BINDURA UNIVERSITY OF SCIENCE EDUCATION

DEPARTMENT OF NATURAL RESOURCES

Assessing the growth rate, feed conversion ratio, feed conversion efficiency, mortality rate and quantity harvested of Nile Tilapia (*Oreochromis niloticus*) at Bindura University Farm in Mashonaland Central Province.

\

FAITH BIZONI

B190318B

A DISSERTATION SUBMITTED IN PARTIAL FULFIMENT OF THE REQUIRMENTS OF THE BACHELOR OF SCIENCE HONOURS DEGREE IN NATURAL RESOURCES MANAGEMENT.

JUNE 2023

DECLARATION

The undersigned attest that they have reviewed and approved this research project for marking in accordance with the department's standards and regulations.

Student: Faith Bizoni B190318B

Signature ………………

Date……………………

Supervisor

Signature…………………………..

Date……………………

DEDICATION

I dedicate this research project to my parents and everyone who has believed in me.

ACKNOWLEDGEMENTS

I want to thank God Almighty for his grace and favour towards the completion of my research. I also want to acknowledge and thank my project supervisor Mr W. Mhlanga for his guidance and supervision throughout my research project. I'm thankful to Mr T Chizororo and other Bindura University Farm workers who have been of great assistance to me during the course of my project.

Finally I extend my thanks to all the lectures at the Faculty of Agriculture and Environmental Science, Department of Natural Resources Management.

ABSTRACT

This study was done to assess the growth rate, feed conversion ratio, feed conversion efficiency, mortality and quantity harvested for *Oreochromis niloticus.* The study was carried out at the Bindura University Farm along Bindura-Shamva road in Mashonaland Central. For this purpose fish weights were initially recorded when they were introduced in November 2021. Tilapia were fed with feed from Profeeds throughout the production cycle. The assessment was carried out in all the six ponds for six months starting from December 2022 till May 2022 with each pond carrying 2200 fish. The growth rate, feed conversion efficiency, feed conversion ratio, mortality and quantity harvested were recorded. The highest mortality rate was obtained as 33.4 %. The least quantity harvested was 178.26 kg in pond 4. This was due to the high mortality rate experienced in the pond. The highest specific growth rate in the final month was recorded in pond 3 with 68.80. This was mostly due to the presence of enough commercial feed in the ponds. The FCR ranged from 6.7 to 7.2 in all the ponds during the first month. The FCR figures declined in the course of the production cycle especially in the last month with the least FCR being 1. The decline in the FCR was due to an increased consumption of food by the fish. The FCE was in a constant increase in all the ponds from the first month till the last. The FCE ranged from 0.13 to 0.88 during the whole production cycle. The recommendation from the study would be to carry out water quality test before and during the production cycle of *Oreochromis niloticus.*

Key words: Food conversion ratio, Food conversion efficiency, Mortality, quantity harvested

Contents

List of tables

List of Figures

LIST OF ACRONYMS

BUSE - Bindura University of Science Education

FCE -Food Conversion Efficiency

FCR -Food Conversion Ratio

SGR -Specific Growth Rate

CHAPTER 1

INTRODUCTION

1.1. Research Background

Due to declining catch fisheries and the necessity to use already existing inland waters for food production, aquaculture is becoming more and more significant in the contribution of the entire fish supply from around the globe (De Silva & Hassan, 2007). According to an FAO (2020) assessment, the world's fish production is expected to have reached 179 million tons in 2018, with a total first sale value of USD 401 billion. Of this amount, 82 million tons, or production from aquaculture accounted for USD 250 billion. Humans consumed 52% of the fish produced through aquaculture, which accounted for 46% of the total production (FAO, 2020).This demonstrates unequivocally that aquaculture may be a supply alternative for meeting needs around the world. For around 200 million people in Africa, fish serves as food and ensures nutritional security, according to Bene & Hack (2005). Despite the fact that the continent has a wealth of natural resources, it has yet to submit any noteworthy advances in aquaculture to the world ordered series. (FAO 2010).

The majority of fish grown for human consumption are freshwater species, with the Nile tilapia ranking first in Ghana (Sarpong et al., 2005) and second globally in terms of aquaculture production (FAO, 2012). Ghana's fishery resources provide 60 to 70 percent of the country's population with natural animal protein (Aggrey-Fynn, 2001). Since fish is nutrient-dense and beneficial, many people are urged to consume more fish protein than meat (Asmah, 2008).

Fish stands out as the key food in terms of food security since it is so much less expensive than other high-quality protein sources like milk, beef, and eggs (FAO, 2020). Additionally, it is an essential source of minerals including iron, calcium, zinc, and selenium as well as vitamins (particularly A, B, and D). It also contains essential amino acids and long-chain omega 3 fatty acids that are good for you. Fish is a valuable source for a diverse diet that promotes health, even in relatively little amounts, because of its distinctive nutritional makeup (FAO, 2020).

Improvements have been made to culture facilities including ponds and cages as well as feed formulation (Munguti, Kim, & Ogello, 2014).Freshwater fishes account for the majority of aquaculture production worldwide (FAO, 2012), with *Oreochromis niloticus* ranking top in Ghana (Sarpong et al., 2005) being the most consumed and second-most cultivated fish species in the world after being the most commonly consumed fish species. The people of Zimbabwe receive 45–65% of their natural animal protein from their fisheries (Aggrey–Fynn, 2001). Many Ghanaians are advised to consume more fish protein than beef because fish is healthy and nutritious (Asmah, 2008).Body size has a substantial impact on fish growth rate, feed conversion ratio, feed efficiency ratio, and energy budget (Jobling 1994). The bulk of studies show that when body size increases, the relative growth rate decreases. The stocking size for grow-out pond production has been determined using the typical size of fingerlings offered by tilapia hatcheries.

The quantity of fish that are first stocked in the pond affects other aspects of fish as well, such as body size, food efficiency ratio, and food conversion rate. It is one of the key elements in determining a fish farm's productivity (El-Sayed, 2006).

Stocking density affects reproduction, feeding, growth, behavior, health, and water quality (Lesvia, 2014). Therefore, additional research would be highly beneficial, particularly in the production of significant fish species, such as Oreochromis niloticus, which is the most farmed and desired by customers in Zimbabwe.

1.2. Problem Statement

Specific growth rate, mortality, feed conversion ratio, feed conversion efficiency and quantity harvested in ponds from the BUSE Farm all are important in the production cycle hence the need to record production data using the variables of fish pond farming at the BUSE Farm.

1.3. Objectives

- To assess the specific growth rate of *Oreochromis niloticus* in ponds.
- To assess the growth rate of *Oreochromis niloticus* in ponds.
- To assess the feed conversion ratio of *Oreochromis niloticus* in ponds.
- To assess the feed conversion efficiency of *Oreochromis niloticus* in ponds

- To assess the quantity harvested in ponds.
- To assess mortality of fish in ponds.

1.4. Research questions

- What is the specific growth rate of *Oreochromis niloticus* in ponds?
- What is the growth rate of *Oreochromis niloticus* in ponds?
- What is the feed conversion ratio of *Oreochromis niloticus* in ponds?
- What is the mortality rate of *Oreochromis niloticus* in ponds?
- What is the quantity harvested of *Oreochromis niloticus* in ponds?

1.4 Justification of the study

No studies done at BUSE FARM in relation to *Oreochromis niloticus* pond farming**.**

1.5 Significance of the study

This research work would provide data to the BUSE Farm. Results obtained from this study are important to fish farmers in Zimbabwe and fish pond production. It provides a guide in making decisions relating to fish farming as a business enterprise.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Small and medium sized tilapia farms vary greatly in productivity. Differences in growth rate and food conversion ratio (FCR) have an impact on the performance gap between the best and worst perfomerrs. (Beveridge 2013)

2.2 Food conversion ratio (FCR)

FCR is referred to as the percentage of the provided full feed divided by harvested absolute biomass. Individual feed proficiency and endurance are still up in the air because fish that die during the development stage eat feed all the way to the end of its life but don't contribute to the overall biomass obtained. According to Rana and Hassan (2013), revealed FCR values for tilapia generally change in lake and pond settings. FCR is considered adequate when it is less than 2 (Craig 2009), however the satisfactory level can fluctuate with the feed cost. Feed cost is the significant expense in fish cultivation (El-Sayed, 1999; Craig 2009) addressing more than half of the variable expenses during the development period (El-Sayed 1999). Where the feed cost is high, a little expansion in FCR is a main pressing issue for hydroponics as it unequivocally and adversely influences the productivity of fish farms (Hassan 2018)

A huge improvement in the general lake FCR in the coordinated medicines over the non-incorporated treatment was noticed. Thus confine squander is a wellspring of sustenance to the open-lake fish comprising of uneaten feed, faeces as well as disintegrated supplements. Subsequently in the coordinated framework, the open-lake tilapia can consume a lot of the strong matter, expanding the feed use productivity. In the non-coordinated framework in treatment, the fish can recuperate the dregs feed squander after mineralization and reusing through the autotrophic and heterotrophic pathways. Trophic changes are generally joined by energy misfortune (Egna and Boyd, 2018), which can be stayed away from through confine cum-lake combination.

In addition, Mensah et al. (2013) provided mean FCR information in the context of leading a stocking thickness probe on Nile tilapia fry. A mean FCR of standard was also maintained by Kapinga et al. (2014) in their examination of the lake development of tilapia fingerlings. FCR is dependent on fish weight gain, hence in an ideal environment, any factor affecting weight gain would have an impact on FCR. It has been documented that the type of feed used and the quality, size, and agreeability of the meal might affect FCR. Additionally, the FCR of the raised fish will change depending on whether a pellet is drifting or sinking. The food change rate and explicit development rate contribute to better fish care in light of the requirement that fish consume less carbs (Chepkirui-Boit et al. 2011).

2.3 GROWTH RATE

Nile tilapia can be cultured in pond culture systems that are either extensive, semi-intensive, or intensive. The main considerations that influences the development rate in Nile tilapia culture are supplement structure of fish feed quality (nourishing synthesis), hereditary variety, loading thickness, taking care of rate, taking care of recurrence and water quality like temperature, broke down oxygen, pH, saltiness and alkali (Getahun An et al. 2011).

A high growth rate was reported by approximately 90% (87.8%) of farmers in the study area during each production cycle. According to Leon et al., two-thirds of farmers reported a growth rate, primarily in fingerlings with an average body weight of 3 to 20 grams. 2016). Comparing the development of individual grass carp by considering the underlying load at starting and the last weight toward the finish of the considered period, ignoring fish eliminated preceding this time, the typical explicit development rate (SGR) was moderate.

The adverse consequence of inaccessibility of value feed predominant in the way of life of *O. niloticus* make sense of why consistent observing is fundamental. As a result, aquaculture systems' monitoring of water quality parameters and feeding fish a well-balanced diet is important because they affect fish's physiological processes. A number of variables, including as fish behaviour, stocking density, feed quality, daily ration, feeding frequency, and water temperature, have an impact on the success of cultured fish. One of the most significant variables is nutrition. Fish that are raised in large numbers require a lot of food. This is on the grounds that the development of fish relies unequivocally upon the nature of feeds gave. Numerous studies (Ernst et al 1990) have shown that this is the case with tilapia in that taking care of rate and taking care of recurrence can impact the creation execution of tilapia. In practice, feeding fish, the feeding rate, or allowance, can be either feeding until the fish are full or feeding a limited amount. A review with Nile tilapia demonstrated the way that best development can be accomplished close to satiation taking care of rate (. Ernst and co-workers 1990). The nutrients and energy sources that fish need to stay healthy and grow normally should be included in their diet. A totally ready and painstakingly formed fish feed assumes a critical part in fish culture.

In the combined cage-cum-pond system, the most efficient management method for production was feeding tilapia in fertilized ponds. Somewhat, use of feed without preparation at 6% prompted decreased fish execution. Since fertilizer application resulted in a 30% increase in growth, these data imply that fertilisation was important the performance enhancement of tilapia. In the production of tilapia, fertilizer plays two major roles. Through the stimulation of natural food and the enhancement of autotrophic and heterotrophic food chains, it provides the fish with nutrition (Schroeder et al., 2018). On the other hand, it increases oxygen budgets and reduces ammonia through photosynthetic algal assimilation, both of which improve water quality (Swingle, 1964).

Elements that affect water quality may have an impact on fish development rates. In fish rearing, dissolved oxygen, water temperature, and saltiness levels are generally regarded as having fundamental significance, and significant variations of these parameters may negatively affect the development of fish (Islam et al. 2006; 2001, Houlihan and Boujard). Under semi-concentrated frameworks, anticipated water quality bounds remained within O. nioloticus way of life cut-off points throughout the experiment period (Boyd and Exhaust, 1992).

Crude proteins make up between 55% and 75% of natural foods (CP). Since fish eat to meet their energy needs (Lee and Putman, 1973), in such circumstances, protein would be catalysed for energy supply, allowing for efficient utilization of natural foods and the need for low-cost, energy-rich diets to supplement in order to preserve high-quality protein for growth (De Silva, 1993). The diet that was used in this study had 24% protein in it. The fish grow better when the feed and fertilizer work together. Comparative outcomes were acquired by Diana et al. (1994), who stated that feed-fertilizer ponds were superior to fed-only ponds in producing *O. niloticus*. Although they show ontogenetic shifts from zooplankton at young ages to phytoplankton, macrophytes, and detritus at advanced ages, tilapias generally are known to be herbivores and detritivores (Bowen, 2019). Additionally, tilapias in nature appear capable of growing on relatively low-quality foods like benthic detrital aggregate, according to Bowen (2019).

2.4Food Conversion Efficiency (FCE)

At various levels, enhanced feed efficiency is anticipated to have significant environmental benefits. To begin with, through a decrease of how much assets utilized, including fish oil and fish feasts, in this manner adding to the conservation of marine biological systems. Improved feed efficiency would also lead to decreased outputs of environmentally hazardous nutrients like phosphorus and nitrogen (Sibanda et al., 2022). Lastly, feed production would reduce energy consumption and emissions of greenhouse gases if feed consumption were reduced (Magqina et al., 2020). From a social point of view, increasing feed efficiency (FE) in animal production ought to result in a decrease in the competition between humans and animals for raw materials, as well as an increase in the quantity of food available to humans, particularly the poorest, thereby expanding their access to proteins and a healthy diet. Through selective breeding, feed formulation, and animal husbandry, feed efficiency can be increased. According to (Sibanda et al, 2022) for instance, rearing systems and feeding regimens can be tailored to increase feed utilization efficiency and reduce unnecessary movement, which in turn reduces energy consumption. 2022). Feeds can be more effectively digested and utilized by careful formulation, lowering the amount of fish oils in diets (Magqina et al., 2020). As was observed with Cirrhinus mrigala (Khan and Abidi, 2004) and hybrid sturgeon (Luo et al., 1996), fish harvested could be improved when raised with an increasing feeding ration up to a certain level.

Shalloof and Khalifa (2009) assert that the historical improvement in feed efficiency for livestock agriculture animals can be largely attributed to selection based on growth rate. However, there are no convincing results in fish species demonstrating an improvement in feed effectiveness with a specific rearing strategy on development. Development could help to increase feed proficiency, but not all reviews are proceeding smoothly. Estimates of the heredity of fish feed efficiency are rare and less accurate than those for animals (Moyo and Rapatsa, 2021). This has been recalled to highlight key differences between (poikilotherm) fish and (homeotherm) animals with different modes of energy distribution. In terrestrial species, it might be challenging to estimate FE, or more specifically the feed conversion ratio.

FCR (Feed intake/body weight growth), which measures the amount of feed required to create one unit of biomass, is considerably more challenging to assess in fish. Fish are reared in big groups in water, making it impossible to collect and gauge each fish's consumption. Special feed tagged with X-ray dense markers has been the main technique used to evaluate fish feed intake (Zvavahera et al., 2018), harmless and exact for a particular feast, the principal drawbacks of this strategy are the pressure related with X-raying, yet additionally the long recuperation time (days or weeks) before the following conceivable evaluation. Because fish do not consume a consistent amount of feed from one feast to the next, there is a generally low repeatability of daily feed consumption. Multiple measurements collected over a long period of time, however, can get around this. Recently, (Moyo and Rapatsa 2021) reviewed video techniques for determining each fish's individual feed intake (FI) for tilapia. It seemed from this earlier investigation that feed intake measurements over 11 meals with two meals per day necessary to achieve 95% accuracy.

2.5 Quantity Harvested

Overall fish production was 1048.93 kg/ha/3 months, 2392.23 kg/ha/3 months, and 5494.10 kg/ha/3 months, respectively. According to Hossain et al. (2004), the maximum production seen in T3 may be attributable to the high protein content of the supplementary-pelleted feed and the significant amount of natural food present in the pond throughout the study period. According to Boyd (2001), fertilisation alone cannot produce as much fish as fertilisation combined with feeding can. According to Gupta et al. (2002), tilapia output increased by 3554.76 kg/ha in the treatment group receiving additional feed compared to 1510.71 kg/ha in fertilised ponds over a 6-month period. Yields were recorded at 1274 to 2929 kg/ha/145 days. According to Green et al.

(2002), among other things, the variation in rearing season and cultural phases as well as the productivity of the ponds may be to blame for the disparity in total production found by different authors.

2.6 Mortality

The environment has a significant impact on fish mortality as well as individual variation in the process by which they convert feed into biomass (de Verdal et al.). 2018). There is a wide range of mortality rates for Nile tilapia, ranging from 20–71% for those raised in fertilized ponds with or without additional feeding (Abdalla et al.). 1996; Ahmad and Abdelghany, 2002). Rana and Hassan (2013) says that pond environments have mortality rates ranging from 25 to 60 percent. Research on Labeo rohita by Ahmed (2007), Khan and Oberg et al. 2014) on *Oreochromis niloticus* reported that pond fish's growth, survival, feed intake, and conversion efficiencies are frequently affected by ration levels.

Thrng (2013), in Vietnam, a mortality rate of 71–72 percent was reported in cage culture, 48 percent in pond nucleus, and 32 percent in polyculture production. The stage of fish mortality determines how much of an impact it has on the economy. Due to the cumulative cost of production, deaths that occur in the later stages of the-grow out phase have the greatest economic impact.

All of the fish ranches considered from different Neighborhood Government Regions had changing degrees of mortality, with around 65% of the fish lakes having essentially high mortality on their homestead (Adar et al. 2022). It is known that young tilapia grow faster, maximizing growth at the initial higher feed rate. Pillay (1990) found that as weight increased, feed consumption decreased in relation to body weight. Under similar cultivation conditions, small O. niloticus require higher feeding rates than large fish. These outcomes are additionally upheld by Lin, (1990) who showed the way that contributions of feed could be decreased by half without unfriendly consequences for fish development

Fish mortality is a common occurrence in all fish lakes and is significantly influenced by the various board practices used by fish ranchers in the various regions evaluated (Nilsen et al., 2020; Mulei and others, 2021). Despite the fact that the majority of farmers were concerned about mortality, none of them kept any mortality records, instead, they made use of memory recall (Ali et al., 2020). Keeping records is crucial to the effectiveness of any biosecurity program because mortality data are one of the most significant sources of information on a farm.

The lack of fence, the existence of neighboring farms, vehicular access, allowing visitors, the frequency of visits, and visitor contact with holding facilities are among the key contributing factors to farm mortality, according to the findings. Greatest mortality is 57.7% in the event that the ranch is fenced and its base mortality is 27.7%. Maximum mortality is 47 percent and minimum mortality is 17 percent without fencing. Deborah et al. 2022). Where guests are permitted much of the time, greatest mortality viewed as 71.2% and least observed to be 35.7% (Deborah 2022). Maximum mortality was found to be 96.4 percent on neighboring farms. (Appiah 2019)

Some fish were held separately in cages to replace fish mortality in cages during the first two weeks of acclimatization due to the problem of high mortality experienced in previous experiments transferring fish directly from ponds to cages (Kinyua, 2004). This was done because the fish used in the study aren't used to living in cages and moving them from ponds to cages puts a lot of stress on them. Therefore, adequate time for acclimatization is essential prior to feeding and ultimately sampling. When compared to previous farm-based experiments, this led to higher caged fish survival rates.

Biosecurity holes are created as a result of these interactions, which put the fish farms at risk for the introduction, emergence, and spread of disease-causing agents (Faye et al 2020). Ali et al. (2020) additionally noted that this was also true among fish farms rather than among veterinarians for diagnosis. Finding fish illnesses is one of the most important aspects of biosecurity since preventing genuine illnesses and demonstrating illness are crucial for lowering fish mortality. Understanding health concerns and the variables influencing mortality is crucial for efficient fish production (Persson et al., 2022).

Most fish farms rely more on extension workers than fish diagnosis. The farm's high death rate has been attributed to the general practice's ignorance of and non-compliance with biosecurity measures (Jia et al., 2017).Fish government assistance and wellbeing are compromised due to mortality during the creation cycle, which brings about financial misfortune for the ranchers. According to Oliveria et al., mortality is a crucial factor in determining any farming enterprise's profitability. 2021.(Persson et al., 2022). It is possible to lessen the financial burden of the disease and eliminate threats to life and health by implementing biosecurity measures. Nigeria is a major aquaculture producer in Africa. However, significant production losses as a result of disease have occurred as a result of the nation's poor policy on aquatic animal health (World Fish, 2021).

CHAPTER 3

METHODOLOGY

3.1 Study Area

The research took place in Bindura at the Bindura University Farm located at Glen Avillin Farm 15 km along Bindura-Shamva road in Mashonaland Central Province. The Farm is divided into several sectors containing activities such as goat breeding, apiculture activities, cattle farming, poultry, maize farming and the pond area where the aquaculture project is being done. In meteorological terms, Bindura experiences temperatures that vary from 52°C to 86°C. Rainfall ranges between 600 to 1200mm (Mapiye et al, 2002). The dry season is mostly clear and dry throughout the year.

3.2 SAMPLING METHOD

Data for this study were gathered by random sampling since this method ensures that all relevant demographic groups are represented (Acharya et al., 2013). There are 6 ponds in the pond area, each with 2200 fish. Five fish samples from each pond were taken for this assessment, totaling 30 samples that were taken at random every 20 to 45 days. With the use of a scale, the weight of the tilapia was determined.

After the fish were trapped they were put in a bucket filled with water to preserve the life of the fish. After this the fish weight and length were then obtained using a weight scale and a ruler. The weights and lengths were recorded per pond. Fish were collected randomly in ponds, counted, and measured for bulk weight at the conclusion of the experiment. The mean total weight for each pond was then calculated. The samples were used to determine the specific growth rate, growth rate, feed conversion ratio, feed conversion efficiency, mortality, and quantity harvested.

3.3 Specific Growth Rate

A fish's specific growth rate (SGR), measured as a percentage of its starting size, is the rate at which the fish increase in size over a specific period of time .SGR is a crucial statistic used in fisheries and aquaculture management to track the expansion and well-being of fish populations. SGR is determined by the following (Brett 1979)

SGR=Average Weight Gain-Initial Weight/Number of Days

3.4 Growth rate

This is defined as any change in size or amount of body material whether positive or negative (Schrek and Moyle 1990). To assess the growth rate of the fish, weight and length was measured on a monthly basis and recorded for assessment. Samples were collected from each of the six ponds. This is done to measure the rate at which the fish are growing.

3.5 Mortality Rate

This is the total number of fish that died It is calculated by the number of fish at recording time subtracted from the initial number. Mortality was assessed by observing the number of dead fish at given intervals. The total number of fish that died was recorded against the initial fish stocking in order to assess the mortality rate.

It is shown as

$$\frac{\text{NUMBER OF FISH THAT DIED}}{\text{NUMBER OF FISH AT STOCKING}} \mathbf{x\ 100}$$

3.6 Feed Conversion Ratio

FCR at the level of production units is defined as the ratio of the total feed given divided by total biomass harvested. (Mengistu et al., 2020) It is calculated by amount of weight gained divided by number of fish stocked (A), which is divided by amount of feed offered divided by number of fish stocked (B). The amount of feed given on a monthly basis per each pond was recorded in (kg). This was divided by the total number of fish stocked in the ponds. Feed conversion ratio is the ratio of the quantity of food distributed (g) to the weight gain of fish (g), over the production period (Jauncey and Ross, 1982).

3.7 Feed Conversion Efficiency

It is calculated by weight gain divided by amount of feed per pond. This was assessed by taking the amount of weight that is gained by the fish and dividing it by the amount of feed given. This is to be calculated on a monthly basis and per each pond.

Formula: The formula for feed conversion efficiency (FCE) is:

FCE = [Total body weight gain of the fish (g) / Amount of feed provided to the fish (g)]

3.8 Number of fish harvested

This is calculated as the total number of fish harvested at the end of the project. Total number of fish on harvest day were recorded against the initial stocking amount of fish.

CHAPTER 4

RESULTS

***Table 4.1** Specific Growth Rate of fish in the 6 ponds (%)*

	Number of	**Months mean**					**Mean SGR**	**SD**
Pond number	**1**	**2**	**3**	**4**	**5**	**6**		
1	64.19	76.30	74.94	57.33	58.98	58.64	65.06	8.516
2	67.74	72.92	81.26	60.74	59.74	58.26	66.77	9.021
3	63.22	72.61	76	62.51	58.48	62.80	65.93	6.787
4	63.54	74.15	79.15	57.70	58.98	54.87	64.73	9.775
5	67.41	76.61	75.15	56.59	58.73	57.48	65.32	9.050
6	61.61	73.84	83.57	54.07	58.22	60.96	65.37	11.093

FCR	**Month means**	**Final mean**	SD

Table 4.1 shows an increase in the specific growth rate in the first, second and third month. The fourth month experienced a decline in the specific growth rate.

Pond number	1	2	3	4	5	6		
1	6.9	5.7	4.6	2.4	1.4	1.1	3.6	2.399
2	7.2	5.5	4.9	2.6	1.5	1. 1	4.3	2.287
3	6.9	5.5	4.6	2.7	1.4	1.2	3.7	2.316
4	6.85	5.62	4.8	2.6	1.4	1	3.7	2.375
5	7.2	5.7	4.6	2.4	1.4	1.1	3.7	2.481
6	6.7	5.6	5.4	2.3	1.4	1.1	3.7	2.482

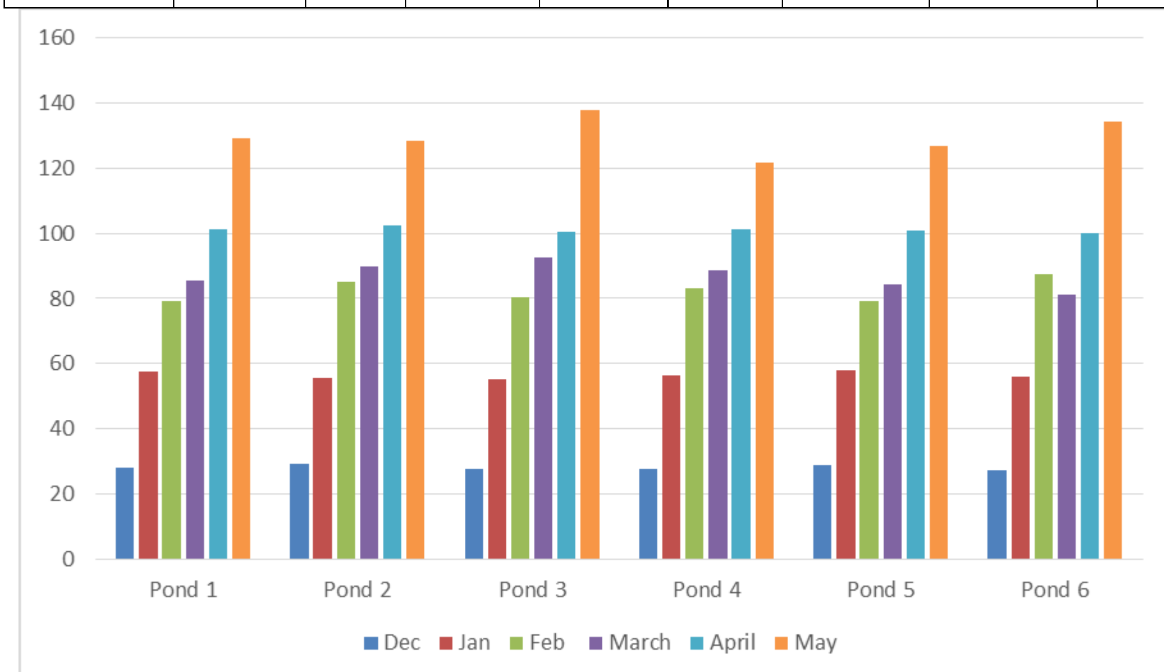

Figure 1 growth (grams) of fish in 6 ponds

A sharp increase in the growth rate was observed in ponds 1,2 and 3. Pond 6 experienced a decline in the growth rate during the fourth month.

Table 4.3: Feed Conversion Ratio of fish in six ponds

Table 4.3 shows the highest FCR obtained in ponds 2 and 5 with an FCR of 7.2. The least FCR was 1 and was recorded in pond 4.

Table 4.4: **Feed Conversion Efficiency for six months in all the six ponds.**

	Month mean						Mean FCE	SD
Pond Number	**1**	**2**	**3**	**4**	**5**	**6**		
1	0.14	0.17	0.21	0.39	0.67	0.87	0.40	0.300
2	0.13	0.18	0.20	0.37	0.66	0.88	0.40	0.303
3	0.14	0.18	0.20	0.37	0.66	0.81	0.39	0.280
4	0.14	0.18	0.21	0.36	0.68	0.80	0.39	0.279
5	0.13	0.17	0.21	0.40	0.68	0.88	0.41	0.306
6	0.14	0.17	0.19	0.41	0.68	0.84	0.40	0.295

Table 4.4 shows a continuous increase in the feed conversion efficiency in the six months for all the six ponds.

Table 4.5: Fish mortality in the six ponds (%)

Pond number	**Mortality %**
1	1.7
2	2.5
3	4.2
4	33.3
5	32.1
6	7.3

Table 4.5 shows the highest mortality recorded in pond 4 and the least mortality in pond 1**.**

Table 4.6: Quantity Harvested in all ponds for the whole production cycle (kg)

Pond No	Total No	Total Weight (kg)	Fish(kg) / square metre(20x10)
1	2162	279.76	1.3kg/m^2
2	2144	275.71	1.3kg/m^2
3	2136	294.76	1.4kg/m^2
4	1466	178.26	0.8kg/m^2
5	1492	189.48	0.9kg/m^2
6	2039	273.63	1.3kg/m^2
	11439	1 491.6	7kg/ m^2

Table 4.6 shows the highest quantities harvested in pond 3 with 294. 76 kg and pond 4 with the least quantity harvested 178.26 kg.

Chapter 5

Discussion

5.1 Specific growth rate

The specific growth rate was increasing in all the ponds from the first month till the third month. This is probably due to the fact that tilapia grow well during the young stage as confirmed by Lee who discovered that there was a decrease in the SGR in the fourth month. This is because the growth of fish declines as they start to reach adult stage. Since fish eat to fulfil their energy requests (Lee and Putman, 1973), hence under such circumstances, protein would be catalysed for energy supply, prompting productive usage of regular food sources which requires supplementation with modest energy rich weight control plans to save the great protein for development (De Silva 1993).

The research study demonstrated that taking care of fish with fish food from Profeeds which is commercial feed was the best administration practice for production in ponds since there was sharp expansion in development rate in the initial three months. According to the results, which have remained nearly constant over the past three months, applying feed that does not require fertilization, such as feed from Profeeds, resulted in a relative decrease in the fish specific growth rate.

Since growth accelerated, these findings suggest that feed was a major contributor to the rise in fish specific growth rate. In Profeeds fish food, fertilizer plays two important roles in fish production. Through the stimulation of natural food and the enhancement of autotrophic and heterotrophic food chains, it provides the fish with nutrition (Schroeder et al., 1990). On the other hand, it increases oxygen budgets and reduces ammonia through photosynthetic algal assimilation, both of which improve water quality (Swingle, 1964).

The results of this study indicate that fish grew poorly starting from the fourth month, indicating that the feedings only approximately maintained the requirements and that most of the nutrients taken were probably used to preserve life and a minor part for growth. The observations obtained by Khan et al. (2004) seem to agree with the most recent information on these species.

Fish growth is strongly influenced by feeding rate. Assurance of ideal qualities for this variable is important to the outcome of hydroponics creation. The growth, SGR, was significantly affected by ration levels in this study. Similar research on Labeo rohita fish by Ahmed (2007), Khan and Oberg et al. (2014), and others found that proportion levels frequently affect the growth displays, endurance, feed admission, and transformation efficiency of fish in lakes and ponds.

Tilapias are known to have quicker development at the youthful stages accordingly augmenting development inside beginning higher feed rate. Pillay (1990) found that as weight increased, feed consumption decreased in relation to body weight. In this way little measured *O. niloticus* require higher taking care of rates than huge fish under comparative culture conditions. These outcomes are additionally upheld by Lin, (1990) who showed the way that contributions of feed could be diminished by half without unfriendly consequences for fish development. It is now widely acknowledged that feed is a significant cost component of fish production; consequently, any production strategy geared toward lowering feed input would effectively boost fish production.

It is possible that factors related to water quality have an effect on fish growth. In fish culture, dissolved oxygen, water temperature, and salinity levels are typically thought to be crucial parameters, and significant variations in these parameters may negatively impact fish growth (Islam et al. 2006; 2001, Houlihan and Boujard). Under semi-concentrated frameworks, predicted water quality bounds were consistent with *O. nioloticus* lifestyle cut-off points throughout the exploration period (Boyd and Exhaust, 1992).

5.2 Food Conversion Ratio

The food from Profeeds that was used had the highest food conversion ratio (FCR) during the first three months. However, there has been an improvement in FCR over the past three months, which indicates that the feeding rate may have been underfed with Profeeds, affecting the pond fish's performance.

In addition, the raised fish's FCR will also be affected by the pellet's sinking or floating properties. The food change rate and explicit development rate help to enhance the taking care of fishes in view of the necessity for the fish slims down (Chepkirui-Boit et al. 2011). Length-weight relationship (LWR) of fish changes in view of the condition fish is exposed to that is the food accessibility. A length-weight relationship is a significant device that might make sense of the development design in fish.

5.3 Mortality

Fish in Ponds 1, 2, 3, and 6 survived similarly, with mortality rates of less than 10%. The pond mortalities that occurred during the fish culture period may have been caused by stress resulting from handling during individual weight, bulk weight, and counting sampling. Ponds 4 and 5 had mortality rates above 10%. The majority of single-dead fish were observed the following day after each sampling, indicating that this was a clear observation. Other ponds may have lower mortality rates because the fish were handled better during sampling. During each pond's sampling, these measures include using aquarium aerators, sampling under shade, and ensuring that fish holding basins have freshwater available (Ethan et al., 2012).

The high mortality cases in pond 4 and 5 might be credited to predation by birds. Birds around the ranch lakes are exceptionally normal and structure the primary loss of fish. These include egrets, cormorants, king fishers, herons, hammer corps, and other birds. According to the company's reports, birds' predation is largely to blame for the high fish loss in ponds. Measures are hence in progress on the compelling ways of controlling this issue.

5.4 Food conversion efficiency

The highest FCE was recorded in the sixth month. This is because as fish grow older, feed is mostly used for energy purposes as confirmed by (Khan et al 2004). The results in the present study revealed that the feed conversion efficiency (FCE) was almost doubled in the fish under the combination treatment compared to those under feeding alone as it has been reported by (Manyala et al. 2015). This study has shown that, the ponds subjected to the Profeeds food, constant feeding at same interval rate of the fish body weight result into faster fish growth and higher food conversion efficient, than the continuously feeding. FCE was high in the first three months which confirmed the results by (Khan et al 2004) and hybrid sturgeon (Luo et al., 1996), fish harvested could be improved when raised with an increasing feeding ration up to a certain level in the first months of rearing. Feeds can be more effectively digested and utilized by careful formulation, lowering the amount of fish oils in diets (Magqina et al, 2020).

5.5 Quantity harvested

The highest quantity harvested was 294.76 in pond 3. This recorded 1.4kg/m^2 and this can be compared to that one confirmed by (William et al, 2018) who said that highest yield will result if fish are given plenty of artificial feed.

This production is somewhat consistent with the results of (Hossain et al., 2004). The reported yields ranged from 1.274 to 2.929 kg/square metre (Green et al. 2002). Different raising seasons, cultural periods, and other variables, as well as differences in overall production reported by different writers, could all contribute to this. (Ahmad et al. 2007). The total fish harvested per pond were almost similar since same food was supplied to all ponds at same time interval as confirmed by (Boyd 2001) who reported that constant food feeding can result in increase of fish production and constant total yield. The least quantity harvested was pond 4 with 178.26kg. This was due to the highest number of mortality (33.3%) that was experienced in the pond.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The study aimed at assessing specific growth rate, growth rate, feed conversion ratio, feed conversion efficiency, mortality and quantity harvested of *Oreochromis niloticus* in ponds. It can be concluded that high mortality rates in tilapia pond production can be attributed to stress during the handling process. It was also observed that high FCR rates are recorded in ponds during the first month of production due to the unfamiliarity of fingerlings to feeding process. Mortality affects quantity harvested as there is a decline in quantity harvested in the pond that experienced the most mortality. It can also be concluded that mortality rates affect the quantity harvested as ponds with high mortality have low quantity harvested.

6.2 Recommendations

- Parameters such as water quality, soil pH and temperature should be tested before and during the course of tilapia pond production.
- There should be a proper disposing practise of dead fish. This is because dead fish have the potential to spread diseases to the remaining fish thereby increasing mortality.

,

References

Abbas, G. and Siddiqui, P.J., 2009. Effects of different feeding level on the growth, feed efficiency and body composition of juvenile mangrove red snapper, Lutjanus argentimaculatus (Forsskal 1775). *Aquaculture Research*, *40*(7), pp.781-789.

Adeleke, B., Robertson-Andersson, D., Moodley, G. and Taylor, S., 2020. Aquaculture in Africa: A comparative review of Egypt, Nigeria, and Uganda vis-a-vis South Africa. *Reviews in Fisheries Science & Aquaculture*, *29*(2), pp.167-197.

Admasu, F. & Wakjira, M. (2021). Non-Infectious diseases and biosecurity managementpractices of fishes health in aquaculture. Journal of FisheriesSciences.com.

Ahmad, M., Ahmed, I., & Hussain, M. (2007). Evaluation of carp polyculture in rain-fed ponds under different management strategies. Pakistan Journal of Agricultural Sciences, 44(3), 397-402.

Aggrey-Fynn, J., 2001. An evaluation of the impact of credit on small-scale farmers in southern Ghana. The Journal of Agricultural Education and Extension, 8(2), pp.87-96

Akbulut, B., Feledi, T., Lengyel, S. and Ronyai, A., 2013. Effect of feeding rate on growth performance, food utilization and meat yield of sterlet (Acipenser ruthenus Linné, 1758). *Journal of FisheriesSciences. com*, *7*(3), p.216

Appiah-Kubi, D.K.S., 2019. *ASSESSMENT OF THE USE OF AGRO-CHEMICALS BY SMALLHOLDER FARMERS IN THE NADOWLI-KALEO DISTRICT* (Doctoral dissertation).

Asmah, E.E., 2008. Agricultural credit delivery in Ghana: A review of approaches. International Journal of Agricultural Economics and Rural Development, 1(1), pp.1-9.

Bureau, D.P., Azevedo, P.A., Tapia-Salazar, M. and Cuzon, G., 2000. Pattern and cost of growth and nutrient deposition in fish and shrimp: Potential implications and applications. *Avances en nutricion acuicola*.

Béné, C. and Heck, S., 2005. Fish and food security in Africa. Naga, World Fish Center Quarterly, 28(3&4), pp.14-19.

Béné K & Heck (2005), Standard method for nutritional and feeding of farmed fish and shrimp. Argent liberations press. Redmond, Wash

Brett, J. R. (1979). Environmental factors and growth. In Fish physiology, Vol. 8, pp. 599-675. Academic Press.

Chepkirui-Boit, V., Njiru, J.M., Munguti, J.M., Muchiri, M. and Wamalwa, M., 2011. Growth, feed utilization and body composition of Nile tilapia (Oreochromis niloticus) fed on various dietary crude protein and energy levels. Journal of Animal and Veterinary Advances, 10(6), pp.714-720.

Craig, S.R. (2009). Understanding fish nutrition, feeds, and feeding. Virginia Cooperative Extension, Publication 420-256.

Deborah, A.D., Ahmed, G., & Chowdhury, M.A.K. (2022). Mortality of Nile Tilapia in outdoor ponds under different management regimes. Aquaculture Reports, 21, 100854.

El-Sayed, A. M. (1999). Tilapia culture. CABI Publishing.

Du, Z.Y., Liu, Y.J., Tian, L.X., He, J.G., Cao, J.M. and Liang, G.Y., 2006. The influence of feeding rate on growth, feed efficiency and body composition of juvenile grass carp (Ctenopharyngodon idella). *Aquaculture International*, *14*, pp.247-257.

Egna, H.S. and Boyd, C.E., 2018. Water quality management for pond fish culture. John Wiley & Sons.

El-Sayed, A.F.M. and Kawanna, M., 2004. Effects of photoperiod on the performance of farmed Nile tilapia Oreochromis niloticus: I. Growth, feed utilization efficiency and survival of fry and fingerlings. *Aquaculture*, *231*(1-4), pp.393-402.

Ernst, D.H., Boyd, C.E., Massaut, L., Hargreaves, J.A. and Ross, L.G., 1990. Water quality in warmwater fish ponds. SRAC Publication No. 1800, Southern Regional Aquaculture Center, Stoneville, Mississippi.

Faye, R., Diouf, N.D., LY, M.A. and Ayih-Akakpo, J.A., Biosecurity Practices Applied in Aquacultural Farms in Northern Senegal, West Africa.

Getahun An, M., Liu, L., Zhang, G. and Li, L., 2011. Effects of dietary protein sources on growth performance, feed utilization, and digestive enzyme activities of juvenile tilapia, Oreochromis niloticus× O. aureus. Aquaculture, 318(3-4), pp.428-433

Green, B.W., Summerfelt, S.T., Vinci, B.J. and Piedrahita, R.H., 2002. Tank culture of rainbow trout using a water recirculating system with a combined nitrification and denitrification filter. Aquacultural Engineering, 26(1), pp.21-42.

Green, B.W., El Nagdy, Z. and Hebicha, H.U.S.S.E.I.N., 2002. Evaluation of Nile tilapia pond management strategies in Egypt. *Aquaculture Research*, *33*(13), pp.1037-1048.

Hassan, M.M., 2018. Aquaponics: Integration of hydroponics with aquaculture. In Aquaponics Food Production Systems (pp. 1-29). Springer, Cham.

Hossain, M.A., Roy, R., Rahmatullah, S.M. and Kohinoor, A.H.M., 2004. Effect of stocking density on the growth and survival of GIFT tilapia,(Oreochromis niloticus) fed on formulated diet. *J. Agric. Rural Dev*, *2*(1), pp.127-133.

Jia, B., St-Hilaire, S., Singh, K., & Gardner, I.A. (2017). Biosecurity knowledge, attitudes, and practices of farmers culturing yellow catfish (*Pelteobagrus fulvidraco*) in Guangdong and Zhejiang provinces, China. *Aquaculture (Amsterdam, Netherlands)*, *471*, 146–156. https://doi.org/10.1016/j.aquaculture.2017.01.016

Kapinga, C., Mmochi, A.J., Mahongo, S.B. and Raphael, E., 2014. Growth performance and survival of Nile tilapia (Oreochromis niloticus) fingerlings reared in Lake Victoria, Tanzania. Journal of Fisheries and Aquatic Science, 9(3), pp.178-185.

Kullander, S. (2003). Family Cichlidae. In R.E. Reis, S.O. Kullander, C.J. Ferraris, (Eds.), Check list of the freshwater fishes of South and Central America Porto.

Lesvia, M.J., 2014. Stocking density influences survival, growth, behavior, health, water quality, feeding and production of Nile tilapia (Oreochromis niloticus). Journal of Fisheries and Aquatic Science, 9(3), pp.163-177.

Magqina, L., Mendieta, O., & Mungondori, H. (2020). The potential of reducing energy consumption and greenhouse gas emissions of feed production by minimizing feed wastage in South African broiler farms. Journal of Cleaner Production, 261, 121189.

Mensah, E.T.D., Attipoe, F.K. and Ashun-Johnson, M., 2013. Effect of different stocking densities on growth performance and profitability of Oreochromis niloticus fry reared in hapa-in-pond system. *International Journal of Fisheries and Aquaculture*, *5*(8), pp.204-209.

Mensah, S., Agyemang, T.K., Larbi, W.O., Asante-Dartey, J., Adjei, J.K., Dovie, B.D.K., & Agyare, W.A. (2013). Comparative economics of catfish and tilapia production in Ghana. International Journal of Fisheries and Aquaculture, 5(3), 30-36.

Moyo, N.A. and Rapatsa, M.M., 2021. A review of the factors affecting tilapia aquaculture production in Southern Africa. *Aquaculture*, *535*, p.736386.

Munguti, J.K., Kim, J. and Ogello, E.O., 2014. Adoption of improved maize varieties among smallholder farmers in Kenya: Factors influencing the decision-making process. Journal of Agricultural Extension and Rural Development, 6(1), pp.1-9.

El-Sayed, (2006), Quantifying requirements of fish. Journal of the Fisheries Research Board of Canada.

Ogata, H.Y. and Shearer, K.D., 2000. Influence of dietary fat and adiposity on feed intake of juvenile red sea bream Pagrus major. *Aquaculture*, *189*(3-4), pp.237-249.

Omasaki, S.K., van Arendonk, J.A.M., Kahi, A.K. and Komen, H., 2016. Defining a breeding objective for Nile tilapia that takes into account the diversity of smallholder production systems. *Journal of Animal Breeding and Genetics*, *133*(5), pp.404-413.

Persson, D., Nødtvedt, A., Aunsmo, A. and Stormoen, M., 2022. Analysing mortality patterns in salmon farming using daily cage registrations. *Journal of Fish Diseases*, *45*(2), pp.335-347.

Rakocy, J. E FAO (2009). Oreochromis niloticus. In Cultured aquatic species fact sheets.

Adeleke, B., Robertson-Andersson, D., Moodley, G. and Taylor, S., 2020. Aquaculture in Africa: A comparative review of Egypt, Nigeria, and Uganda vis-a-vis South Africa. *Reviews in Fisheries Science & Aquaculture*, *29*(2), pp.167-197.

Rana, K.J. and Hassan, M.M., 2013. Comparison of feed conversion ratio (FCR) of tilapia in confined and lake conditions. Journal of Fisheries and Aquatic Science, 8(1), pp.1-7.

R Development Core Team, (2011). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria

Rutten, M.J., Komen, H. and Bovenhuis, H., 2005. Longitudinal genetic analysis of Nile tilapia (Oreochromis niloticus L.) body weight using a random regression model. *Aquaculture*, *246*(1-4), pp.101-113.

Sarpong, D.B., Amponsah, S.K., Agyepong, E.A. and Ofori, I.K., 2005. Evaluation of the effectiveness of cowpea storage technologies in Ghana. Journal of Stored Products Research, 41(3), pp.227-239

Sibanda, T., Gwiriri, L., & Muzenda, E. (2022). An overview of the environmental impacts of fish production systems and their mitigation strategies. Science of The Total Environment, 804, 150229.

Tacon, A.G., 1990. Standard Methods for the Nutrition and Feeding of Farmed Fish and Shrimp.

Tran-Duy, A., van Dam, A.A. and Schrama, J.W., 2012. Feed intake, growth and metabolism of Nile tilapia (Oreochromis niloticus) in relation to dissolved oxygen concentration. *Aquaculture Research*, *43*(5), pp.730-744.

Trọng, T.Q., Mulder, H.A., van Arendonk, J.A. and Komen, H., 2013. Heritability and genotype by environment interaction estimates for harvest weight, growth rate, and shape of Nile tilapia (Oreochromis niloticus) grown in river cage and VAC in Vietnam. *Aquaculture*, *384*, pp.119-127.

Vehviläinen, H., Kause, A., Quinton, C., Koskinen, H. and Paananen, T., 2008. Survival of the currently fittest: genetics of rainbow trout survival across time and space. *Genetics*, *180*(1), pp.507-516.

World Fish. (2021). Improving Biosecurity: A Science-Based Approach to Manage Fish Disease Risks and Increase the Socioeconomic Contribution of the Nigerian Catfish and Tilapia Industries. Penang, Malaysia: World Fish. Fact Sheet: 2021-11

Appendix A

FOOD CONSUMED

PONDS	**Feed Consumed Monthly (kg)**					
	Dec	January	February	March	April	May
1	9	22	38	75	150	250
2	9	22	38	75	150	250
3	9	22	38	75	150	250
4	9	22	38	75	150	250
5	9	22	38	75	150	250
6	9	22	38	75	150	250

Appendix B

FISH INTRODUCED AND NUMBER OF FISH DIED

Total number of fish introduced =2200		
Pond 1		deaths
2021-11-06		7
2021-11-09		5
2021-11-24		1
2022-01-03		6
2022-01-11		4
2022-01-08		1
2022-01-20		4
2022-01-21		4
2022-01-24		6
pond 2		
2021-11-06		43
2021-11-09		2
2021-11-24		1
2022-02-03		4
2022-02-04		3
2022-02-05		2
2022-02-09		2
pond 3		
2021-11-25		5
2021-11-27		27
2021-11-28		0

2021-11-29		36
2021-11-30		11
2022-02-05		15
pond 4		
2021-11-25		26
2021-11-27		33
2021-11-28		144
2021-11-29		370
2021-11-30		99
2021-12-01		43
2021-12-02		7
2022-02-03		2
2022-02-04		10
pond 5		
2021-11-25		36
2021-11-27		60
2021-11-28		224
2021-11-29		216
2021-11-30		138
2021-12-01		17
2021-12-02		9
2022-02-05		8
pond 6		
2021-11-06		104
2021-11-09		16
2021-11-24		2

2021-11-27		1
2021-12-31		8
2022-01-03		8
2022-01-16		3
2022-01-30		5
2022-02-03		9
2022-02-05		1
2022-02-09		2

APPENDIX C

FISH WEIGHTS FOR THE SIX MONTHS

Sampling	Pond	length	weight	
date	number	cm	grams	
11/1/2021	1	6	8	
11/1/2021	1	6	8	
11/1/2021	1	6	8	
11/1/2021	1	6	8	
11/1/2021	1	6	8	
11/1/2021	2	6	8	
11/1/2021	2	6	8	
11/1/2021	2	6	8	
11/1/2021	2	6	8	
11/1/2021	2	6	8	
11/1/2021	3	6	8	
11/1/2021	3	6	8	
11/1/2021	3	6	8	
11/1/2021	3	6	8	
11/1/2021	3	6	8	
11/1/2021	4	6	8	
11/1/2021	4	6	8	
11/1/2021	4	6	8	
11/1/2021	4	6	8	
11/1/2021	4	6	8	
11/1/2021	5	6	8	
11/1/2021	5	6	8	
11/1/2021	5	6	8	
11/1/2021	5	6	8	
11/1/2021	5	6	8	
11/1/2021	6	6	8	
11/1/2021	6	6	8	
11/1/2021	6	6	8	
11/1/2021	6	6	8	
11/1/2021	6	6	8	

	First Month of collecting data			
12/2/2021	1	9	25.5	
12/2/2021	1	10	30	
12/2/2021	1	9.5	30	
12/2/2021	1	9	25	
12/2/2021	1	10	29	
12/2/2021	2	10.5	30	
12/2/2021	2	10	30	
12/2/2021	2	9.5	28	
12/2/2021	2	10	27.5	
12/2/2021	2	10	29.5	
12/2/2021	3	10	30	
12/2/2021	3	10	27	
12/2/2021	3	10.5	26	
12/2/2021	3	10	25	
12/2/2021	3	10	30	
12/2/2021	4	9	25	
12/2/2021	4	9	29	
12/2/2021	4	9.5	27.5	
12/2/2021	4	10	30	
12/2/2021	4	9	27	
12/2/2021	5	10	30	
12/2/2021	5	10	28.5	
12/2/2021	5	10	29	
12/2/2021	5	9	27	
12/2/2021	5	10	30	
12/2/2021	6	10	27	
12/2/2021	6	9.5	28	
12/2/2021	6	10	29.5	
12/2/2021	6	9.5	25	
12/2/2021	6	10	26	
		Second Month of data collected		
1/5/2022	1	12.5	60	
1/5/2022	1	12	54	
1/5/2022	1	11.5	55	
1/5/2022	1	12.5	59	
1/5/2022	1	12	60	

1/5/2022	2	12.5	58	
1/5/2022	2	11	49	
1/5/2022	2	11.5	50	
1/5/2022	2	12.5	60	
1/5/2022	2	12.5	60	
1/5/2022	3	11	48	
1/5/2022	3	11.5	54	
1/5/2022	3	11.5	55	
1/5/2022	3	12	59	
1/5/2022	3	12	60	
1/5/2022	4	12.5	60	
1/5/2022	4	11.5	58	
1/5/2022	4	12	54	
1/5/2022	4	12	60	
1/5/2022	4	11	49	
1/5/2022	5	11.5	57	
1/5/2022	5	11	55	
1/5/2022	5	12	60	
1/5/2022	5	12	60	
1/5/2022	5	11.5	57	
1/5/2022	6	11	49	
1/5/2022	6	11	59	
1/5/2022	6	12	60	
1/5/2022	6	11	59	
1/5/2022	6	11	53	
	3rd Month			
2/4/2022	1	14.4	88	
2/4/2022	1	14	80	
2/4/2022	1	13	75	
2/4/2022	1	13	70	
2/4/2022	1	14	83	
2/4/2022	2	13	79	
2/4/2022	2	14	80	
2/4/2022	2	14.5	90	
2/4/2022	2	14	90	
2/4/2022	2	14.5	87	
2/4/2022	3	14	80	
2/4/2022	3	13.5	79	
2/4/2022	3	13.5	76	

2/4/2022	3	14	80	
2/4/2022	3	14.5	86	
2/4/2022	4	13	75	
2/4/2022	4	14.5	89	
2/4/2022	4	14	88	
2/4/2022	4	13.5	85	
2/4/2022	4	13	79	
2/4/2022	5	13	74	
2/4/2022	5	13.5	79	
2/4/2022	5	13	75	
2/4/2022	5	13.5	80	
2/4/2022	5	14	89	
2/4/2022	6	14.5	90	
2/4/2022	6	14	81	
2/4/2022	6	14	90	
2/4/2022	6	14.5	90	
2/4/2022	6	14	86	
	Fourth month			
3/16/2022	1	15	89	
3/16/2022	1	14	70	
3/16/2022	1	16.5	87	
3/16/2022	1	17	100	
3/16/2022	1	16	81	
3/16/2022	2	16	76	
3/16/2022	2	17	100	
3/16/2022	2	15	80	
3/16/2022	2	16	95	
3/16/2022	2	17	99	
3/16/2022	3	18	84	
3/16/2022	3	17	95	
3/16/2022	3	18	89	
3/16/2022	3	16	98	
3/16/2022	3	15	96	
3/16/2022	4	13	90	
3/16/2022	4	16	96	
3/16/2022	4	14	88	
3/16/2022	4	17	79	
3/16/2022	4	15	90	
3/16/2022	5	16	90	

3/16/2022	5	15	92	
3/16/2022	5	16	95	
3/16/2022	5	13	75	
3/16/2022	5	13	70	
3/16/2022	6	16	83	
3/16/2022	6	17	86	
3/16/2022	6	14.5	69	
3/16/2022	6	15	65	
3/16/2022	6	17	102	
		fifth month		
4/8/2022	1		105	
4/8/2022	1		98	
4/8/2022	1		111	
4/8/2022	1		99	
4/8/2022	1		93	
4/8/2022	2		100	
4/8/2022	2		112	
4/8/2022	2		102	
4/8/2022	2		98	
4/8/2022	2		100	
4/8/2022	3		104	
4/8/2022	3		103	
4/8/2022	3		98	
4/8/2022	3		95	
4/8/2022	3		102	
4/8/2022	4		105	
4/8/2022	4		99	
4/8/2022	4		97	
4/8/2022	4		100	
4/8/2022	4		105	
4/8/2022	5		95	
4/8/2022	5		97	
4/8/2022	5		103	
4/8/2022	5		111	
4/8/2022	5		98	
4/8/2022	6		99	
4/8/2022	6		100	
4/8/2022	6		102	
4/8/2022	6		97	

4/8/2022	6		102	
	sixth month			
5/27/2022	1		111	
5/27/2022	1		134	
5/27/2022	1		107	
5/27/2022	1		145	
5/27/2022	1		150	
5/27/2022	2		111	
5/27/2022	2		128	
5/27/2022	2		134	
5/27/2022	2		145	
5/27/2022	2		125	
5/27/2022	3		150	
5/27/2022	3		147	
5/27/2022	3		133	
5/27/2022	3		111	
5/27/2022	3		149	
5/27/2022	4		125	
5/27/2022	4		130	
5/27/2022	4		142	
5/27/2022	4		111	
5/27/2022	4		100	
5/27/2022	5		125	
5/27/2022	5		144	
5/27/2022	5		111	
5/27/2022	5		130	
5/27/2022	5		125	
5/27/2022	6		139	
5/27/2022	6		111	
5/27/2022	6		135	
5/27/2022	6		140	
5/27/2022	6		146	