suitability modeling. These factors were then evaluated and refined based on expert opinions from aquaculture specialists to enhance the accuracy and relevance of the analysis. To validate the model, we compared the location of the current aquaculture farm with the predicted suitable site. The model is deemed acceptable if over 60% of the existing farm is situated within the identified suitable area. In the project site, only one fish pond farm is present which lies on the most suitable class.

We also organised two workshop to discuss the validity of the identified suitable site for aquaculture development and two sites for each category of suitability were visited to confirm the validity of the identified sites.

3.4. Objective 4: Create awareness of fishpond farming adoption for livelihood diversification

To raise the awareness of the fishing communities on fishpond farming adoption for livelihood diversification we conceived and designed two awareness creation toolkits in the form of posters and pamphlets or brochure. The messages for sensitization and awareness raising were based on the findings of the surveys. We used easily understandable language in the writing of all the posters and made sure that the content was explained in local languages without changing the meaning on the fields. During that activity we also raise awareness of the importance of conserving aquatic life with a particular focus on fish biodiversity. The same three communities targeted during our surveys were involved in the awareness creation activities. The target of the individuals awareness campaign were fishermen, local authorities, fishmongers and fisheries managers.

3.5. Objective 5: Train fishing communities on approaches to developing pond aquaculture without interfering with biodiversity.

During our surveys, we assessed the feasibility and willingness of fishermen, fishmongers, local authority to use fish farming as supplementary activity to fishing. From those results, we also designed training material to introduce earthen pond aquaculture farming of *Clarias gariepinus* and *Oreochromis niloticus* feasible in the suitable aquaculture sited identified in this project at Dapali, Adayili and Nawuni. We used visual tool as training materials including PowerPoint presentation, video tutorial, and pamphlet.

They were trained on selecting a suitable site for your farm, pond design and construction, bringing fingerlings to pond, feeds and feeding, pond management, harvesting and marketing, aquaponic system, and also in techniques for the production of fish feed using locally available ingredients.

4. Results

4.1. Objective 1: assess threats to endangered fish species and the knowledge level of fishing communities on threatened fish species conservation

4.1.1. Socio-demographic and economic characteristics of the respondent

In assessing the risks to endangered fish species and gauging the conservation knowledge within local fishing communities, majority of respondents were from Adayili (35.8%), followed by Dapali (34.2%) and Nuwuni (30.0%). The majority of respondents were identified as Adaa (50.4%), followed by Ewe (30.0%) and Dagomba (12.9%). Smaller ethnic groups included Gonja (2.9%), Hausa (1.3%), Ga (0.8%), Frafra (0.4%), Gurinsi (0.4%), Moshi (0.4%), and Yoruba (0.4%). Regarding respondents' religion, majority of the respondents practiced Christianity (61.3%), followed by Islam (22.5%) and traditional African religion (16.3%). Respondents' ages ranged from 18 years and above. The largest age group was between 42 and 50 years (28.3%), followed by those above 50 years (27.1%). The age groups 34–41 years (21.3%), 26–33 years (17.9%), and 18–25 years (5.4%) had relatively fewer respondents. Most respondents were married (88.8%), while 23 (9.6%) were single. A small proportion were either divorced (1.3%) or widowed (0.4%). The household size of respondents varied, with nearly half (47.5%) living in households of 6–11 members. Households with 0–5 members accounted for 37.5%, while those with 12–18 members (12.9%) and above 18 members (2.1%) were less common. A substantial proportion of respondents had no formal education (39.2%). Others had completed primary education (34.6%) or junior high school/senior high school (24.2%). Only a small fraction had tertiary education (2.1%).

The predominant occupation among respondents was fishing (66.7%). Other occupations included fishmongering (30.4%), environmental health officer (1.3%), farming (1.3%), and driving (0.4%). More than half of the respondents were involved in farming as a secondary occupation (62.5%). Other secondary occupations included trading (5.8%), food vending (2.9%), and leadership roles such as president of a fishermen's association (1.3%). A notable proportion had no secondary occupation (16.3%), while 23 (9.6%) reported other unspecified occupations. Fishing experience varied among respondents. The most common experience levels were 22–33 years (33.8%) and 11–21 years (33.3%). Others had been in the industry for 34–45 years (17.1%), 0–10 years (10.0%), or over 45 years (5.8%). Half of the respondents earned between 501 and 2000 Ghanaian cedis per month (50.0%). Income levels varied, with 17.1% earning between 2001 and 4000 GHS, 13.3% earning 4001–6000 GHS, 7.1% earning above 6000 GHS, and 12.5% earning 0–500 GHS. For those with a secondary occupation, the majority (73.3%) earned 0–500 GHS. Others earned between 501 and 2000 GHS, 2001–4000 GHS (1.7%), 4001–6000 GHS (0.8%), and above 6000 GHS (0.4%).

Table 1: Socio-demographic and economic characteristics of respondents

Variables	Frequency	Percent
Fishing communities		
Nuwuni	72	30,0
Adayili	86	35,8
Dapali Adayili	82	34,2
Fishing_community		
Nuwuni	72	30.0
Adayili	86	35.8
Dapali Adayili	82	34.2
Ethnic group		
Adaa	121	50.4
Dagomba	31	12.9
Ewe	72	30.0
Frafra	1	0.4
Ga	2	0.8
Gonja	7	2.9
Gurinsi	1	0.4
Hausa	3	1.3
Moshi	1	0.4
Yoruba	1	0.4
Religion		
Christianity	147	61.3
Islam	54	22.5
Traditionalist	39	16.3
Age		
18-25	13	5.4
26-33	43	17.9
34-41	51	21.3
42-50	68	28.3
Above 50	65	27.1
Marital Status		
Married	213	88.8
Single	23	9.6
Widowed	1	0.4
Divorced	3	1.3
Household size		
0-5	90	37.5
6-11	114	47.5

12-18	31	12.9
Above 18	5	2.1
Educational level		
No formal education	94	39.2
Primary	83	34.6
Junior high school/Senior high school	58	24.2
Tertiary education	5	2.1
Main occupation		
Fishing	160	66.7
Environmental health officer	3	1.3
Farming	3	1.3
Driver	1	0.4
Fishmonger	73	30.4
Secondary occupation		
Fishing	2	0.8
Fishmonger	2	0.8
Farming	150	62.5
President (Fishermen association)	3	1.3
Trading	14	5.8
Food vendor	7	2.9
None	39	16.3
Other	23	9.6
Experience in fishing industry		
0-10	24	10.0
11-21	80	33.3
22-33	81	33.8
34-45	41	17.1
Above 45	14	5.8
Monthly income (main occupation)		
0-500	30	12.5
501-2000	120	50.0
2001-4000	41	17.1
4001-6000	32	13.3
Above 6000	17	7.1
Monthly income (secondary occupation)		
0-500	176	73.3
501-2000	20	8.3
2001-4000	4	1.7
4001-6000	2	0.8

Above 6000	1	0.4

4.1.2. Awareness level of fishing communities on fish biodiversity conservation in the White Volta Basin

Table 2 presents the awareness level of respondents regarding the IUCN Red List and fish biodiversity conservation. Findings indicated that only 2.5% of respondents were aware of the IUCN Red List, while the reminding majority (97.5%) had no knowledge of it. This suggests a significant lack of awareness regarding globally threatened fish species among the fishing communities. Despite the limited awareness of the IUCN Red List, 86.3% of respondents recognized the importance of fish biodiversity conservation, whereas 13.7% reported no awareness. This indicates that most fishing community members acknowledge the need for conservation, even though their knowledge of global conservation frameworks is limited. Among those who were aware of the need for conservation (N = 207), 7.9% reported having no knowledge, while the majority (43.8%) had basic knowledge. Additionally, 24.6% had moderate knowledge, and 10.0% reported extensive knowledge of fish biodiversity conservation. These findings suggest that although awareness is relatively high, in-depth knowledge remains limited.

Regarding regulations and laws on fish conservation, 41.7% of respondents reported being aware of existing legal frameworks, while 58.3% were unaware of any conservation regulations. This indicates a gap in regulatory awareness that could hinder compliance and effective conservation efforts. Among those who were aware of regulations (N = 100), 36% were familiar with laws prohibiting the use of explosives, 35% knew about laws restricting unapproved fishing gear (e.g., small mesh nets), and 21% were aware of laws banning the use of chemicals or poisons in fishing. Additionally, 8% of respondents reported knowledge of a local rule prohibiting fishing on Fridays, which suggests some level of community-based conservation efforts.

Table 2: Level of awareness of fishing communities (Nawuni, Adayili, Dapali) on UICN red list and threatened fish species conservation in white volta basin in northern Ghana

Variables	Frequency	Percent
Awareness of UICN redlist		
Yes	6	2.5
No	234	97.5
Awareness of the need to conserve fish biodiversity		
Yes	207	86.3
No	33	13.7
Level of knowledge of fish biodiversity conservation (N=207)		

No knowledge	19	7.9
Basic knowledge	105	43.8
Moderate knowledge	59	24.6
Extensive knowledge	24	10.0
Awareness of regulations and laws concerning fish conservation		
Yes	100	41.7
No	140	58.3
Awareness of existing laws or regulations or local rules (N=100)		
Law banning the use of chemicals or poisons	21	21
Law prohibiting any unapproved fishing gear (small mesh nets. other fishing tools)	35	35
Law prohibiting the use of explosives	36	36
Local rule that No fishing on Friday	8	8

The findings indicated that informal and community-based information sources play a dominant role in knowledge dissemination, while formal educational channels remain limited (Figure 1). The most frequently cited source of information was parents (85.7%), suggesting that traditional knowledge and intergenerational learning are key in shaping conservation awareness within fishing communities. Similarly, community meetings (31.1%) play a crucial role in spreading conservation-related information, likely through local discussions, cultural practices, and participatory engagements. While government and NGO programs contribute to conservation awareness (25.5%), their reach appears relatively low compared to informal sources. This suggests a gap in formal conservation education and outreach programs, which may need to be strengthened for effective policy implementation. The school system had the lowest impact on conservation awareness (5.1%), indicating that formal education on fish biodiversity conservation is not a major source of knowledge for the fishing communities. Similarly, media sources such as radio, television, and newspapers played a minimal role (12.8%), suggesting that conservation-related messages may not be widely broadcasted or effectively reaching the target audience.

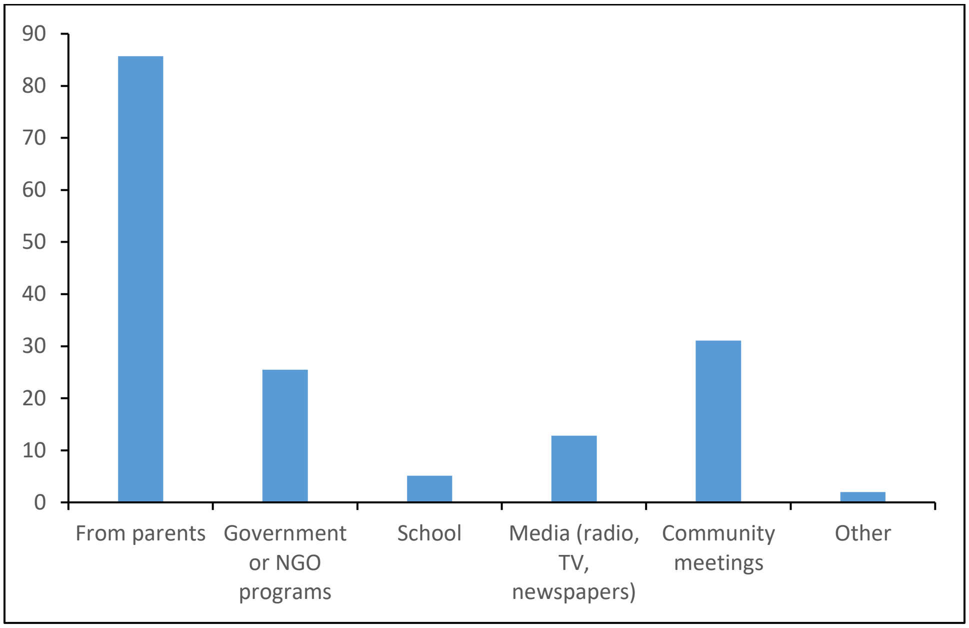

Figure 1: Fishing communities information channels on threatened fish species conservation in the white volta basin in northern Ghana

4.1.3. Anthropogenic activities threatening fish Biodiversity in White Volta Basin in Northern Ghana

Figure 2 presents the various human activities contributing to the endangerment of fish biodiversity in the White Volta Basin, Northern Ghana. The findings revealed that unsustainable fishing practices, habitat destruction, and pollution are major threats to aquatic biodiversity in the region. The most frequently reported activities were the use of inappropriate (small) fishing nets (62.5%), capture of fingerlings (52.1%), over exploitation (42.9%). Other harmful fishing methods include the use of chemicals (37.9%) and explosives (33.3%). Apart from fishing-related threats, sand weaning (13.8%), farming close to riverbanks (8.8%) and dumping of waste (10%) into the river were also reported as human activities that poses a significant pollution threat, affecting water quality and fish health. Additionally, noise pollution in the water (4.6%) and the opening of the Bagri Dam (4.2%) were identified as additional stressors to the aquatic ecosystem.

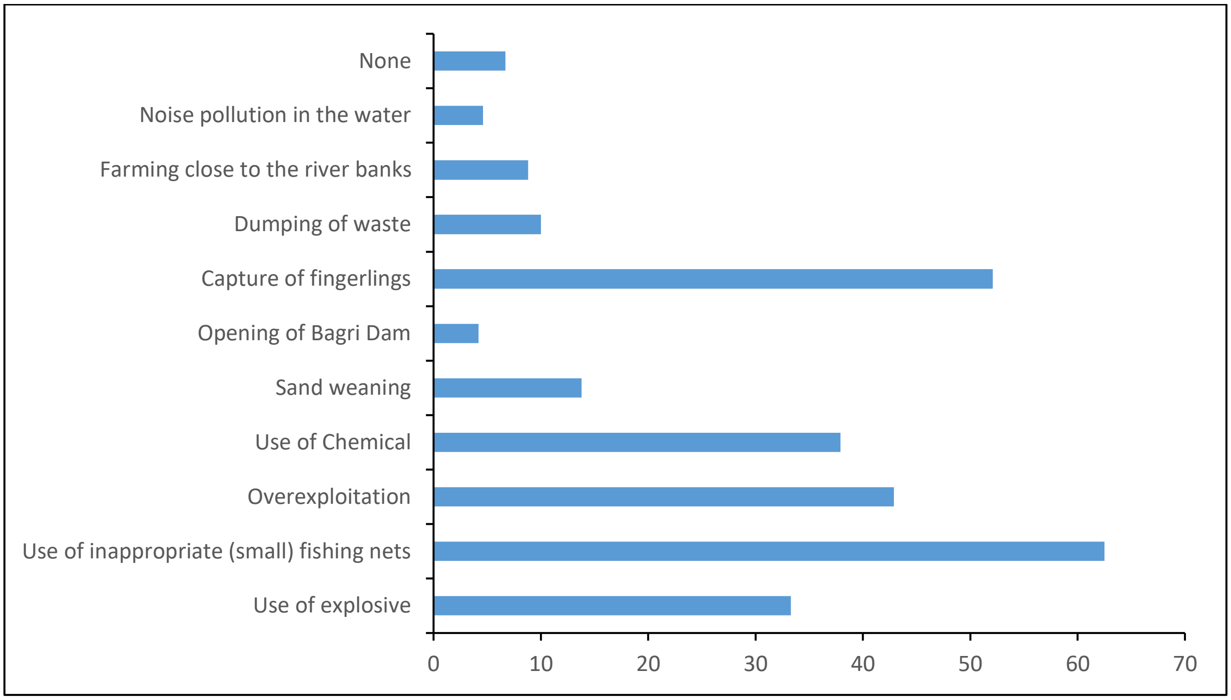

Figure 2: Anthropogenic activities endangering fish biodiversity in white volta basin in northern Ghana

The table 3 presents the list of endangered fish species raised by respondents in the White Volta River in Ghana. The result showed that *Synodontis macrophthalmus* (92.8%) and *Fundulopanchax gularis* (89.3%) are the most commonly raised endangered fish species. *Brycinus brevis* (47.0%) and *Nimbapanchax petersi* (46.2%) are also frequently raised, but at lower levels compared to the top species. *Limbochromis robertsi* (41.5%), *Mormyrus subundulatus* (40.6%), *Pronothobranchius seymouri* (38.5%), and *Enteromius subinensis* (35.5%) are raised by a moderate percentage of respondents, indicating a diverse range of endangered species in the White Volta River. *Clarias laeviceps* (21.4%) was the least raised among the listed endangered species. Other species (2.1%) including *Chrysichthys walker* and *Bathygobius burtoni* represent a small fraction of fish raised by respondents.

Table 3: Some of the endangered fish species raised by respondent in the white volta river in the Northern region of Ghana

Endengered Fish Species	Percentage
Nimbapanchax petersi	46.2%
Synodontis macrophthalmus	92.8%
Fundulopanchax gularis	89.3%
Brycinus brevis	47.0%

Limbochromis robertsi	41.5%
Pronothobranchius seymouri	38.5%
Mormyrus subundulatus	40.6%
Clarias laeviceps	21.4%
Enteromius subinensis	35.5%
Other	2.1%

4.1.4. Involvement, activities, motivations and main barriers to participating in conservation activities

Fishermen and fishmongers' participation in fish biodiversity conservation efforts in the White Volta Basin in Northern Ghana is presented in Table 4. The results indicated low participation proportion (35.0%) of respondents reported involvement in conservation activities while the majority (65.0%) had not engaged in such initiatives. This suggests that barriers to participation remain a significant challenge within these communities. Among those involved in conservation efforts, 35.0% participation varied across different activities: The most common activity was practicing sustainable fishing (77.4%). indicating that some individuals adopt environmentally responsible fishing techniques. Educating others about conservation was also prevalent (42.9%) followed by relatively low participation in organized conservation programs (44.0%).

Motivational factors influencing participation in fish biodiversity conservation were diverse (Table 4). The most frequently cited motivation was economic benefits (20.0%). This suggests that financial incentives may drive conservation efforts more than intrinsic or communal motivations. Conversely, personal belief in conservation was reported by 12.9% indicating that some respondents engage voluntarily due to environmental concerns. However, community pressure played a minimal role (1.7%), implying that social expectations do not strongly influence conservation behaviors.

A range of barriers hindered conservation participation. The most significant constraint was a lack of awareness (72.1%) which reflect gaps in knowledge dissemination and environmental education. Additionally, economic constraints were reported by 58.8% reinforcing the trade-offs between conservation and financial survival. Lack of time (25.4%) was another key barrier suggesting that livelihood demands may limit active engagement in conservation efforts.

Table *4*: Fishermen and fishmongers' involvement. activities. motivations and main barriers to participating in fish biodiversity conservation activities in White volta basin

Variables	**Frequency**	**Percent**
Involvement in conservation activities		
Yes	84	35.0
No	156	65.0
Activities performance		

Participating in conservation programs	36	44.0
Educating others about conservation	38	42.9
Practicing sustainable fishing	65	77.4
Motivation to participate in for conservation activities (N=84)		
Personal belief in conservation	31	12.9
Community pressure	4	1.7
Economic benefits	48	20.0
Main Barrier to fish biodiversity conservation		
Lack of awareness	173	72.1
Lack of time	61	25.4
Economic constraints	141	58.8
Other	1	0.4

a = In percentage where each case was selected

4.2. Objective 2: determine factors influencing fishing communities' perceptions towards sustainable aquaculture development

4.2.1. Fishermen perception of the feasibility of aquaculture development in White Volta basin in Northern region of Ghana

Table 5 presents the perceptions of fishermen in the White Volta Basin regarding the feasibility of aquaculture development. The results showed that a majority of the respondents (56.5%) believe that aquaculture development is feasible whereas 43.5% do not view it as a viable option.

Table *5*: Distribution of fishermen perception of the feasibility of aquaculture development in White Volta basin in Northern region of Ghana

Perception of the feasibility of aquaculture development	Count	Percent (%)
Feasible	113	56.5
Not feasible	87	43.5
Total	200	100.0

4.2.2. Univariate test of potential factors influencing the feasibility of aquaculture development

A total of 200 respondents were classified according to their perception of aquaculture feasibility ("Feasible" vs. "Not feasible") and a series of potential influencing factors were examined using chi-square tests (Table 6a). Out of the 32 potential factors, 15 showed a significant association with feasibility perception. Among the socio-demographic factors, a statistically significant association emerged between gender and feasibility perception ($\chi^2(1) = 4.991$, $p = 0.025$). Males were more likely to perceive aquaculture as feasible (62.1%) compared to females (45.6%). The association between age and perception was significant ($\chi^2(3) = 10.434$, $p = 0.015$) with highest feasibility among those aged 34–41 years (56.0%) and lowest among 18–25-year-olds (34.5%). Educational attainment was also significantly associated with perceptions ($\chi^2(3) = 16.718$, $p = 0.001$). About 49.1% of respondents with primary education and 29.8% with junior/senior high school education reported feasibility, compared to 16.7% with no formal education and 4.4% with tertiary education

Table 6a: Descriptive statistics and univariate test of socio-demographic factors influencing the feasibility of aquaculture development White Volta basin in Northern region of Ghana

Factors	Count (%)	Perception on the feasibility of aquaculture development				χ^2 (df) [p-value]
		Feasible		Not feasible		
		Count	Percent	Count	Percent	
District/Municipality						0. 005 (1) [0.942]
Savelugu	142 (71.0)	80	56.3%	62	43.7%	
Kumbungu	58 (29.0)	33	56.9%	25	43.1%	
Fishing communities						2.897 (2) [0.639]
Nuwuni	62 (31.0)	36	58.1%	26	41.9%	
Adayili	71 (35.5)	37	52.1%	34	47.9%	
Dapali Adayili	67 (33.5)	40	59.7%	27	40.3%	
Ethnic group						11.624 (9) [0.235]
Ewe	67 (35.5)	31	46.3%	36	53.7%	
Yoruba	1 (0.5)	1	100.0%	0	0.0%	
Dagomba	26 (13.0)	18	69.2%	8	30.8%	
Adaa	94 (47.0)	57	60.6%	37	39.4%	
Gonja	4 (2.0)	2	50.0%	2	50.0%	
Ga	2 (1.0)	0	0.0%	2	100.0%	
Gurinsi	1 (0.5)	1	100.0%	0	0.0%	
Frafra	1 (0.5)	1	100.0%	0	0.0%	
Moshi	1 (0.5)	1	100.0%	0	0.0%	
Hausa	3 (1.5)	1	33.3%	2	66.7%	
Religion						4.881 (2) [0.087]
Christianity	136 (68.0)	73	53.7%	63	46.3%	
Islam	47 (23.5)	30	63.8%	17	36.2%	
Traditionalist	17 (8.5)	10	58.8%	7	41.2%	
Gender						4.991 (1) [0.025*]
Male	132 (66.0)	82	62.1%	50	37.9%	

Female	68 (34.0)	31	45.6%	37	54.4%	
Age						10.434 (3) [0.015*]
18-25	29 (14.5)	10	8.8%	19	22.1%	
26-33	15 (7.5)	11	9.6%	4	4.7%	
34-41	116 (58.0)	65	57.0%	51	59.3%	
Above 41	40 (20.0)	28	24.6%	12	14.0%	
Marital Status						3.818 (3) [0.282]
Married	180 (90.0)	99	55.0%	81	45.0%	
Single	16 (8.0)	12	75.0%	4	25.0%	
Widowed	1 (0.5)	0	0.0%	1	100.0%	
Divorced	3 (1.5)	2	66.7%	1	33.3%	
Household size						5.763 (3) [0.124]
0-5	69 (34.5)	38	55.1%	31	44.9%	
6-11	98 (49.0)	51	52.0%	47	48.0%	
12-18	29 (14.5)	20	69.0%	9	31.0%	
Above 18	4 (2.0)	4	100.0%	0	0.0%	
Educational level						16.718 (3) [0.001*]
No formal education	55 (27.5)	19	16.7%	36	41.9%	
Primary	83 (41.5)	56	49.1%	27	31.4%	
Junior high school/Senior high school	52 (26.0)	34	29.8%	18	20.9%	
Tertiary education	10 (5.0)	5	4.4%	5	5.8%	

Among the economic and livelihood factors (Table 6b), respondents with 0–10 years of experience rated aquaculture as feasible at a higher rate (63.0%) than those with over 21 years (44.0%), $\chi^2(2) = 10.08$, $p = 0.006$. Perceptions regarding whether aquaculture will improve livelihoods significantly influenced feasibility views ($\chi^2(1) = 7.86$, $p = 0.005$). Respondents who believed aquaculture could improve their livelihood were more likely to find it feasible (64.1%) than those who did not (43.5%). Overall perceptions of feasibility varied by the barrier cited, $\chi^2(4) = 10.58$, $p = 0.032$. Notably, only 23.1% of respondents concerned about market-demand uncertainty rated aquaculture as feasible, compared with 44 – 45% of those citing high start-up costs or technical-training gaps. How respondents compared the profitability of aquaculture to existing practices was highly significant ($\chi^2(1) = 41.92$, $p < 0.001$). 93.0% of those who perceives aquaculture feasible believed it to be profitable, whereas only 53.5% of those who viewed it as not feasible did so.

Table 6b: Descriptive statistics and univariate test of economic and livelihood factors influencing the feasibility of aquaculture development White Volta basin in Northern region of Ghana

Factors	Count (%)	Perception on the feasibility of aquaculture development				χ² (df) [p-value]
		Feasible		Not feasible		
		Count	Percent	Count	Percent	
Main Occupation						7.630 (3) [0.054]
Fishing	131 (65.5)	81	61.8%	50	38.2%	
Fishmonger	66 (33.0)	30	45.5%	36	54.5%	
Driver	1 (0.5)	0	0.0%	1	100.0%	
Farming	2 (1.0)	2	100.0%	0	0.0%	
Secondary occupation						11.437 (7) [0.121]
Fishing	1 0.5	1	100.0%	0	0.0%	
Farming	121 60.5	72	59.5%	49	40.5%	
President (Fishermen association)	3 1.5	3	100.0%	0	0.0%	
Trading	12 (6.0)	3	25.0%	9	75.0%	
Food vendor	6 (3.0)	4	66.7%	2	33.3%	
Fishmonger	2 (1.0)	2	100.0%	0	0.0%	
None	36 (18.0)	17	47.2%	19	52.8%	
Other	19 (9.5)	11	57.9%	8	42.1%	
Experience in fishing						10.081 (2) [0.006*]
0-10	27 (13.5)	17	14.9%	10	11.6%	
11-21	89 (44.5)	60	52.6%	29	33.7%	
Above 21	84 (42.0)	37	32.5%	47	54.7%	
Monthly income Main occupation						6.288 (4) [0.179]
0-500	27 (13.5)	48	52.7%	43	47.3%	
501-2000	62 (31.0)	38	61.3%	24	38.7%	
2001-4000	91 (45.5)	16	59.3%	11	40.7%	
4001-6000	10 (5.5)	8	80.0%	2	20.0%	
Above 6000	10 (5.5)	3	30.0%	7	70.0%	
Monthly income secondary education						5.835 (4) [0.212]
0-500	141 (70.5)	79	56.0%	62	44.0%	
501-2000	19 (9.5)	15	78.9%	4	21.1%	
2001-4000	3 (1.5)	2	66.7%	1	33.3%	
4001-6000	1 (0.5)	1	100.0%	0	0.0%	
Above 6000	1 (0.5)	0	0.0%	1	100.0%	
Livelihood improvement						7.858

Yes	131 (65.5)	84	73.7%	47	54.7%	(1)
No	69 (34.5)	30	26.3%	39	45.3%	[0.005*]
Implementation Barriers						10.584
Lack of technical knowledge and training	76 (38.0)	44	38.6%	32	37.2%	(4) [0.032*]
Uncertainty about market demand	13 (6.5)	3	2.6%	10	11.6%	
Lack of access to quality inputs	10 (5.0)	9	7.9%	1	1.2%	
High initial investment costs	89 (44.5)	51	44.7%	38	44.2%	
Resistance to change	12 (6.0)	7	6.1%	5	5.8%	
Profitability comparison						41.919
Profitable	152 (76.0)	106	93.0%	46	53.5%	(1)
Not profitable	48 (24.0)	8	7.0%	40	46.5%	[0.000*]

For the cultural and traditional factors (Table 6c), there was a significant association between the perceived importance of cultural heritage and aquaculture feasibility $\chi^2(1) = 4.06$, $p = 0.044$. Among those who rated heritage "not important," 50.9% viewed aquaculture as feasible versus 34.9% of those who rated it "important." The extent to which community leaders influenced opinions on aquaculture was significant ($^2(2) = 10.94$, $p = 0.004$). While the pattern was not strictly linear, variations in feasibility perception were noted across the "not at all" "somewhat" and "to a large extent" categories. Respondents who felt leaders exerted influence "somewhat" were more likely to deem aquaculture not feasible (33.7%) than feasible (15.8%). Additionally, respondents' perceptions of traditional beliefs acting as barriers to the adoption of sustainable aquaculture were significantly associated with feasibility perceptions ($\chi^2(2) = 17.69$, $p < 0.001$). Those viewing beliefs as "very likely" barriers were far more inclined to perceive aquaculture as not feasible (41.9%) than feasible (18.4%). Cultural identity and integration was also significant ($\chi^2(1) = 6.27$, $p = 0.012$). Interestingly, respondents affirming strong cultural identity, 79.8% viewed aquaculture as feasible versus 64.0% of those who did not.

Table 6c: Descriptive statistics and univariate test of cultural and traditional factors influencing the feasibility of aquaculture development White Volta basin in Northern region of Ghana

Factors	**Count (%)**	**Perception on the feasibility of aquaculture development**				**χ^2 (df) [p-value]**
		Feasible		**Not feasible**		
		Count	**Percent**	**Count**	**Percent**	

Cultural Heritage & Practices						4.055 (1) [0.044*]
Not important	114 (57.0)	58	50.9%	56	65.1%	
Important	86 (43.0)	56	49.1%	30	34.9%	
Alignment with traditions						1.363 (2) [0.506]
Yes	154 (77.0)	86	55.8%	68	44.2%	
No	27 (13.5)	14	51.9%	13	48.1%	
Not sure	19 (9.5)	13	68.4%	6	31.6%	
Influence of community leaders						10.938 (2) [0.004*]
Not at all	46 (23.0)	33	28.9%	13	15.1%	
Somewhat	47 (23.5)	18	15.8%	29	33.7%	
To a large extent	107 (53.5)	63	55.3%	44	51.2%	
Traditional beliefs as barriers of adoption of sustainable aquaculture						17.692 (2) [0.000*]
Not likely	112 (56.0)	78	68.4%	34	39.5%	
Somewhat likely	31 (15.5)	15	13.2%	16	18.6%	
Very likely	57 (28.5)	21	18.4%	36	41.9%	
Traditional beliefs as barriers of the species of fish consumed or sold						2.090 (2) [0.352]
Yes	81 (40.5)	50	61.7%	31	38.3%	
No	101 (50.5)	52	51.5%	49	48.5%	
I don't know	18 (9.0)	11	61.1%	7	38.9%	
Cultural identity and integration						6.265 (1) [0.012*]
Yes	146 (73.0)	91	79.8%	55	64.0%	
No	54 (27.0)	23	20.2%	31	36.0%	

Among the social and community collaboration factors (Table 6d), chi square test confirmed the significance of community events in influencing aquaculture perceptions ($\chi^2(2) = 6.85$, $p = 0.033$). Those who saw a significant role for community events were most likely to perceive aquaculture as feasible (74.6%), compared to those who saw "some" role (48.4%) or "no" role (41.4%). Also, respondents' openness to innovation was significantly related to feasibility perceptions ($\chi^2(2) = 12.08$, $p = 0.002$). Those very open to innovation were much more likely to view aquaculture as feasible (79.8%) than those somewhat open (47.6%) or not open (34.2%). The perceived success of collaborative efforts was significantly associated with aquaculture feasibility ($\chi^2(2) = 10.70$, $p = 0.005$). Respondents reporting success "to a large extent" were most likely to perceive feasibility (69.3%), whereas those reporting "some" success (50.0%) or "no" success (38.1%) were less likely to do so.

Table 6d: Descriptive statistics and univariate test of social and community collaboration factors influencing the feasibility of aquaculture development White Volta basin in Northern region of Ghana

Factors	Count (%)	Perception on the feasibility of aquaculture development				χ^2 (df) [p-value]
		Feasible		Not feasible		
		Count	Percent	Count	Percent	
Resource Sharing						1.143 (1) [0.285]
Not supportive	12 (6.0)	5	41.7%	7	58.3%	
Supportive	188 (94.0)	108	57.4%	80	42.6%	
Role of community events						6.847 (2) [0.033*]
Significant role	136 (68.0)	85	74.6%	51	59.3%	
Some role	33 (16.5)	16	14.0%	17	19.8%	
No role	31 (15.5)	13	11.4%	18	20.9%	
Openness to innovation						12.076 (2) [0.002*]
Very open	141 (70.5)	91	79.8%	50	58.1%	
Somewhat open	21 (10.5)	10	8.8%	11	12.8%	
Not open	38 (19.0)	13	11.4%	25	29.1%	
Collaborative success						10.704 (2) [0.005*]
To a large extent	120 (60.0)	79	69.3%	41	47.7%	
Somehow	38 (19.0)	19	16.7%	19	22.1%	
Not at all	42 (21.0)	16	14.0%	26	30.2%	

Concerning the environmental and institutional factors (Table 6e), the perception of biodiversity benefits from aquaculture was significantly associated with feasibility ($\chi^2(1) = 23.58$, $p < 0.001$). Notably, among respondents who believed aquaculture would confer biodiversity benefits, only 35.1% judged it feasible, whereas 64.9% of those who did not foresee such benefits judged it feasible. Conversely, 69.8% of the "benefits" group deemed it not feasible versus 30.2% of the "no benefits" group. Perceptions of environmental impact were unrelated to feasibility judgments ($\chi^2(2) = 1.75$, $p = 0.416$). Feasibility was similar whether respondents expected negative impacts (48.5% feasible), no significant impact (100% feasible), or positive impacts (57.8% feasible).

Table 6e: Descriptive statistics and univariate test of environmental and biodiversity factors influencing the feasibility of aquaculture development White Volta basin in Northern region of Ghana

Factors	Count (%)	Perception on the feasibility of aquaculture development		χ^2 (df) [p-value]
		Feasible	Not feasible	

		Count	Percent	Count	Percent	
Biodiversity benefits						23.582 (1) [0.000*]
Yes	100 (50)	40	35.1%	60	69.8%	
No	100 (50)	74	64.9%	26	30.2%	
Environmental impact						1.752 (2) [0.416]
Negative impacts	33 (16.5)	16	48.5%	17	51.5%	
No significant impact	1 (0.5)	1	100.0%	0	0.0%	
Positive impacts	166 (83.0)	96	57.8%	70	42.2%	

Finally, on the institutional and support factors (Table 6f), the perceived importance of government support was significantly related to aquaculture feasibility ($\chi^2(2) = 8.72$, $p = 0.013$.). Of those who considered government support "very important" (52.5%), 61.4% judged aquaculture development feasible versus 40.7% not feasible. In contrast, among participants who rated it "somewhat important" (30.5%), only 23.7% saw feasibility (39.5% not feasible), and among those who saw it as "not important" (17.0%), 14.9% viewed it as feasible (19.8% not feasible).

Table 6f: Descriptive statistics and univariate test of institutional and support factors influencing the feasibility of aquaculture development White Volta basin in Northern region of Ghana

Factors	**Count (%)**	**Perception on the feasibility of aquaculture development**				**χ² (df) [p-value]**
		Feasible		**Not feasible**		
		Count	**Percent**	**Count**	**Percent**	
Government support						8.721 (2) [0.013*]
Very important	105 (52.5)	70	61.4%	35	40.7%	
Somewhat important	61 (30.5)	27	23.7%	34	39.5%	
Not important	34 (17.0)	17	14.9%	17	19.8%	
Capacity and confidence						1.543 (3) [0.672]
Not confident	1 (0.5)	1	100.0%	0	0.0%	
Somehow confident	8 (4.0)	5	62.5%	3	37.5%	
Very confident	188 (94.0)	106	56.4%	82	43.6%	
I can't tell	3 (1.5)	1	33.3%	2	66.7%	
Adoption of new technologies						1.642 (2) [0.440]
Very likely	107 (53.5)	62	57.9%	45	42.1%	
Somehow likely	49 (24.5)	24	49.0%	25	51.0%	
Not likely	44 (22.0)	27	61.4%	17	38.6%	

4.2.3. Binary logistic regression analysis for the feasibility of aquaculture development

A binary logistic regression was conducted to identify predictors of respondents' perceptions that aquaculture development is feasible (Table 7). The overall model included socio-demographic, economic, cultural, social, and environmental/institutional factors. The results showed that age, implementation barriers, profitability perceptions, cultural identity, traditional beliefs, and biodiversity benefits significantly predicted respondents' perceptions of aquaculture feasibility in the White Volta Basin. Regarding the age, compared to respondents aged 18–25 (reference category), respondents aged 34–41 were significantly less likely to view aquaculture as feasible (B = -1.466, p = 0.041, OR = 0.23, 95% CI [0.06, 0.94]) with a significant reduced odd. Older age groups (26–33 and above 41) showed no significant differences.

For the implementation barriers, respondents reporting lack of access to quality inputs as barrier to aquaculture development were significantly less likely to perceive aquaculture as feasible (B = -3.782, p = 0.044, OR = 0.02, 95% CI [0.001, 0.91]). Additionally, respondents citing "uncertainty about market demand" as an implementation barrier were significantly less likely to perceive aquaculture as feasible (B = 1.822, p = 0.066, OR = 6.19, 95% CI [0.88, 43.30]). This indicates that such uncertainty drastically reduces the odds of viewing aquaculture favourably. On the profitability of aquaculture, respondents who perceived aquaculture as "Less profitable" had 8.48 times higher odds of viewing it as feasible compared to those who deemed it profitable (B = 2.137, p = 0.005 OR = 8.48, 95% CI [1.92, 37.51]). This counterintuitive result implies non-economic motivations (e.g., food security or cultural value) may drive feasibility perceptions.

On the cultural identity and integration, respondents who said "no" cultural identity and integration (relative to those who affirmed it) reported 6.71 times higher odds of feasibility (B = 1.904, p = .002 OR = 6.71, 95% CI [2.05, 21.99]), indicating that reduced cultural alignment may foster openness to aquaculture. This result was confirmed during the focus group discussion in Dapali where a participant confirmed that *"I don't see aquaculture as something tied to our traditions, and honestly, that's why I think it could work here. Our old ways are important, but they haven't stopped the struggles we face. If we keep waiting for methods that 'fit' our culture perfectly, we'll never progress. Aquaculture might feel foreign, but that's exactly why it could bring new opportunities. My family needs income now, even if it means trying something that doesn't mirror our heritage. Sometimes, you have to let go of the past to survive in the present."* (**FGD: Dapali; participant #° 7**).

Perceptions regarding biodiversity benefits were also significant predictors. Compared to respondents who perceived aquaculture as providing biodiversity benefits. Those who answered "No" (B = -2.365, p < 0.001OR = 0.09, 95% CI [0.03, 0.27]) were substantially less likely to view aquaculture as feasible. In our discussion (FDG in Nawuni), one participant shared his perspective by saying, "*Honestly, I just can't see aquaculture as a benefit to our local wildlife. When I look at our natural rivers, I worry that turning them into controlled aquaculture environments might actually reduce the variety of species we have. If* *aquaculture doesn't clearly enhance biodiversity or support our native life, then how can it really be a good option for us*" (**FDG Nawuni, participant #° 6**). These point of view shows that successful implementation of aquaculture not only depends on technical or economic factors but also heavily relies on environmental perceptions and cultural acceptance within the community. Awareness activities are needed to enhance local communities' knowledge and perception about aquaculture.

Table 7: Result of the binary logistic regression analysis for the feasibility of aquaculture development in white Volta basin in Northern Ghana

Factor	**Coefficient (B)**	**S.E.**	**Sig.**	**Odd Ratio (OR)**	**95% C.I. for OR**	
					Lower	**Upper**
Gender (Ref.: Male)						
Female	0.334	0.855	0.696	1.397	0.262	7.460
Age (Ref.: 18-25)						
26-33	-1.527	1.026	0.136	0.217	0.029	1.620
34-41	-1.466	0.718	0.041*	0.231	0.057	0.943
Above 41	-1.158	0.770	0.132	0.314	0.069	1.420
Educational level (Ref.: No formal education)						
Primary	-0.249	0.743	0.738	0.780	0.182	3.347
Junior high school/Senior high school	0.567	0.798	0.477	1.764	0.369	8.431
Tertiary education	0.076	1.076	0.944	1.079	0.131	8.881
Experience in fishing (Ref.: 0-10 years)						
11-21	0.800	0.746	0.283	2.226	0.516	9.598
Above 21	0.008	0.866	0.992	1.008	0.185	5.502
Livelihood improvement (Ref.: Yes)						
No	-0.445	0.649	0.493	0.641	0.180	2.286
Implementation barriers (Ref.: Lack of technical knowledge and training)						
Uncertainty about market demand	1.822	0.993	0.066	6.186	0.884	43.304
Lack of access to quality inputs	-3.782	1.879	0.044*	0.023	0.001	0.906
High initial investment costs	-1.187	0.690	0.085	0.305	0.079	1.180
Resistance to change	0.297	1.175	0.801	1.345	0.135	13.453
Profitability comparison (Ref.: Profitable)						
Less profitable	2.137	0.759	0.005*	8.477	1.916	37.507
Cultural heritage practices (ref.: Not important)						
Important	0.558	0.498	0.262	1.748	0.659	4.638
Influence of community leaders (Ref.: Not at all)						

Somewhat	0.908	0.699	0.194	2.480	0.630	9.760
To a large extent	0.441	0.564	0.434	1.555	0.515	4.697
Traditional beliefs as barriers of adoption Aquaculture (Ref.: Not likely)						
Somewhat likely	0.687	0.747	0.358	1.987	0.460	8.587
Very likely	1.462	0.659	0.026*	4.316	1.186	15.702
Cultural identity and integration (Ref.: Yes)						
No	1.904	0.605	0.002*	6.713	2.049	21.990
Role of community events (Ref.: Significant role)						
Some role	0.744	0.640	0.245	2.104	0.600	7.376
No role	-0.472	0.751	0.529	0.624	0.143	2.715
Openness to innovation (Ref.: Very open)						
Somewhat open	0.407	0.832	0.624	1.503	0.295	7.669
Not open	0.542	0.881	0.539	1.719	0.305	9.671
Collaborative success (Ref.: To a large extent)						
Somehow	0.928	0.646	0.151	2.530	0.714	8.970
Not at all	0.914	0.692	0.186	2.495	0.643	9.677
Biodiversity benefits (Ref.: Yes)						
No	-2.365	0.531	0.000*	0.094	0.033	0.266
Government support (Ref.: Very important)						
Somewhat important	-0.051	0.570	0.929	0.951	0.311	2.906
Not important	-0.340	0.713	0.633	0.712	0.176	2.879
Constant	-1.059	1.121	0.345	0.347		

*= 5% level of significance

4.3. Objective 3: Identify suitable sites for pond aquaculture development

A suitability analysis was conducted using Geographic Information System (GIS) tools to identify appropriate sites for pond aquaculture development in the White Volta Basin. The study aimed to assess and classify land suitability based on key environmental and socioeconomic factors to ensure sustainable aquaculture development without compromising biodiversity and existing land use patterns.

Following the map generation (figure 3), site visits were conducted in collaboration with community members from the fishing communities to validate and confirm the accuracy of the identified suitable sites. These field assessments provided additional insights into local environmental conditions and reinforced the practical applicability of the suitability model. The successful identification of suitable pond aquaculture sites provides a strong foundation for future aquaculture expansion in the White Volta Basin. Moving forward, we believe that these findings will be instrumental in guiding community-based aquaculture initiatives, ensuring environmentally sustainable fish farming practices, and enhancing livelihoods through diversified income sources.

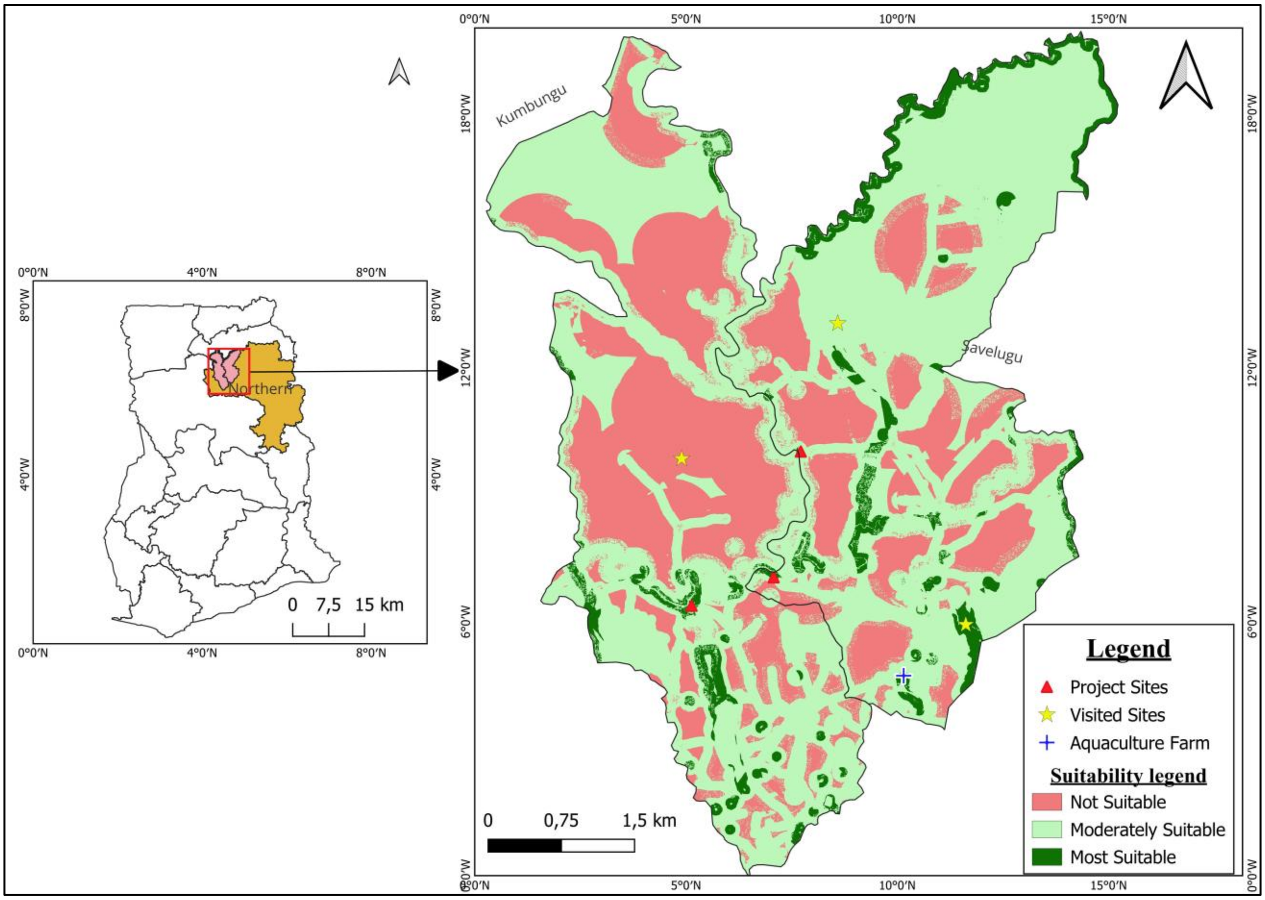

Figure 3: Suitability map for earthen pond aquaculture development in the white volta basin in Northern region of Ghana

The suitability modeling categorized the land in the White Volta Basin into three main classes: Not Suitable, Moderately Suitable, and Most Suitable for pond aquaculture. The results indicated that 1059.01 km² (34.4%) of the land was classified as Not Suitable, 1841.74 km² (60%) was found to be Moderately Suitable, and 173.46 km² (5.6%) was identified as the Most Suitable areas for pond aquaculture development (figure 4).

Also, the suitability map, along with the geographic coordinates of the most suitable sites, was shared with fishing community members to facilitate informed decision-making.

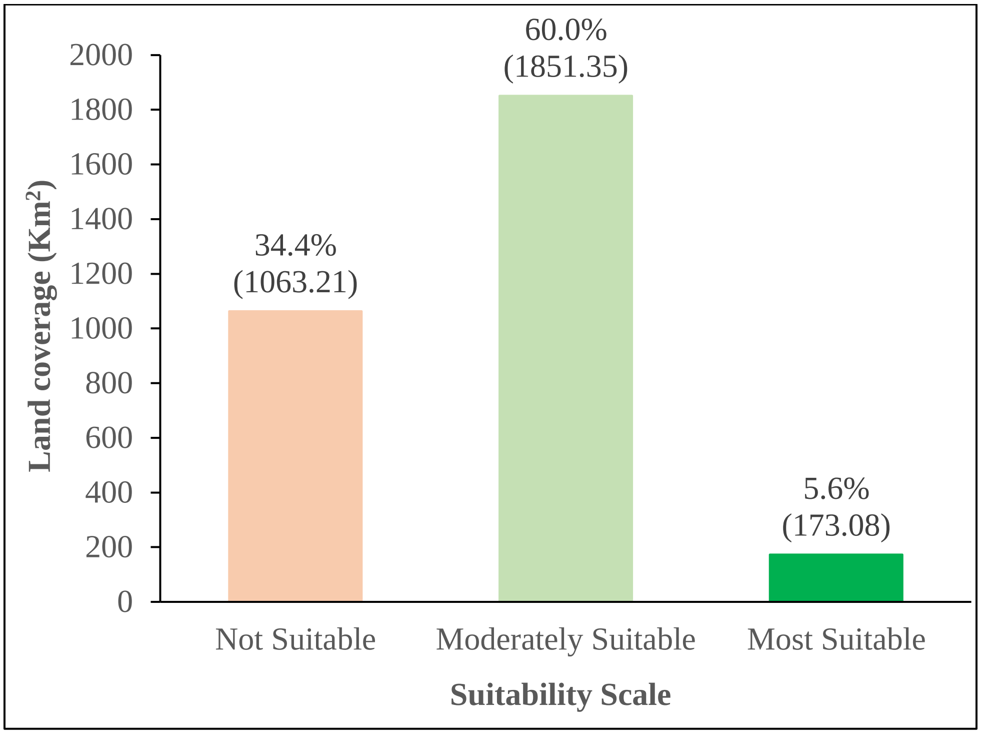

Figure 4: Suitability land coverages of the earthen pond aquaculture site identification in the White Volta River in northern Ghana

Figure 5: Consultative workshop with local fishermen associations to discuss and identify key factors for earthen pond aquaculture site identification in the White Volta River in northern Ghana

4.4. Objective 4: Create awareness of fishpond farming adoption for livelihood diversification

As part of efforts to promote sustainable fishing practices and enhance livelihood diversification among fishing communities, an awareness creation activity was organized in three fishing communities: Adayili, Dapali, and Nawuni. This was done to introduce local fishermen, fishmongers, local fisheries managers, and other community members to fishpond farming as an alternative source of income while promoting fish biodiversity conservation. During the sessions, the participants expressed interest in fish biodiversity conservation and recognized fish farming as a viable source of income that could contribute to protecting fish populations in the White Volta River. The awareness creation was facilitated using specially developed information materials, including pamphlets and posters. The activities were structured as follows:

- **Presentation of survey findings**

Participants were taken through the findings of a previous survey conducted on fish biodiversity and community fishing practices. Also, the importance of conserving fish biodiversity was emphasized, highlighting how unsustainable fishing practices contribute to ecosystem degradation.

- **Education on ecosystem protection and sustainable fishing practices**

Using posters, participants were educated on key practices to avoid ecosystem degradation and protect fish species in the White Volta River. The discussion centered on responsible fishing methods, the protection of endangered species, and the role of local communities in conservation efforts.

- **Introduction to fishpond farming**

Fishpond farming was introduced as a practical and sustainable approach to livelihood diversification. Participants learned about the economic benefits of fish farming and how it could reduce overdependence on wild fish stocks.

- **Presentation of suitable aquaculture site identification Map**

The results of the suitable aquaculture site identification study were shared with the communities. The importance of selecting appropriate locations for fishpond construction was emphasized to ensure sustainability and productivity.

A key outcome of the awareness program was the engagement of local authorities on the need to preserve endangered fish species and advocate for sustainable fishing practices. This engagement aimed to secure support for conservation initiatives and policy enforcement on sustainable fisheries management in the White Volta River. The awareness creation activities successfully increased community interest in fish biodiversity conservation and fishpond farming.

Figure 6: Some picture took during the awareness campaign in the project sites

4.5. Objective 5: Train fishing communities on approaches to developing pond aquaculture without interfering with biodiversity

In other to promote sustainable aquaculture practices without compromising biodiversity, a comprehensive training program was conducted for fishing communities in Adayili, Dapali, and Nawuni. The training engaged fishermen, local authorities, and district assembly members, equipping them with knowledge on selecting suitable sites for aquaculture, pond design and construction, stocking ponds with fingerlings, feeds and feeding strategies, pond management, harvesting, and marketing. A key aspect of the training was the production of fish feed using locally available ingredients, including maggot production as an alternative protein source. Participants were also introduced to aquaponic systems as a sustainable method for integrating fish farming with plant cultivation. The training was delivered using PowerPoint presentations, pamphlets, and video tutorials to enhance understanding. Following the training, a site visit was organized to one of the identified suitable locations, allowing participants to observe firsthand the practical aspects of aquaculture site selection. The training resulted in enhanced knowledge and skills among participants, increased community interest in pond aquaculture as an alternative livelihood, and reinforced commitment to biodiversity conservation. The successful execution of this initiative has laid a strong foundation for environmentally responsible fish farming in the participating communities. Moving forward, additional technical support and stakeholder engagement would be pursued to ensure the long-term sustainability of the intervention.

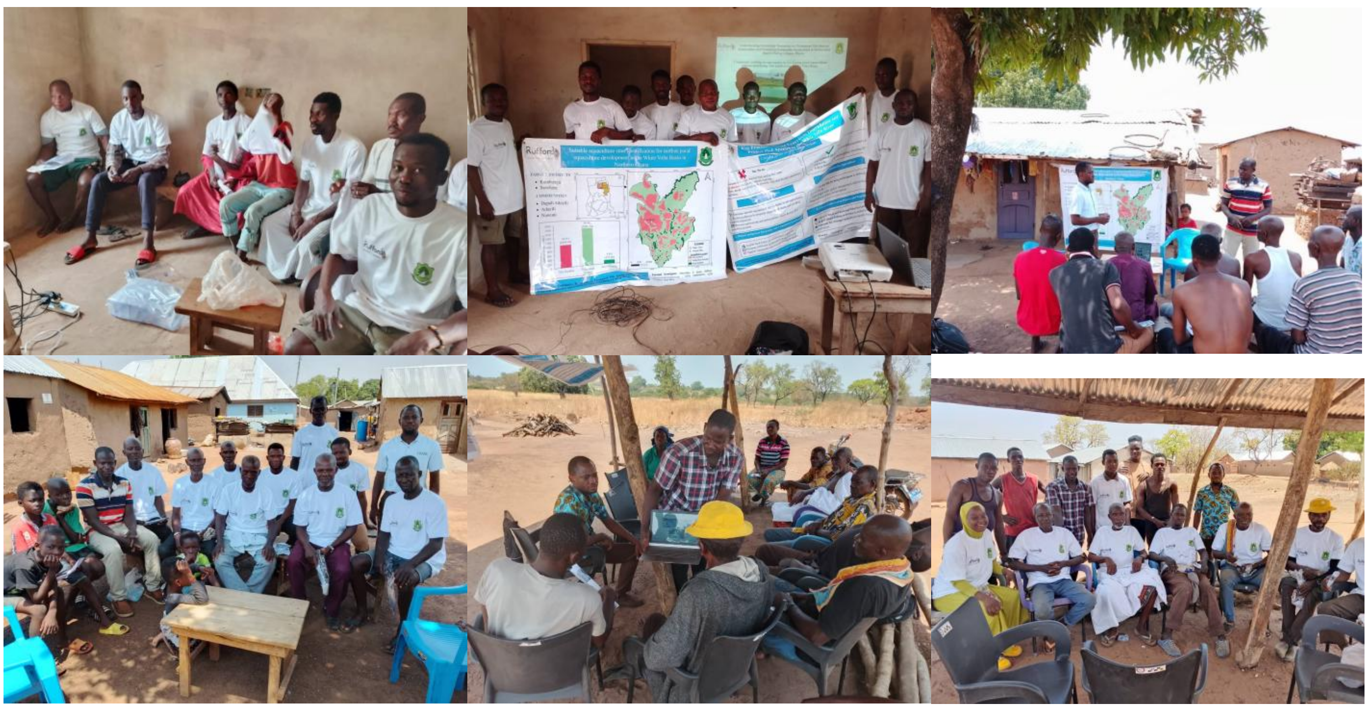

Figure 7: Some picture took during the training activities in the White volta basin in northern Ghana

Figure 8: Suitable earthen pond aquaculture site visit along the white volta river in the northern Ghana

5. Conclusion

Over the one year of the project execution, research and practical conservation actions have been successful implemented in the White Volta Basin Northern Ghana. Despite the relatively high recognition of the importance of conservation, the majority of community members remain unaware of global conservation frameworks such as the IUCN Red List. Knowledge of existing fish conservation laws and regulations is limited, potentially impeding compliance and enforcement efforts. Informal and community-based information sources, such as parental teachings and community meetings, are the primary source of knowledge dissemination. However, formal education and media play a minimal role in conservation awareness. Strengthening conservation messaging through schools, government programs, and mass media could significantly improve knowledge transfer and influence behavioural change. Unsustainable fishing practices, habitat destruction, and pollution were identified as the primary threats to fish biodiversity. The use of inappropriate fishing gear, capture of fingerlings, over exploitation, and destructive methods such as the use of chemicals and explosives pose significant risks to aquatic ecosystems. Additionally, non-fishing-related threats, including sand weaning, farming along riverbanks, and waste disposal into water bodies, contribute to environmental degradation. Addressing these challenges requires a multi-faceted approach involving policy enforcement, community participation, and sustainable livelihood alternatives. Participation in fish biodiversity conservation efforts remains low, with economic constraints, lack of awareness, and time limitations being key barriers. While some individuals practice sustainable fishing and educate others, organized conservation initiatives face limited engagement. Economic incentives and financial support could serve as effective motivators to enhance conservation participation. Regarding aquaculture development, the findings indicate that a majority of respondents perceive aquaculture as a feasible alternative to traditional fishing, particularly among younger individuals and those with higher educational attainment. However, significant variations exist based on socio-demographic factors, economic prospects, and cultural influences. Addressing concerns related to profitability, cultural heritage, and traditional beliefs will be essential in fostering the adoption of aquaculture as a sustainable livelihood strategy.

The execution of our project showed the need for integrated conservation strategies that combine policy enforcement, community education, and economic incentives to promote sustainable fishing practices and biodiversity conservation and we hope that future interventions through the Rufford foundation grant will help us strengthen institutional support, leveraging traditional knowledge, and enhancing aquaculture feasibility to ensure the long-term sustainability of fish biodiversity in the White Volta Basin.

6. References

Ahmed, S. F., Kumar, P. S., Kabir, M., Zuhara, F. T., Mehjabin, A., Tasannum, N., Hoang, A. T., Kabir, Z., & Mofijur, M. (2022). Threats, challenges and sustainable conservation strategies for freshwater biodiversity. *Environmental Research*, *214*, 113808.

Cardia, F., Ciattaglia, A., & Corner, R. A. (2017). *Guidelines and Criteria on Technical and Environmental Aspects of Cage Aquaculture Site Selection in the Kingdom of Saudi Arabia.* [Report]. Food and Agriculture Organization of the United Nations (FAO). https://doi.org/10.25607/OBP-1548

Emmanuel, E. I., Asuquo, I. E., & Abiaobo, N. O. (2016). Threatened and endangered fish species in Nigeria, A menace to biodiversity–A Review. *African Journal of Education, Science and Technology*, *3*(1), 12–26.

Saaty, T. L. (1990). How to make a decision: The analytic hierarchy process. *European Journal of Operational Research*, *48*(1), 9–26.

Yeboah, A. A. (2014). Distribution and Utilization of Freshwater Oyster, Etheria Sp.(Bivalvia, Unioniforme, Etheriidae) in the Major Rivers of Northern Volta Basin of Ghana. *Ghana Journal of Science, Technology and Development*, *1*(1), 27–37.

Annexes

Annex 1: Toolkit used during awareness creation and training

Annex 2: Endangered and critically endangered fish species pictorial checklists used during surveys

Protecting Our Waters: Fish Biodiversity Conservation & Sustainable Aquaculture in the White Volta Basin

Protecting Our Fish, Securing Our Future

TARGET DISTRICTS

Kumbungu
Savelugu

Why Does Fish Biodiversity Matter?

Fish biodiversity is essential for the health of our rivers, the sustainability of our fisheries, and the livelihoods of local communities. However, many fish species in the White Volta Basin are under threat due to unsustainable fishing practices, habitat destruction, and pollution. Conserving fish biodiversity ensures food security, income generation, and the long-term health of our aquatic ecosystems.

Current Awareness of Fish Conservation

Our recent survey revealed that:

- Only **2.5%** of respondents were aware of the **IUCN Red List** of threatened fish species.
- Despite this, **86.3%** of respondents recognized the **importance of fish biodiversity conservation**.
- However, in-depth knowledge remains low, with only **10%** of respondents have knowledge on fish conservation.
- **58.3%** of respondents were unaware of **existing fish conservation regulations**.

Threats to Fish Biodiversity in the White Volta Basin

Several human activities are endangering fish biodiversity in the region:

- **Use of small fishing nets (62.5%)** and **capture of fingerlings (52.1%)** threaten fish populations.
- **Overexploitation (42.9%)** and illegal fishing methods such as the use of **chemicals (37.9%)** and **explosives (33.3%)**.
- **Sand weaning (13.8%)**, **farming near riverbanks (8.8%)**, and **waste dumping (10%)** pollute water bodies, affecting fish health.
- **Opening of the Bagri Dam (4.2%)** and **noise pollution (4.6%)** add further stress to the River.

Endengered Fish Species identified

- *Nimbapanchax petersi*
- *Synodontis macrophthalmus*
- *Fundulopanchax gularis*
- *Brycinus brevis*
- *Limbochromis robertsi*
- *Pronothobranchius seymouri*
- *Mormyrus subundulatus*
- *Megalops atlanticus*
- *Clarias laeviceps*
- *Enteromius subinensis*

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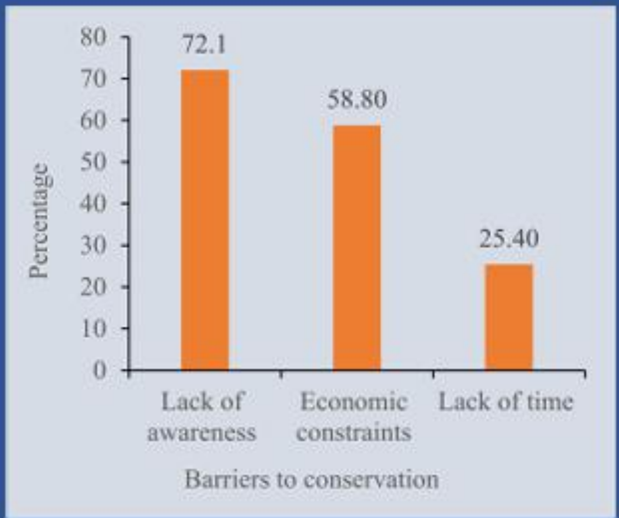
Community Engagement in Fish Conservation

While some community members are engaged in conservation efforts, participation remains **low (35.0%)**. The main conservation activities include:

- Sustainable fishing practices (**77.4%**)
- Educating others on conservation (**42.9%**)
- Participation in conservation programs **(44.0%)**

Barriers to Conservation Participation



Sustainable Aquaculture: An Alternative Livelihood

To reduce pressure on wild fish stocks and provide alternative income sources, we encourage the adoption of **pond aquaculture**.

Why sustainable pond aquaculture

- **Reliable source of income** for fishing communities.
- **Reduces overfishing** by providing an alternative to wild fish capture.
- **Enhances food security** through steady fish production.
- **Less environmental impact** compared to overfishing.

How Can You Get Involved?

- **Adopt sustainable fishing methods** to protect fish populations.
- **Participate in conservation programs** and community discussions.
- **Educate others** about the importance of fish biodiversity conservation.
- **Explore pond aquaculture** as a sustainable alternative to fishing.
- **Advocate for better conservation policies** and enforcement of fishing

Together, We Can Make a Difference!

Protecting our fish biodiversity is vital for the future of our communities. By raising awareness, adopting sustainable practices, and promoting aquaculture, we can safeguard our aquatic resources for generations to come.

Project: Understanding Community Perception on Threatened Fish Species Conservation and Promoting Sustainable Aquaculture in White Volta Basin's Fishing Villages, Ghana

Principal Investigator: Orou-Seko C Abdou (MPhil), abdouorouseko@gmail.com , (233) 2466850570, (229) 64249655; **Year 2024**

Understanding Community Perception on Threatened Fish Species Conservation and Promoting Sustainable Aquaculture in White Volta Basin's Fishing Villages, Ghana

1. Understanding Pond Aquaculture

1.1 What is Pond Aquaculture?

Pond aquaculture, also known as fish farming, involves raising fish in controlled pond environments for commercial or subsistence purposes.

1.2 Importance of Sustainable Aquaculture

Sustainable aquaculture ensures that fish farming practices do not harm local biodiversity or ecosystems. It provides economic opportunities while maintaining ecological balance.

1.3 Differences Between Traditional and Modern Pond Aquaculture

Traditional pond aquaculture relies on natural water bodies, while modern methods use managed ponds with controlled feeding, stocking, and water quality management to maximize productivity and sustainability.

2. Site Selection and Pond Design

2.1 Criteria for Selecting a Suitable Site

Selecting the right location is crucial for successful aquaculture. Factors to consider include water availability, soil quality, accessibility, and minimal environmental impact.

2.2 Designing and Constructing a Pond

Proper pond design ensures optimal fish growth and environmental sustainability. This includes determining pond size, depth, and drainage systems.

2.3 Water Management for Sustainable Aquaculture

Water quality management, including pH levels, oxygen availability, and pollution control, is essential for healthy fish populations and biodiversity conservation.

3. Fish Species Selection and Stocking Methods

3.1 Choosing the Right Fish Species

Selecting fish species that are compatible with local biodiversity and market demand is key to sustainable aquaculture. Indigenous species are often preferred to prevent ecosystem disruption.

3.2 Proper Stocking Density

Maintaining the right number of fish per pond prevents overcrowding, reduces disease risks, and ensures sustainable growth.

3.3 Feeding and Nutrition for Sustainable Growth

Balanced diets, natural feeds, and eco-friendly feeding practices enhance fish health and reduce environmental pollution.

4. Biodiversity Conservation and Environmental Management

4.1 The Impact of Aquaculture on Biodiversity

Unregulated fish farming can lead to habitat destruction, water pollution, and loss of native fish species. Sustainable practices help mitigate these risks.

4.2 Best Practices for Biodiversity Conservation

Using eco-friendly inputs, maintaining natural vegetation, and adopting responsible waste management help protect aquatic ecosystems.

4.3 Integrated Aquaculture Systems

Combining fish farming with crops or livestock (e.g., rice-fish farming) reduces waste, enhances productivity, and promotes biodiversity conservation.

5. Economic Benefits and Market Opportunities

5.1 Economic Advantages of Pond Aquaculture

Aquaculture provides food security, generates income, and creates employment opportunities within fishing communities.

5.2 Accessing Markets and Value Addition

Training on fish processing, packaging, and marketing strategies enhances profitability and ensures sustainable livelihoods.

5.3 Financial Management and Business Planning

Teaching financial literacy, cost management, and investment planning helps fish farmers run profitable and sustainable aquaculture businesses.

Conclusion and Next Steps

By adopting sustainable pond aquaculture practices, fishing communities can enhance their livelihoods while contributing to biodiversity conservation. Ongoing training, policy support, and community engagement will be essential for long-term success.

Contact

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Year 2024

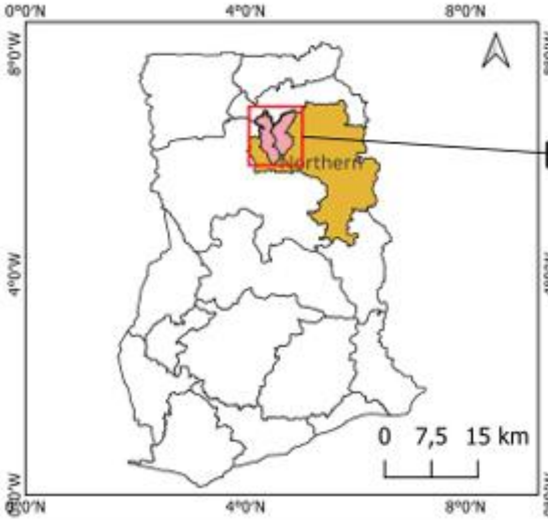
Suitable aquaculture sites identification for earthen pond aquaculture development in the White Volta Basin in Northern Ghana

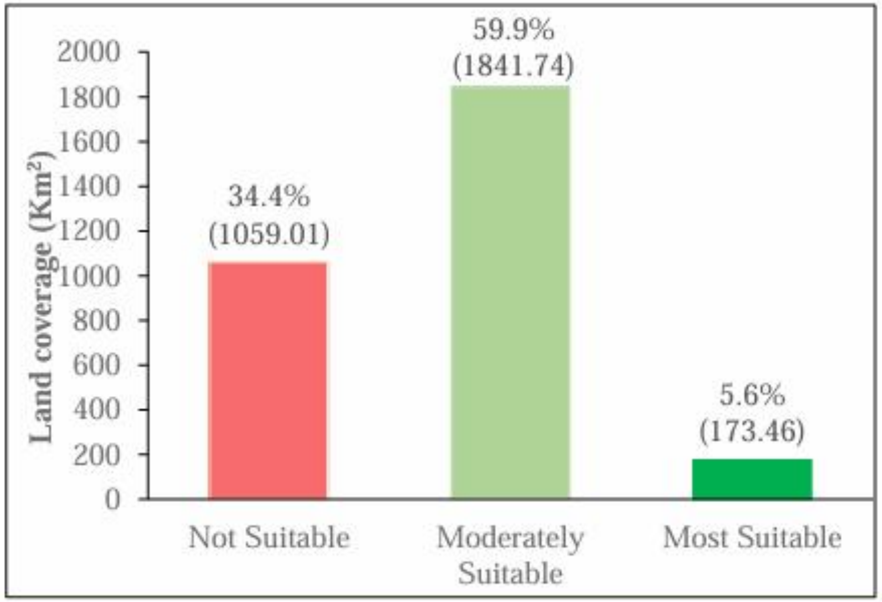
TARGET DISTRICTS

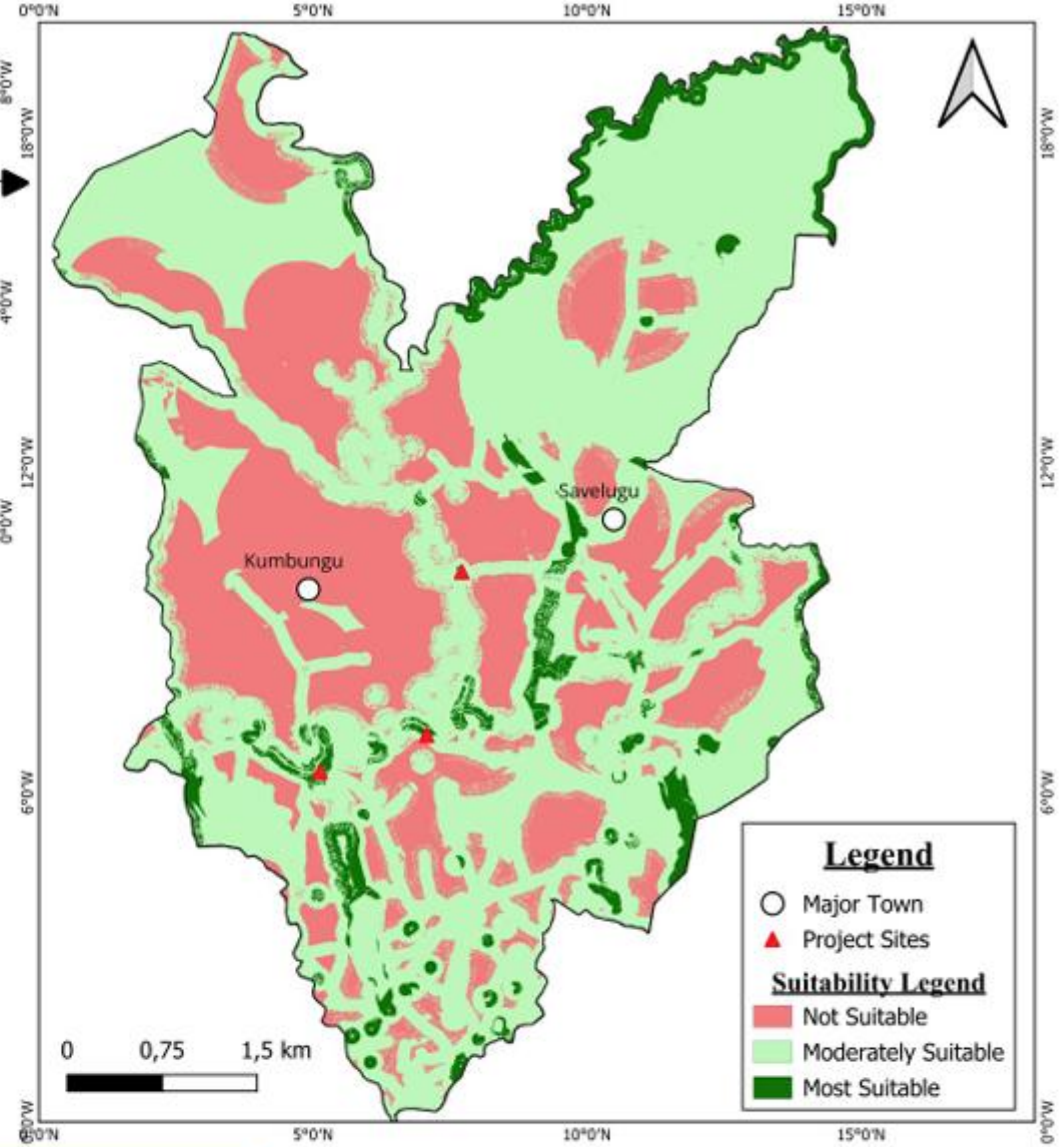
- Kumbungu
- Savelugu

COMMUNITIES

- Dapali Adayili
- Adayili
- Nawuni







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Key Practices to Avoid Ecosystem Degradation and Protect Fish Species in the White Volta River

1. Avoid Illegal and Destructive Fishing Methods

Say No to:

- **Poisonous chemicals** that kill fish and pollute water.
- **Explosives** which destroy aquatic habitats.
- **Fine mesh nets**, which catch juvenile fish and disrupt population balance.

Instead:

- Use **regulated fishing gear** to allow fish populations to regenerate.
- Follow **seasonal fishing bans** to protect breeding fish.

2. Protect Aquatic Habitats

Maintain natural vegetation along riverbanks to prevent erosion.
Reduce pollution by properly disposing of waste and avoiding harmful chemicals.
Prevent sand mining and deforestation, which destroy fish breeding grounds.

3. Promote Sustainable Aquaculture

Use **eco-friendly fish farming techniques** to reduce pressure on wild fish stocks.
Ensure proper water quality management and avoid excessive feeding to prevent water contamination.

4. Respect Indigenous Knowledge and Community Involvement

Engage local fishers in conservation initiatives.
Promote traditional sustainable fishing practices.
Support community-led river monitoring programs.

5. Enforce Conservation Policies and Regulations

Adhere to **local and national fisheries laws**.
Report illegal fishing activities to authorities.
Advocate for stronger policies on aquatic biodiversity conservation.

Project: Understanding Community Perception on Threatened Fish Species Conservation and Promoting Sustainable Aquaculture in White Volta Basin's Fishing Villages, Ghana

Principal Investigator: Orou-Seko C Abdou (MPhil), abdouorouseko@gmail.com , (233) 2466850570, (229) 64249655; **Year 2024**

National and Global Threatened Fresh Water Fish Species Pictorial Checklist

Intervention Communities

Nawuni, Adayili, Dapali

By: Orou-Seko C Abdou (Mphil) as part of the Rufford project_43601-1 with UDS

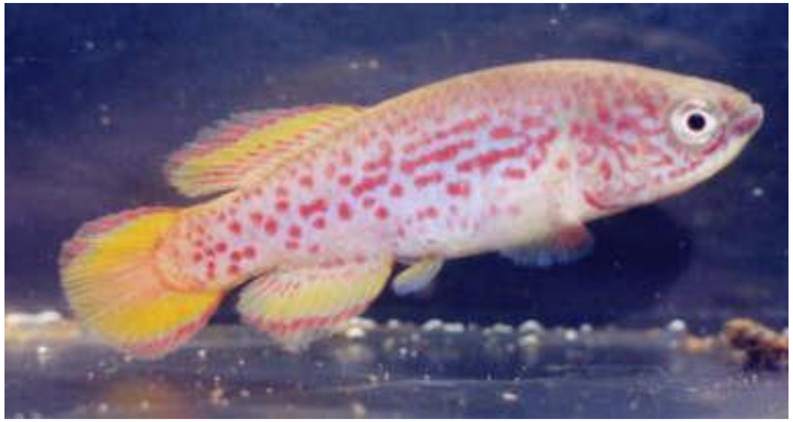
September 2024

Nimbapanchax petersi

Fundulopanchax gularis

Brycinus brevis

Limbochromis robertsi



Pronothobranchius seymouri

Synodontis macrophthalmus

Mormyrus subundulatus

Clarias laeviceps

Enteromius subinensis

Lepidarchus adonis

Chrysichthys walkeri

Bathygobius burtoni

Corcyrogobius lubbocki