FACULTY OF SCIENCE AND EDUCATION

DEPARTMENT OF BIOLOGY

ASSESING THE ABUNDANCE OF FISH SPECIES IN RELATION TO PHYSICAL CHEMICAL PARAMETERS AND HUMAN ACTIVITIES IN NAGONGERA STREAM, NAGONGERA TOWN COUNCIL TORORO DISTRICT

By

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Report submitted to the Department of Biology in partial fulfillment of the requirements for the award of the Degree of Bachelor of Science Education of Busitema University

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DECLARATION

I **CHEROP AGGREY, declare** to the best of my understanding that this research entitled "**assessing the abundance of fish species in relation to physico-chemical parameters and human activities in Nagongera stream, Nagongera town council, Tororo district, Uganda"** is my original work and has never been presented to any other institution of higher learning for a scholarly award before. I therefore present it for the award of a bachelor's degree of science education of Busitema University.

Signature ....

Date 28th/08/2026

APPROVAL

The undersigned certify that research work titled **"Assessing the abundance of fish species in relation to physico-chemical parameters and human activities in Nagongera stream, Nagongera town council, Tororo district, Uganda"** has been developed under their supervision as the candidate's university supervisors and now approved for submission.

Mr. Kifuko Richard

Signature ....

Date 28th/08/2026..............................

DEDICATION

I dedicate this research report to the university Biology department and my supervisor and without their commitment, understanding, support and most of all love, the completion of this report would have not been possible.

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I sincerely thank the almighty God for my life and the gift of perseverance He gave me throughout this research and my educational journey through the various levels that I have gone to this point of university. I wish to acknowledge and appreciate the valuable contribution of my supervisor Mr. Kifuko Richard and Mr. Olowo Moses (Lab technician) who tirelessly guided me throughout my research work.

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ABSTRACT

This study assessed fish abundance in relation to physico-chemical parameters and human activities in Nagongera Stream. A cross-sectional design was used with three sampling stations (upstream, midstream and downstream). Fish were sampled using hooks and identified to species level while water quality parameters (temperature, pH, turbidity, electrical conductivity and dissolved oxygen) were measured in situ using portable meters. Structured questionnaires and key informant interviews assessed human activities. Results showed high turbidity (301 NTU), slightly alkaline pH (8.23), moderate conductivity (208.69 µS/cm) and generally good dissolved oxygen (92.18%). Thirty fish belonging to four species were recorded, dominated by *Clarias gariepinus* (63.3%). Respondents identified sand mining, farming and waste disposal as the major threats. The study concluded that human activities influence water quality and fish abundance and recommends improved catchment management, riparian restoration and routine monitoring.

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ABBREVIATIONS / ACRONYMS USED

DO	Dissolved Oxygen
EC	Electrical Conductivity (measured in µS/cm)
NTU	Nephelometric Turbidity Units
°C	Degrees Celsius (temperature)
µs/cm	Microsiemens per centimetre (unit for conductivity)

DEFINITION OF KEY TERMS USED

Fish species diversity / Fish assemblage: The variety and composition of different fish species in the ecosystem. Includes richness (number of species) and evenness (how evenly distributed individuals are among species). Assessed using indices like Shannon-Wiener.

Physico-chemical parameters: Physical and chemical properties of water that influence aquatic life. In this study: temperature, pH, dissolved oxygen (DO), turbidity, and electrical conductivity (EC).

Water quality: Overall condition of the stream water, determined by the physico-chemical parameters. Poor quality (e.g., high turbidity, low DO) negatively affects fish.

Human activities Anthropogenic influences. Human-induced pressures on the stream, such as sand mining, agriculture (farming near banks, fertilizer/pesticide use), washing/bathing, waste disposal, and overfishing.

Turbidity. Cloudiness or murkiness of water caused by suspended particles (e.g., from sand mining and runoff). Measured in NTU; high levels (avg. ~301 NTU here) reduce light penetration and harm fish gills/habitat.

Dissolved Oxygen (DO). Amount of oxygen gas dissolved in water, essential for fish respiration. Measured in % saturation; generally good (>85%) but lower midstream in the study.

PH. Measure of water acidity or alkalinity. Slightly alkaline (avg. ~8.23) in the stream.

Electrical Conductivity (EC). Ability of water to conduct electricity, indicating dissolved salts/ions (pollutants). Moderate levels (~208 µS/cm) recorded.

Temperature. Water temperature (°C), which affects fish metabolism, oxygen solubility, and species distribution.

Shannon-Wiener Index. A mathematical index used to calculate species diversity, accounting for both species' richness and evenness.

Sand mining. Extraction of sand from the stream bed or banks, a major activity increasing turbidity and destroying fish habitat.

Agriculture / Agricultural runoff: Farming near the stream, leading to sediment, nutrients, and entering pollutants the water.

Waste disposal. Dumping of domestic or other waste into or near the stream, contributing to pollution.

Sustainable fisheries management. Practices aimed at conserving fish populations and stream health for long-term use, including regulations and restoration.

Clarias gariepinus: African catfish the dominant, pollution-tolerant fish species found (63% of catch).

Oreochromis leucostictus: A tilapia species (cichlid) recorded in smaller numbers.

Enteromius kersteni. A small barb/cyprinid species.

Stream habitat structure. Physical features of the stream (substrate, flow, vegetation, depth) that provide shelter, feeding, and breeding areas for fish.

Riparian vegetation. Plants growing along the stream banks that help filter runoff, stabilize soil, and provide habitat/shade.

1.0 CHAPTER ONE: INTRODUCTION

1.1 Background of the study

The relationship between fish abundance and environmental factors has been widely studied across various aquatic systems, but limited studies have been conducted in smaller streams like Nagongera (Garcia et al., 2025). Understanding how Physico-chemical parameters and human activities influence fish abundance is therefore essential for developing conservation strategies and sustainable fisheries management. Freshwater ecosystems provide important habitats for fish and support biodiversity, food security, and livelihoods worldwide (Allan & Castillo, 2007). Fish abundance and distribution are influenced by physico-chemical parameters such as temperature, pH, dissolved oxygen, turbidity, and electrical conductivity (Wetzel & Karr, 2001). Globally freshwater ecosystems are increasingly threatened by human activities including agricultural expansion, industrial development, waste disposal, and excessive exploitation of aquatic resources. These activities alter stream morphology increase sedimentation, introduce pollutants, and degrade water quality , thereby reducing fish diversity and abundance (Bangu, 2024). Several studies have demonstrated that degraded water quality often leads to disappearance of pollution sensitive species while favoring the few tolerant species capable of surviving under stressful environmental conditions.

In Uganda, freshwater resources contribute significantly to national food production, biodiversity conservation, and rural livelihoods. However, many rivers and streams are experiencing increasing pressure from human settlement, poor waste management, cultivation along riverbanks, and unregulated sand mining. These activities have accelerated the deterioration of water quality in many aquatic ecosystems, threatening fish populations and ecosystem health. Small streams such as Nagongera Stream are particularly vulnerable because they receive runoff directly from surrounding agricultural fields and settlements, yet they receive limited scientific attention compared to larger water bodies such as Lake Victoria(*NEMA (2016). State of the Environment Report for Uganda 2014. National Environment Management Authority (NEMA), Kampala*, 2016).

Nagongera Stream flows through Nagongera Town Council in Tororo District and supports surrounding communities through water supply, fishing, agriculture, and other socio-economic activities. However, increasing farming activities, domestic waste disposal, washing, bathing, and sand mining along the stream have raised concerns about declining water quality and fish populations. Although studies have examined fish abundance in larger freshwater systems, little information exists regarding the interaction between physico-chemical parameters, human activities, and fish abundance in Nagongera Stream (Rosette et al., 2020). This study therefore seeks to assess fish abundance in relation to physico-chemical parameters and human activities in Nagongera Stream to provide information that will support sustainable management and conservation of the ecosystem. Human activities including agriculture, waste disposal, sand mining, and settlement near streams contribute to water quality degradation and habitat alteration (Tickner et al., 2025).

1.2 Statement of the Problem

Freshwater ecosystems in Uganda are increasingly under pressure from anthropogenic influences that degrade water quality and threaten aquatic life (*NEMA*, 2024). Nagongera Stream, which provides important ecological and socio-economic benefits, is exposed to intense human activities such as cultivation near riverbanks, direct waste discharge, and washing (*NEMA*, 2024). These activities alter water quality by introducing pollutants, increasing turbidity, and reducing dissolved oxygen levels. Consequently, fish abundance and diversity decline, affecting both ecological integrity and local livelihoods (Musinguzi et al., 2025). Despite these challenges, limited scientific information exists regarding the relationship between fish abundance, Physico-chemical parameters, and human activities in Nagongera Stream. This knowledge gap hinders effective management and conservation efforts. Declining fish abundance in many freshwater ecosystems has been associated with deteriorating water quality and increasing anthropogenic disturbances (Wetzel & Karr, 2001).

1.3 Objectives of the study

1.3.1 General objective

To assess the abundance of fish species in relation to physico-chemical parameters and human activities in Nagongera Stream, Nagongera Town Council, Tororo District.

1.3.2 Specific objectives

1. To assess the physico-chemical parameters of water in Nagongera Stream.
2. To determine the abundance and diversity of fish species in Nagongera Stream.
3. To identify the major human activities affecting fish abundance and water quality in Nagongera Stream.

1. 4 Research questions

1. What are the Physico-chemical characteristics of water in Nagongera Stream?
2. What are the dominant fish species found in Nagongera Stream?
3. What human activities impact water quality and fish abundance in the stream?

1.5 Justification for the present study

Combined seasonal sampling and multivariate modeling: There is a need for studies that combine repeated seasonal sampling, measurement of multiple physico-chemical parameters, documented human-activity scoring, and multivariate statistical modeling of fish abundance responses. Given the above review, the present study of the target stream in Nagongera Town Council, Tororo District, Uganda addresses several of these gaps: it targets a small tropical stream subject to multiple human-activity pressures; it plans to quantify fish abundance and measure multiple physico-chemical parameters concurrently; and it will employ disturbance scoring adjacent to sampling sites. This integrative approach will help elucidate how fish abundance in such streams responds to physico-chemical variables and human-activity gradients in an East African context.

1.6 Significance of the study

The findings of this study will provide baseline information on the relationship between fish abundance and environmental factors in small freshwater ecosystems. The results will be valuable to fisheries managers, environmental scientists, and policymakers in developing effective management strategies for sustainable aquatic resource utilization. Additionally, the study will contribute to academic literature and future research in aquatic ecology, conservation, and water quality assessment in Uganda (*Uganda Environment Management Authority*, 2019).

1.7 Scope of the study

The study focuses on assessing fish abundance, water quality parameters, and human activities along Nagongera Stream in Tororo District. Sampling covered selected sections of the stream influenced by varying degrees of human activity. The study analyzed parameters such as temperature, pH, dissolved oxygen, turbidity, and electrical conductivity, along with documentation of surrounding land use (Smith et al., 1997).

2.0 CHAPTER TWO: LITERATURE REVIEW

2.1 Conceptual framework

Aquatic ecosystems are structured by multiple interacting drivers: abiotic variables (Physico-chemical parameters such as temperature, pH, dissolved oxygen, turbidity, nutrients), habitat structure (substrate, flow regime, riparian vegetation), and biotic factors (competition, predation, species interactions). Human activities (land-use change, waste discharge, sand mining, riparian vegetation removal, fishing pressure) act as external stressors that modify habitat structure and water chemistry, thereby influencing aquatic communities (Adu-manu et al., 2017). In stream systems, a stressor response model is applicable: human disturbance altered Physico-chemical/ habitat conditions shifts in fish assemblage composition, abundance and diversity. The present study adopts this framework to examine how Physico-chemical parameters and human activities affect fish abundance in the target stream (Mwangi, 2024).

2.2 Physico-chemical drivers of fish abundance and community structure

Research across freshwater and near-shore systems has consistently shown that fish abundance and community composition are sensitive to water quality variables. For example, in a tropical estuary on the Colombian Pacific coast, fish species richness and biomass were significantly correlated with variables such as nitrite, nitrate, temperature, dissolved solids and dissolved oxygen. Specifically, biomass increased in lower-quality water (high nitrite, low DO) while richness was higher in intermediate salinity and better-quality water (Boyd, 2015).

Similarly, in an analysis of streams across agricultural, urban and forested land-uses in Ethiopia, concentrations of nutrients (NO_3-N, NH_4-N), conductivity and turbidity increased with human-perturbed land-use, while dissolved oxygen decreased. Streams in forested areas exhibited better quality (Gebrekiros & Bagenal, 2016).Studies of general fish community composition likewise emphasize that both habitat suitability and water chemistry shape assemblages. In addition, a recent review on physicochemical parameters in aquatic systems highlighted that temperature, dissolved oxygen, pH and nutrient levels influence aquatic-plant abundance, food availability and ultimately fish habitat and biodiversity (Ochieng et al., 2021).

2.2.1 Temperature, dissolved oxygen, pH and Electrical conductivity

Temperature affects metabolic rates of fish, oxygen solubility and species physiological tolerance. Dissolved oxygen (DO) is critical for fish survival; low DO often results from eutrophication or organic loading and correlates with reduced abundance of sensitive species. For instance, in an Indian wetland study, species density positively correlated with water temperature and DOES in pre-monsoon, and negatively correlated with DO and BOD in post-monsoon (Allan & Castillo, 2007). pH influences ion balance, gill function and species distribution. In degraded waters, pH deviations can exclude sensitive taxa. Though explicit fish-based studies are fewer, the role of pH remains established in aquatic ecotoxicology.

Electrical conductivity reflects the concentration and mobility of dissolved ions in water. It may be influenced by natural geology, groundwater, agricultural inputs and domestic or other wastes. Conductivity therefore provides useful information about changes in the ionic character of water. The mean conductivity in the study was 208.69 µS/cm, with 216.07 µS/cm upstream, 190.33 µS/cm midstream and 219.67 µS/cm downstream (Petry et al., 2003). The downstream value was the highest among the three stations, while the midstream value was the lowest.

2.2.2 Nutrients and turbidity

Elevated concentrations of nitrates, phosphates and other nutrients generally derive from agricultural runoff, sewage input or land-use change. Nutrient enrichment may stimulate primary production (possibly increasing fish food) but may also lead to hypoxia, altered substrate and sedimentation, thus reducing suitable habitat for fish. In the Colombian estuary study, higher nitrate and phosphate loads were associated with lowered species richness (Fiksen et al., 2002). Turbidity and suspended solids influence light penetration, primary productivity, and substrate refuge. These variables also affect spawning and feeding substrate suitability for many stream fish species. Streams with high turbidity often show reduced fish diversity.

2.3 Human activities

Intensive human activities like agriculture, waste disposal, and sand mining profoundly degrade aquatic habitat structures and reduce fish diversity by altering water quality, physical riverbeds, and food webs (Emmons et al., 2024). Agricultural runoff introduces excessive nutrients and sediments that increase turbidity and cause eutrophication, suffocating native fish. Improper waste disposal releases toxic chemicals that disrupt endocrine systems and reduce species richness, while in stream sand mining physically destroys spawning grounds, deepens channels, and removes macro invertebrate food sources, ultimately replacing sensitive native fish with resilient, degradation-resistant species.

Human activities affect stream ecosystems through both direct and indirect pathways. Land-use change (agriculture, urbanization), riparian vegetation removal, sand mining and waste-dumps alter stream morphology, flow regime, sediment load and water chemistry. In a study of 25 tropical and subtropical streams in Brazil, human pressure (via an Integrated Disturbance Index combining land use and stream physical integrity) was found to reduce habitat diversity, increase primary productivity and favor non-native or degradation-tolerant fish species. While species richness was not strongly changed, numerical abundance and equitability declined.

Similarly, in a Nigerian river study of the tropical Ikang River, human-induced impacts on fish fauna were shown to correspond with Physico-chemical changes and fish abundance and distribution (Mzungu et al., 2025). Land-use specific studies in Ethiopia revealed that urban streams exhibited the highest nutrient and turbidity loads, lowest DO and poorest water quality, compared to agricultural and forested streams (Ediako, 2021). These findings underline the importance of considering the land-use and disturbance context when assessing stream fish abundance and habitat suitability.

2.5 Fish assemblage responses to environmental and human stressors

Fish assemblages are sensitive indicators of ecological condition. Changes in abundance, species composition, evenness and dominance patterns can reflect cumulative impacts of Physico-chemical and anthropogenic stressors. In the Colombian estuary example, dominant biomass in “poor-quality” waters was often by tolerant species, while sensitive species were lost or reduced. Other studies indicate that fish abundance and richness decline with increasing human disturbance and degraded habitat. Species assemblages in streams are non-random and shaped by habitat filtering: disturbance often reduces specialists and increases generalists(Jared et al., 2023). It is also notable that certain physico-chemical thresholds may trigger abrupt changes in assemblage structure for example, low DO or high turbidity beyond specific levels may cause local extirpation of sensitive species even if richness remains superficially similar.

2.6 Integrative synthesis and gap identification

The literature clearly supports that physico-chemical parameters (temperature, DO, pH, nutrients, turbidity) and human-disturbance factors (land-use, riparian alteration, mining, waste input) jointly influence fish abundance and assemblage composition in tropical and subtropical freshwater systems. However, key gaps remain, particularly relevant to the target stream context, Local-scale seasonal data for small tropical streams: Many studies focus on larger rivers or estuaries, but fewer address smaller tributary streams in East Africa, with repeated seasonal measurement of both fish assemblages and physico-chemical parameters. Also, East African context specific references: Although many studies exist globally and in Africa, relatively few peer-reviewed articles focus on small streams in Uganda or the Tororo District region.

3.0 CHAPTER THREE: METHODOLOGY

3.1 Introduction

This chapter presents the methodology that was used to assess the abundance of fish species in relation to physico-chemical parameters and human activities in Nagongera Stream. It was describing research design, study area, population, sampling procedures, data collection methods, data analysis, and ethical considerations.

3.2 Scope of the study

The study was conducted in Nagongera Town Council, located in Tororo District. Nagongera Stream flows through agricultural land and residential areas where various human activities occur. Major activities conducted included, Crop farming near stream banks, Washing and bathing, Sand mining, Small-scale fishing, Disposal of domestic waste. These activities are likely to influence water quality and fish abundance. The study was conducted along a 2.5 km reach of Nagongera stream. The interest of study was a section of this stream stretching from the upstream downwards on a latitude of 0084295E and longitude of 36°0616876' N, at an elevation of 1101m with 16% of its water area covered by native fish species to downstream on latitude of 0083690E and longitude of 36°0615517N

3.2 Research design

The study adopted a cross-sectional research design which involved collection of data at one point in time from different respondents and sampling sites. This design was appropriate because, fish abundance was assessed during a specific sampling period, physico-chemical parameters were measured simultaneously, questionnaires were administered once to respondents, it allowed analysis of relationships between fish abundance, water quality, and human activities and the study used both quantitative and qualitative approaches.

3.4 Target population

The study targeted fish species in Nagongera Stream, fishermen operating along the stream, households living near the stream and local leaders and environmental officers

3.5 Sample size and sampling techniques

3.5.1 Sampling of fish

Three sampling stations were selected, including Upstream, Midstream, Downstream. Purposive sampling was used to select stations based on visible human activities.

Before fish collection

Permission to conduct fish sampling was obtained from the relevant local authorities. The three sampling stations were identified and marked as upstream, midstream and downstream. Fishing equipment, including hooks, line and bait, was prepared and checked. A field data sheet was prepared to record the station, date, fishing effort, species caught, number of individuals, length and weight. The same general fishing procedure and effort were maintained at each station to allow comparison of fish abundance. Fish sampling was conducted alongside water-quality measurements so that fish abundance could be related to the prevailing physico-chemical conditions.

Collection of Fish Using Hooks

At each station, hooks were prepared with suitable bait. The hooks were placed in suitable sections of the stream where fish were likely to occur. The fishing effort was kept as consistent as possible among the three stations. Captured fish were carefully removed from the hooks to minimize injury. Each fish was temporarily placed in a clean container containing stream water while identification and measurements were being conducted. The number of fish captured at each station was recorded. Each individual fish was identified to species level using appropriate fish identification guides and distinguishing morphological characteristics. The species name and number of individuals were entered into the field data sheet. Fish were handled carefully to minimize stress and unnecessary mortality. After measurements and identification, fish were handled according to the ethical requirements of the study.

All fish caught was identified to species level, counted, and measured for length and weight

3.5.2. Sampling of respondents

Thirty (30) household members were selected using simple random sampling, ten (10) fishermen were selected purposively and five (5) key informants were selected purposively making a Total sample size of 45 respondents.

3.6 Data collection methods

3.6.1 Fish abundance assessment

Fish abundance was determined using, Number of individuals per species and Species diversity indices

3.6.2 Measurement of physico-chemical parameters

The following parameters were measured at each station:

Water temperature (°C)

The digital thermometer was checked to ensure that it was clean, functional and properly calibrated. The thermometer was switched on and allowed to initialize according to the manufacturer's instructions. The probe was carefully immersed in the stream water to a depth of approximately 10–15 cm below the water surface. Care was taken to avoid touching the bottom sediment, stones, vegetation or the sides of the stream because these could influence the reading. The probe was left in the water for approximately 2–3 minutes or until the displayed temperature became stable. The temperature displayed on the digital thermometer was recorded in degrees Celsius (°C). The measurement was repeated two more times at the same station. The three readings were recorded in the field data sheet. The arithmetic mean of the three readings was calculated to obtain the representative temperature for that sampling station. The same procedure was repeated at the upstream, midstream and downstream stations. Water temperature was measured because it affects fish metabolism, oxygen solubility and the distribution of fish species. The original study specifically used a calibrated digital thermometer with the probe positioned approximately 10–15 cm below the water surface.

PH

Before going to the field, the pH meter was checked to ensure that the electrode was clean and functioning properly. The pH meter was calibrated using standard buffer solutions of pH 4.0, 7.0 and 10.0. The electrode was first rinsed thoroughly with distilled water to remove any contaminants. The pH meter was switched on and allowed to stabilize. At the sampling station, the electrode was immersed in the stream water without allowing it to touch the stream bed, stones or vegetation. The electrode was moved gently through the water to ensure adequate contact between the sensor and the water. The electrode was left immersed until the pH reading became stable. The pH value displayed on the meter was recorded in the field data sheet. The electrode was removed and rinsed with distilled water. The measurement was repeated twice more, giving three readings at each station. The three values were recorded and their mean calculated. The same procedure was followed at the upstream, midstream and downstream stations. After each measurement, the electrode was rinsed with distilled water to prevent cross-contamination between stations.

Electrical Conductivity (EC)

The conductivity meter was checked and calibrated according to the manufacturer's instructions before field measurements. The conductivity probe was rinsed with distilled water to remove residues from previous measurements. The meter was switched on and allowed to initialize. The probe was immersed into the stream water at the selected sampling station. The probe was positioned below the water surface without touching the bottom sediment, stones or aquatic vegetation. The probe was gently moved or allowed to equilibrate so that the sensor was completely surrounded by the water. The reading was allowed to stabilize. The electrical conductivity value displayed on the meter was recorded in MicroSiemens per centimeter (μS/cm). The probe was removed and rinsed with distilled water. Two additional measurements were taken at the same station. The three readings were recorded and the mean value calculated. The procedure was repeated at all three sampling stations.

Dissolved Oxygen (DO)

The dissolved oxygen meter was inspected and calibrated according to the manufacturer's instructions before use. The DO probe was rinsed with distilled water. The instrument was switched on and allowed to initialize. The probe was immersed into the stream water below the water surface. The probe was positioned carefully to avoid contact with the stream bottom, rocks or vegetation. The probe was held in the water until the reading became stable. The dissolved oxygen value was recorded as percentage saturation (%), as specified in the research. The probe was removed and rinsed before moving to another measurement point. Two additional readings were taken at the same station. The three readings were recorded in the field data sheet. The mean dissolved oxygen value was calculated for that station. The procedure was repeated at upstream, midstream and downstream stations. Dissolved oxygen was measured because oxygen dissolved in water is essential for fish respiration and survival.

Turbidity

The turbidity meter was checked and calibrated according to the manufacturer's instructions. A clean sample bottle was used to collect water from the sampling station. The bottle was rinsed appropriately with the sample water where applicable to minimize contamination. A representative water sample was collected without disturbing the stream bed or unnecessarily stirring up sediments. The water sample was transferred carefully into the clean turbidity-meter cuvette. The cuvette was checked to ensure that there were no dirt particles, fingerprints or air bubbles on the outside that could interfere with the optical reading. The cuvette was placed into the turbidity meter in the appropriate position. The instrument was allowed to stabilize and the turbidity value was recorded in Nephelometric Turbidity Units (NTU). The water sample was measured two more times or fresh representative samples were used as appropriate. The three readings were recorded. The mean turbidity value was calculated for the station. The procedure was repeated at upstream, midstream and downstream stations. All measurements were entered into the field data sheet for subsequent analysis All measuring instruments were calibrated according to the manufacturers' instructions before fieldwork commenced. The recorded measurements were entered into field data sheets and later transferred to Microsoft Excel for statistical analysis to determine the relationship between physico-chemical parameters and fish abundance.

3.6.3 Use of Questionnaires

A structured questionnaire was used to collect data on human activities affecting the stream. The questionnaire contained Section A having demographic information, Section B having Human Activities and Section C having Perceptions on Fish Abundance. The questionnaire included both Closed-ended questions (Yes/No, Multiple choice) and Open-ended questions

3.7 Validity and reliability

Validity

The questionnaire was reviewed by the supervisor and pre-tested in a nearby community. validity of the questionnaire ensured that the questions collected information relevant to the study objectives concerning human activities, changes in water quality, fish abundance and factors that influenced fish distribution in Nagongera Stream. The questionnaire was developed based on the research objectives, research questions and variables of the study. Questions were designed to obtain information about activities such as farming, waste disposal, sand mining and other activities carried out around the stream, as well as respondents' observations concerning changes in fish abundance and water quality. This reduced the possibility of collecting information that is irrelevant to the study.

Reliability

Water testing equipment was calibrated before use and Standard sampling procedures were followed. It also ensured the ability of the questionnaire to consistently collect information about human activities and their perceived effects on water quality and fish abundance. It did not produce substantially different results because questions were correctly worded or administered in a similar way by using clear questions, standardized procedures and consistent instructions when administering the questionnaire to respondents.

3.8 Data Analysis

Quantitative Data

Data was entered into Excel and analyzed using Frequencies and percentages, Means and standard deviations.

Qualitative Data

Interview responses were analyzed using thematic analysis and results were presented in Tables for table 4.1 containing the physico-chemical water parameters and table 4,2 containing fish species, Graphs and Charts

3.9 Ethical Considerations

Permission was obtained from Nagongera Town Council authorities, informed consent was obtained from respondents, confidentiality was maintained and fish sampling followed ethical environmental practices.

4.0 CHAPTER 4: RESULTS

4.1 Introduction

This chapter presents the results obtained from the assessment of fish abundance in relation to physico-chemical parameters and human activities in Nagongera Stream, Nagongera Town Council, Tororo District, Uganda. The results are presented according to the objectives of the study and are based on data collected from three sampling stations, namely upstream, midstream and downstream. The chapter presents also the physico-chemical characteristics of the stream water, including turbidity, pH, electrical conductivity and dissolved oxygen. It also presents the abundance and distribution of fish species recorded at the different sampling stations. In addition, the results include information on the respondents' perceptions regarding changes in fish abundance and the major human activities affecting the stream.

The findings are presented using tables, percentages and other appropriate forms of data presentation to facilitate comparison between the sampling stations. The results provide a basis for examining the relationship between water quality, human activities and fish abundance in Nagongera.

4.2 Physical chemical parameters of Nagongera stream

Table 4. 1: Physico-chemical water parameters of Nagongera stream.

Parameter	**Upstream**	**Midstream**	**Downstream**	**Average**	**Remarks**
Turbidity (NTU)	301	300	302	301	Very high
Ph	8.4	8.1	8.2	8.23	Slightly alkaline
Electrical Conductivity (µS/cm)	216.07	190.33	219.67	208.69	Moderate
Dissolved oxygen (%)	97.5	85.23	93.8	92.18	Generally good, lower midstream

According to table 4.1 Turbidity showed very little numerical variation among the three stations, with all values close to 301 NTU. The highest value was 302 NTU downstream and the lowest was 300 NTU midstream. The mean value was therefore 301 NTU. The pH values ranged from 8.1 at midstream to 8.4 upstream, with a mean of 8.23. These results indicate slightly alkaline water with relatively small differences among stations. Electrical conductivity ranged from 190.33 µS/cm at midstream to 219.67 µS/cm downstream. The average was 208.69 µS/cm as the dissolved oxygen was highest upstream at 97.5% and lowest midstream at 85.23%, while downstream recorded 93.8%. The mean dissolved oxygen was 92.18%.

4.3 Fish Species Composition

Table 4. 2: Fish species along the upstream, midstream and downstream.

Species	Upstream	Midstream	Downstream	Total	Percentage of fish species
Clarias gariepinus	10	6	3	19	63.33
Oreochromis leucostictus	0	4	1	5	16.67
Enteromius kersteni	0	1	2	3	10
Rastrineobola argentia	0	1	2	3	10
TOTAL	10	12	8	30	100

From the table 4.2, a total of 30 fish individuals were recorded from the three sampling stations. *Clarias gariepinus* was the most abundant, accounting for 19 individuals (63.33%) of the catch. *Oreochromis leucostictus* contributed five individuals (16.67%), while *Enteromius kersteni* and silver fish each contributed three individuals (10%).

Figure 4. 1: *Clarius gariepinus*

Figure 4. 2: *Enteromius kersteni*

Figure 4. 3: *Rastrineobola argentia*

Figure 4. 4: *Oreochromis leucostictus*

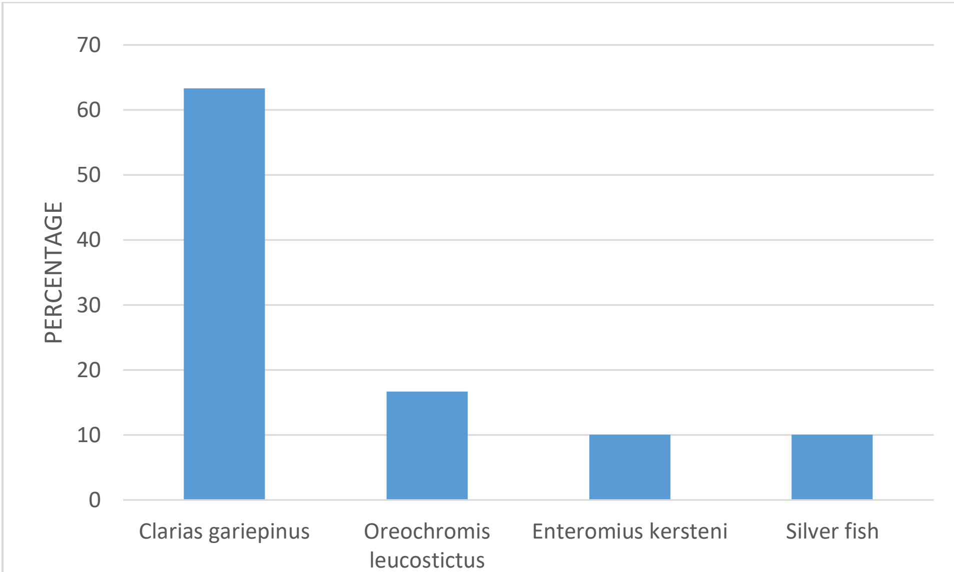

Figure 4. 5: shows the percentage of fish species captured.

The graph shows variation in the percentage composition of fish species recorded in Nagongera Stream. A total of 30 fish individuals belonging to four species were recorded. Clarias gariepinus was the most abundant species, accounting for 63.33% of the total catch. Oreochromis leucostictus contributed 16.67%, while Enteromius kersteni and silver fish each contributed 10%. The graph therefore shows a strong dominance of Clarias gariepinus, followed by a marked decline to Oreochromis leucostictus and then to the two least abundant species. The overall trend is Clarias gariepinus (63.33%) → Oreochromis leucostictus (16.67%) → Enteromius kersteni (10%) = silver fish (10%). This demonstrates low evenness in the fish community because one species contributed substantially more individuals than the other three species. Clarias gariepinus contributed 19 individuals, compared with five for Oreochromis leucostictus and three each for Enteromius kersteni and silver fish.

Table 4. 3: Total fish in different stations.

Station	Total Fish
Upstream	10

Midstream	12
Downstream	8

The midstream station recorded the highest total number of fish (12), followed by upstream (10), while downstream recorded the lowest number (8).

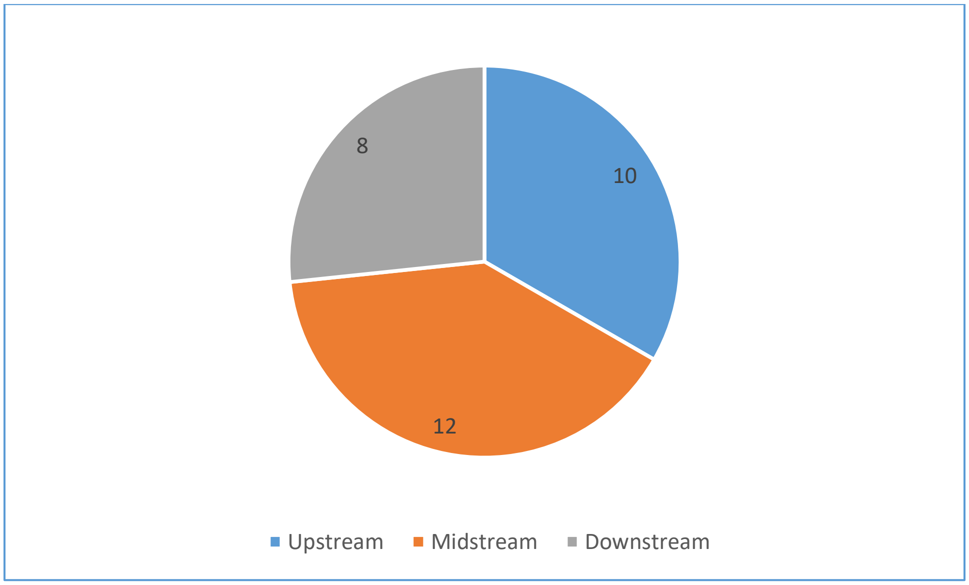

Figure 4. 6: A pie chart showing the number of fish captured at different sites of Nagongera stream.

The pie chart shows that a total of 30 fish were recorded from the three sampling sites: upstream, midstream and downstream. where 10 fish were recorded from upstream, representing 33.3% of the total fish sampled, 12 fish from midstream, representing 40.0% of the total and 8 fish from downstream, representing 26.7% of the total. The midstream section had the highest number of fish (12), accounting for 40% of all fish recorded. This was followed by the upstream section with 10 fish (33.3%), while the downstream section had the lowest number with 8 fish (26.7%). The difference indicates that fish were not evenly distributed along the stream. The relatively higher abundance at midstream could be associated with the availability of suitable habitats, food resources, vegetation cover, water conditions or other local environmental factors. However, the pie chart alone cannot establish the specific cause of the difference; this should be interpreted together with the physico-chemical results and observations of human activities.

Table 4. 4: Respondents' perception of declining fish numbers.

Perception of the cause of decline in fish numbers	Frequency(out of 45)	Percentage %
Noticed decline in fish numbers	38	84.4
Attributed to pollution/waste	25	55.6
Attributed to sand mining/farming	30	66.7
Attributed to overfishing	12	26.7

The second part of the figure presents information obtained from 45 respondents. According to the table, 38 respondents (84.4%) reported that they had noticed a decline in fish numbers in the stream. This represents a large majority of the respondents and suggests that declining fish abundance is a commonly perceived environmental change within the study area.

The high percentage of respondents noticing a decline is important because it provides community-based evidence that fish abundance may have changed over time. However, respondents' perceptions represent people's observations and experiences and should not be treated as a direct measurement of fish population decline. The actual fish sampling data provide quantitative evidence of the fish recorded during the study period, while the questionnaire provides information about people's observations over time.

The table further indicates that 25 respondents, representing 55.6% of the 45 respondents, attributed the decline to a particular factor or factors. However, the image cuts off the remainder of the statement after "Attributed to", so the specific factor cannot be identified from the displayed table. If, for example, the missing part refers to human activities such as waste disposal, farming or sand mining, that factor should be stated explicitly in the final table and discussed in relation to the study objectives.

Overall, the fish-sampling results show that 30 fish were recorded, with the highest number occurring at midstream (12), followed by upstream (10) and downstream (8). In contrast, the questionnaire results show that 84.4% of respondents perceived a decline in fish numbers, while 55.6% associated the decline with the factor represented by the incomplete "Attributed to" row. The combination of field observations and community perceptions strengthens the description of changes in fish abundance because the study does not rely solely on either biological sampling or questionnaire responses.

Important to note is that there is a difference between the two totals. The pie chart is based on 30 sampled fish, whereas the questionnaire table is based on 45 respondents. These are different units of analysis and should therefore not be combined as though they represent the same sample.

5.0 CHAPTER FIVE: DISCUSSION OF RESULTS

5.1 Introduction

This chapter discusses the findings of the study entitled Assessing the Abundance of Fish Species in Relation to Physico-Chemical Parameters and Human Activities in Nagongera Stream, Nagongera Town Council, Tororo District, Uganda. The discussion is organized according to the four specific objectives of the study: determining the abundance and diversity of fish species, assessing the physico-chemical parameters of the stream water, evaluating the relationship between fish abundance and physico-chemical parameters, and identifying the major human activities affecting fish abundance and water quality.

5.2 The physico-chemical parameters of water in Nagongera Stream

The study assessed turbidity, pH, electrical conductivity and dissolved oxygen at upstream, midstream and downstream stations. The results showed that turbidity was the most notable water-quality concern, while pH, electrical conductivity and dissolved oxygen were comparatively less variable.

5.2.1 Turbidity

Turbidity was the most notable water-quality concern in Nagongera Stream. The study recorded turbidity values of 301 NTU upstream, 300 NTU midstream and 302 NTU downstream, giving an overall mean of 301 NTU. The very small variation between the stations indicates that high suspended material was not restricted to one section of the stream but occurred throughout the sampled sections. Suspended particles can reduce light penetration, interfere with feeding, increase sediment deposition and affect substrates used for spawning and refuge. Consequently, persistently high turbidity may reduce the suitability of the stream for species that require clearer water conditions (Ochieng et al., 2021). The observed turbidity is consistent with the presence of sand mining and farming identified around the stream. Sand extraction directly disturbs substrate, while farming can increase soil erosion where stream-bank vegetation is reduced(Emmons et al., 2024). These activities provide plausible explanations for the sediment-related pattern.

5.2.2 pH

The average pH recorded was 8.23, with values of 8.4 upstream, 8.1 midstream and 8.2 downstream. The water was therefore slightly alkaline. The relatively small variation between the stations suggests that pH conditions were relatively stable during the sampling period. The stable pH also illustrates why water-quality assessment should use multiple variables. A stream can have a pH that appears suitable for fish while simultaneously experiencing physical problems such as high turbidity.

5.2.3 Electrical conductivity

Electrical conductivity averaged 208.69 µS/cm, ranging from 190.33 µS/cm at midstream to 219.67 µS/cm downstream. The results classified the conductivity as moderate. Electrical conductivity provides an indication of dissolved ions in water and can be influenced by natural geological conditions as well as agricultural and domestic inputs. The moderate conductivity suggests that dissolved substances were present in the stream but that conductivity was not as prominent an environmental concern as turbidity. Studies of Ugandan streams have demonstrated that human activities can produce changes in conductivity and other water-quality parameters, particularly in downstream sections receiving greater anthropogenic inputs(Petry et al., 2003).

5.2.4 Dissolved oxygen

Dissolved oxygen averaged 92.18%, with 97.5% upstream, 85.23% midstream and 93.8% downstream. The results indicated generally good oxygen availability, although the midstream station recorded the lowest value. Adequate dissolved oxygen is essential for fish respiration and survival. The relatively high oxygen levels suggest that oxygen availability was generally sufficient to support aquatic organisms during the sampling period. However, the reduction at midstream may indicate increased biological oxygen demand or organic matter decomposition associated with human activities in that section(Allan & Castillo, 2007).

5.3 Abundance and diversity of fish species in Nagongera Stream

The study recorded a total of 30 fish individuals belonging to four species from the three sampling stations. The fish species recorded were *Clarias gariepinus, Oreochromis leucostictus, Enteromius kersteni* and silver fish. *Clarias gariepinus* was the most abundant species, contributing 19 individuals, equivalent to 63.33% of the total catch. *Oreochromis leucostictus* contributed five individuals (16.67%), while *Enteromius kersteni* and silver fish each contributed three individuals (10%).

The dominance of *Clarias gariepinus* suggests that the species was better able to persist under the environmental conditions prevailing in Nagongera Stream. The dominance of *C. gariepinus* is therefore consistent with the study's general finding that Nagongera Stream is experiencing environmental stress.

The distribution of fish among sampling stations also showed differences. The upstream station recorded 10 fish, the midstream station recorded 12 fish, and the downstream station recorded eight fish. The higher number of fish at the midstream station indicates the presence of relatively favorable feeding or habitat conditions at that point. However, the relatively small number of species recorded indicates that the stream supports a limited fish assemblage within the sampled sections.

The finding is comparable with research on fish communities in Ugandan wetlands, where anthropogenic ally impacted sites showed reduced fish diversity and richness compared with less impacted reference sites. That study found that environmental variables such as dissolved oxygen, conductivity, pH and nutrients were associated with differences in fish community structure (Ochieng et al., 2021).

The present findings therefore suggest that the fish community in Nagongera Stream is not only characterized by a relatively small number of species but also by strong dominance of one species. This then indicates that environmental conditions in the stream favor tolerant species.

5.4 The relationship between fish abundance and physico-chemical parameters

The findings indicate an apparent association between fish distribution and the physico-chemical conditions of Nagongera Stream.

Turbidity appears to be the most important potential water-quality factor affecting the fish assemblage. The stream had an average turbidity of 301 NTU while only four fish species were recorded. High turbidity can reduce visibility and light penetration, increase sediment deposition and interfere with fish feeding, respiration and reproduction. These effects may make the environment less suitable for sensitive species. The dominance of *Clarias gariepinus* may therefore be partly explained by its ability to persist under stressful environmental conditions.

The dissolved oxygen results provide a more complex pattern. The midstream station had the lowest dissolved oxygen value (85.23%) but recorded the highest number of fish (12). This shows that fish abundance was not determined by dissolved oxygen alone. Other factors such as food availability, habitat structure, flow conditions and species-specific tolerance influenced the number of fish caught.

5.5 Perception of the major human activities on fish abundance and water quality in Nagongera Stream

The study identified several human activities around Nagongera Stream, including farming, sand mining, waste disposal, washing, bathing and fishing. Respondents particularly associated declining fish abundance with sand mining and farming, pollution and waste disposal, and, to a lesser extent, overfishing.

Out of 45 respondents, 38 (84.4%) reported noticing a decline in fish numbers. Furthermore, 30 respondents (66.7%) attributed the decline to sand mining and farming, 25 (55.6%) attributed it to pollution and waste disposal, and 12 (26.7%) attributed it to overfishing. The high proportion of respondents reporting a decline in fish numbers is important because it supports the ecological observations from the fish sampling. Although perceptions alone cannot establish the exact cause of fish decline, the consistency between community observations and the biological findings strengthens the argument that the stream is experiencing environmental pressure.

Sand mining is particularly significant because it directly disturbs stream banks and the streambed and can increase sediment input. This provides a plausible explanation for the very high turbidity recorded in the study. Continued sand extraction can also alter habitat structure by removing or disturbing substrates used by fish for feeding, shelter and reproduction.

Farming near the stream may contribute to sediment and nutrient runoff, particularly where vegetation along the stream banks has been removed.

Improper waste disposal affected fish abundance by introducing organic matter and other pollutants into the stream. Organic waste decomposition can consume dissolved oxygen, while other waste materials can directly degrade habitat quality. The generally good dissolved oxygen recorded in this study suggests that severe oxygen depletion was not occurring during the sampling period, but the lower midstream value indicates that localized effects existed.

Overfishing was identified by fewer respondents than sand mining, farming and pollution. Nevertheless, fishing pressure remained an important potential factor because excessive harvesting can reduce fish populations independently of water quality.

Research from Uganda and other freshwater systems similarly demonstrates that anthropogenic disturbance can modify water quality and fish community structure.

6.0 CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The study conclude that fish abundance and distribution are influenced by physico chemical conditions and human activities. *Claris gariepinus* dominated the fish community suggesting greater tolerance to environmental stress. High turbidity indicted considerable sedimentation which is likely associated with farming, waste disposal and sand mining. Although pH and dissolved oxygen were generally favorable human activities may threaten fish habitat and fish diversity.

6.2 Recommendations

Regulation of human activities through enforcing buffer zones for farming, ban sand mining in sensitive areas, and improve waste management.

Restoration efforts for example Riparian vegetation planting to reduce runoff and turbidity.

Community engagement through educating locals on sustainable practices through local leaders.

Promoting environmentally responsible farming practices near the stream, including maintenance of vegetation along stream margins and reduction of direct soil disturbance close to the water.

Improving community waste management and discouraging direct disposal of domestic waste into the stream.

Promoting sustainable fishing practices and discourages harvesting methods that unnecessarily damage habitat or remove fish at unsustainable rates.

Institute routine monitoring of turbidity, pH, electrical conductivity, dissolved oxygen and temperature at the three stations and, where possible, expand monitoring to additional sites.

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APPENDIX

Title: Questionnaire on Fish Abundance, Water Quality and Human Activities in Nagongera Stream

Instructions:

Tick (✓) or write the correct answer where appropriate.

Information given will be kept confidential and used only for academic purposes.

Section A: Background Information

Gender☐ Male☐ Female

Age☐ Below 18☐ 18–30☐ 31–45☐ Above 45

Occupation☐ Fisherman☐ Farmer☐ Trader☐ Student☐ Other (Specify) __________

How long have you lived near Nagongera Stream?

☐ Less than 5 years☐ 5–10 years☐ More than 10 years

Section B: Fish Abundance and Diversity

Do you think the number of fish in Nagongera Stream has:

☐ Increased☐ Decreased☐ Remained the same

Which fish species are commonly found in the stream?

In which season are fish more abundant?

☐ Rainy season☐ Dry season☐ Same throughout the year

What fishing methods are commonly used?

☐ Nets☐ Hooks☐ Traps☐ Others __________

Have some fish species disappeared over time?

☐ Yes☐ NoIf yes, mention them ____________________

Section C: Physico-Chemical Conditions of Water

How would you describe the water colour of the stream?

☐ Clear

☐ Brown