Maren Elgsaas Alnæs

The effect of salmon protein hydrolysate on palatability for Atlantic salmon smolts

Master's thesis in Natural Science with Teacher Education
Supervisor: Rolf Erik Olsen
Co-supervisor: Ingeborg Hollekim Bringslid
January 2024

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Norwegian University of Science and Technology
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Abstract

Demands for better fish welfare and more sustainable aquaculture make finding new and better feed resources necessary. When assessing new ingredients for feed, the choice of strategies can substantially impact the interpretation of their quality, and a structured approach is necessary. The palatability is essential because it can affect whether the fish accept the feed and has great importance for growth and yield and should be assessed early.

Effective feeding stimulants may help increase acceptance of new diets and improve growth performance in fish fed with low fish meal diets. Fish protein hydrolysates and protein hydrolysates from other marine protein sources are commonly used as feeding attractants. Krill meal and krill protein hydrolysates have been used as attractants with positive effects on feed intake in studies including salmonids. Salmon protein hydrolysate is made from slaughter by-products from farmed salmon. Hydrolysates from fish by-products have generally been regarded as a promising nutritive supplement due to their content of amino acids. The aim of this study was to find out whether salmon protein hydrolysate is a possible new feed resource for Atlantic salmon smolts by investigating whether it has a negative effect on palatability. This can result in further studies regarding the quality of salmon protein hydrolysate as an ingredient in feed for Atlantic salmon.

In this thesis, three diets were tested in triplicate tanks. Feed with salmon protein hydrolysate (LH) was tested against a control feed (CTRL), and a positive control feed added krill protein hydrolysate (KH). All fish were measured before and after the experiment to assess the growth. The fish were fed twice a day, and underwater cameras recorded the fish during feedings. The recordings were used to study quantitative feeding behaviour. The first video clip from each feeding period was used for further analyses. The excess feed was collected to measure feed intake and to ensure overfeeding during the experiment. Statistical analyses were performed using Minitab.

Analyses of growth and biomass using one-way ANOVA found no statistically significant difference between the populations before or after the experiment that could affect the appetite and feed consumption. The SGR was around 1.0, and TGC was between 6.68 and 6.85 for all three diets. Together with the feed collections, this indicates that the fish were sufficiently overfed. Further analysis of the feed collections using one-way ANOVA found no statistically significant difference between the three diets. One-way ANOVA of the data material from the video analyses of the first video clip from each feeding period showed no statistically significant difference between the three diets, except for the number of pellets eaten for Day 3 after the feed change. The LH feed did significantly better than the two other feeds in that analysis. There was expected to be a significant difference between the CTRL feed and the KH feed, but this was not found. One explanation could be that the coating method or percentage of included protein hydrolysate was insufficient to differentiate the feed types. However, this can not explain why the LH feed did significantly better in one analysis.

No negative effect of LH on palatability in Atlantic salmon smolts was found, but further studies might be necessary. The experiment resulted in a large data set. It is possible to do further behavioural and statistical analysis of the data and video material.

Sammendrag

Krav om bedre fiskevelferd og mer bærekraftig akvakultur gjør det nødvendig å finne nye og bedre fôrressurser. Når man vurderer nye ingredienser til fôr, kan valg av strategi ha stor innvirkning på tolkningen av kvaliteten deres, og en strukturert tilnærming er nødvendig. Smakeligheten er viktig fordi den kan påvirke om fisken aksepterer fôret og har stor betydning for vekst og avkastning, og bør vurderes tidlig.

Effektive fôrstimulerende stoffer kan bidra til å øke aksepten av nye dietter og forbedre vekstytelsen hos fisk som fôres med dietter med lavt innhold av fiskemel. Fiskeproteiner og proteinhydrolysat fra andre marine proteinkilder brukes ofte som fôratraktanter. Krillmel og krillproteinhydrolysat har blitt brukt som atraktanter med positive effekter på fôropptak i studier på laksefisk. Lakseproteinhydrolysat er laget av slakteavfall fra oppdrettslaks. Hydrolysater fra slakteavfall fra fisk har generelt blitt ansett som et lovende næringssupplement på grunn av innholdet av aminosyrer. Målet med denne studien var å finne ut om lakseproteinhydrolysat er en mulig ny fôrressurs for Atlantisk laksesmolt ved å undersøke om det har en negativ effekt på smakeligheten. Dette kan resultere i videre studier angående kvaliteten på lakseproteinhydrolysat som en ingrediens i fôr til atlantisk laks.

I denne masteroppgaven ble tre dietter testet i triplikattanker. Fôr med lakseproteinhydrolysat (LH) ble testet mot et kontrollfôr (CTRL), og et positivt kontrollfôr tilsatt krillproteinhydrolysat (KH). Fisken ble målt før og etter eksperimentet for å vurdere veksten. Fisken ble fôret to ganger om dagen, og undervannskameraer filmet fisken under fôringene. Opptakene ble brukt til å studere kvantitativ fôringsatferd. Det første videoklippet fra hver fôringsperiode ble brukt til videre analyser. Overflødig fôr ble samlet inn for å måle fôropptak og for å sikre overfôring under eksperimentet. Statistiske analyser ble utført ved hjelp av Minitab.

Analyser av vekst og biomasse ved hjelp av enveis variansanalyse fant ingen statistisk signifikant forskjell mellom populasjonene før eller etter eksperimentet som kunne påvirke appetitten og fôrforbruket. SGR var rundt 1,0, og TGC var mellom 6,68 og 6,85 for alle tre diettene. Sammen med fôroppsamlingene indikerer dette at fisken var tilstrekkelig overfôret. Videre analyse av fôroppsamlingene ved hjelp av enveis variansanalyse fant ingen statistisk signifikant forskjell mellom de tre diettene. Enveis variansanalyse ble utført på datamaterialet fra videoanalysene av det første videoklippet fra hver fôringsperiode. De viste ingen statistisk signifikant forskjell mellom de tre diettene, bortsett fra for antall pellets spist for dag 3 etter fôrskiftet. LH-fôret gjorde det betydelig bedre enn de to andre fôrene i den analysen. Det var forventet å være en signifikant forskjell mellom CTRL-fôret og KH-fôret, men dette ble ikke funnet. En forklaring kan være at metoden brukt for å tilsette eller prosentandelen av tilsatt proteinhydrolysat var utilstrekkelig til å differensiere fôrtypene. Imidlertid kan ikke dette forklare hvorfor LH-fôret gjorde det betydelig bedre i den ene analysen.

Det ble ikke funnet en negativ effekt av LH på smakeligheten hos Atlantisk laksesmolt, men videre studier kan være nødvendige. Eksperimentet resulterte i et stort datasett og det er mulig å gjøre videre atferds- og statistiske analyser av dataene og videomaterialet.

Preface

This master's thesis is written as the final part of the integrated master's programme in Natural Science with Teacher Education, with a specialisation in Marine biology and aquaculture, at the Norwegian University of Science and Technology. The research for this thesis was conducted during the spring of 2022. It is assumed that the reader possesses basic knowledge in statistics, biology and aquaculture.

Acknowledgement

First, I would like to thank my main supervisor, Professor Rolf Erik Olsen, and my co-supervisor, PhD candidate Ingeborg Hollekim Bringslid. Together, we have defined an interesting scope and objective for this thesis. Thank you for all your guidance regarding interesting literature and perspectives on the topic. I would especially like to thank Ingeborg for all the support, guidance and help before, during and after the experiment.

I would also like to thank the staff and the other PhD candidates at NTNU Sealab for practical help and advice during the experimental work at the wet lab.

Finally, I must express my gratitude to my family for all their support and encouragement throughout my years of study and the process of writing this thesis. To my parents and my parents-in-law, thank you for all your love and support, as well as all your help when I needed it the most. To my son, Kristian, you are my biggest inspiration. Last but not least, I would like to express my deepest appreciation to my husband, Fredrik; I could not have undertaken this journey without you.

Kristiansund, 31th January 2024

Maren Elgsaas Alnæs

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Abbreviations

ANOVA - Analysis of variance
CI - Confidence interval
CTRL - Control
DW - Dry weight
ICS - Industrial control system
KH - Krill protein hydrolysate
LH - Salmon protein hydrolysate
SGR - The specific growth rate
StDev - Standard deviation
TGC - The thermal growth coefficient

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Chapter 1

Introduction

There is a need for new and better feed resources for salmon farming regarding fish health and sustainability (Hansen 2019; Boissy et al. 2011; Silva et al. 2018). The choice of feed resource can affect the taste of the feed. Since the palatability of the feed can affect whether the fish accept the feed, feed attractants can be of great importance for growth and yield for breeders (Kasumyan and Døving 2003). The challenges associated with palatability are typically greatest in connection with the fish being given new diets (Refstie et al. 1998). New components can act as flavour enhancers and will, therefore, be very important, especially concerning feed change.

1.1 Aim of study

In this study, a feeding experiment was conducted to investigate the possibility of using salmon protein hydrolysate (LH) in feed given to Atlantic salmon smolts. The aim of the experiment was to find out whether the LH had negative effects on palatability. To answer this question, the feed added salmon protein hydrolysate (LH) was tested against a control feed (CTRL), and a positive control feed added krill protein hydrolysate (KH). Each diet was tested in triplicate tanks.

1.2 Background

1.2.1 Nutritional research strategies

When assessing ingredients for aquaculture feeds, the choice of strategies can strongly impact the interpretation of their quality (Glencross 2020; Glencross et al. 2007). To standardize the assessment process, a structured approach using seven steps for assessing the quality of ingredients has been proposed;

- Step 1 Characterization
- Step 2 Palatability
- Step 3 Digestibility
- Step 4 Utilization
- Step 5 Immunological
- Step 6 Processing Effects
- Step 7 Product Quality Influences

Based on this, it is possible to make an appropriate choice whether to use any particular ingredient and with what advantages and disadvantages. In this thesis, the focus is on steps 1 and 2.

Step 1, the characterization of ingredients, is a critical step in the evaluation process. The users of the information must be able to relate the data to a particular type of ingredient. Chemical characterization needs to include the basic parameters used to formulate feeds and/or allow a clear assessment of the ingredient (Glencross 2020). Comprehensive characterization makes it easier for the reader of the data to relate the work to other materials or obtain the same material. Characterization is also important in an assessment of the sustainability of an ingredient, and this is gaining more importance (Glencross 2020; Boissy et al. 2011; Malcorps et al. 2019; Silva et al. 2018).

Step 2, palatability, is critically important to the feed. If an ingredient reduces feed intake due to negative effects on palatability, it has some limitations as a potential feed ingredient (Glencross 2020). The nutritional values of the feed are irrelevant if the feed is not ingested. Therefore, palatability is assessed early. Conversely, an ingredient with positive effects on palatability that can stimulate intake has added value as an ingredient in feed. Some studies show that variation in palatability can affect greater than 80% of the variability in growth response to diets testing alternative ingredients (Glencross 2020; Kousoulaki et al. 2018). If the fish are fed a fixed ration instead of overfed, it is impossible to assess the impact of the diet on palatability responses. Overfeeding is therefore important (Glencross 2020). Effects on palatability can often be detected within days of introduction and are usually at their most sensitive point of assessment between day 4 and 10 after introduction. The fish may begin to adapt to the diet after this period, and the ability to discriminate palatability effects diminishes (Glencross 2020; Kousoulaki et al. 2018). In Glencross (2020) a decision hierarchy framework was suggested as a mean of defining the responses to feeds to aid in defining how the feed is impacting the response, and this hierarchy framework can be seen in figure 1.1.

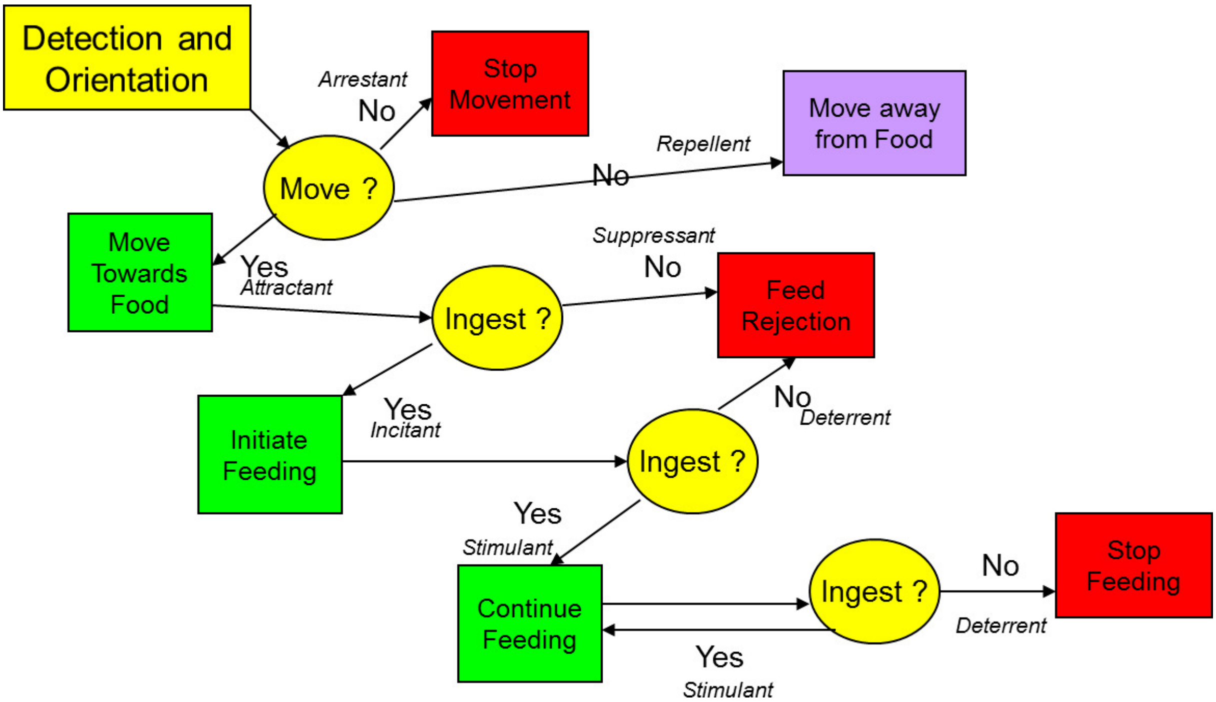

Figure 1.1: Decision hierarchy based on the nature of the response of a fish to the presence of a feed. *Courtesy of Glencross (2020).*

1.2.2 Feeding behaviour

Feeding behaviour in fish in general

Feeding behaviour in fish is affected by several sensory systems, from the detection of the food up to the swallowing of the food (Morais 2017). Sensory systems for detecting the food can be vision, olfaction, acoustic, lateral line organ and electroreception, while sensory systems intervening in whether or not the fish swallows it can be taste or mechanoreception. Because fish live in aquatic environments that are rich in dissolved compounds, they have evolved a variety of well-developed chemosensory systems, including olfaction and taste cells (Morais 2017; Hara 1994). Both olfaction and taste receptors are used to detect food at a distance and determine the attractability of food based on chemical cues. The gustatory system then provides the final evaluation of the sensorial and nutritional properties of the food and affects whether or not the fish will consume the feed (Morais 2017).

Fish have more taste buds than any other animal and can have both extraoral and oral location (Morais 2017). The number and distribution of taste buds varies according to species and the species' lifestyle. Taste buds in fish can be found in lips, gill rakers, oral cavity, pharynx, oesophagus and in other body surfaces as barbels and fins (Morais 2017; Ishimaru et al. 2005). Oral taste buds still have the most important role in determining whether or not the fish will consume the food, indicated by observations of fish often reject a food after it has been ingested by spitting it out (Morais 2017; Kasumyan and Døving 2003). Salmonids lack external taste buds, but have the highest densities of taste buds in the palate (Morais 2017; Hara 1994).

The classical taste modalities (sweet, sour, bitter and salt), together with the taste of free amino acids, have been examined in fish (Morais 2017; Kasumyan and Døving 2003).

Fish and mammals appear to share similar mechanisms for taste discrimination. Both attractive and aversive taste modalities have been described. Tastes that are attractive and aversive are often explained by the role they play in the metabolic process based on the feeding ecology of the species. Unlike in mammals, the taste of sweet is found to be indifferent or aversive for several species of fish (Morais 2017; Kasumyan and Døving 2003; Kasumyan and Sidorov 2005). This might reflect the fact that dietary carbohydrates have low nutritional value for those fish species. Fish rely primarily on gluconeogenesis from amino acids, and free amino acids are strong elicitors of electrophysiological and behavioural responses in fish (Morais 2017; Wilson 1994). Some fish species have a wide response range and respond to many different types of amino acids, while other species have a limited response range and respond to only a few amino acids. The preferences to taste are highly species-specific and are believed to be genetically determined, with low plasticity (Morais 2017; Kasumyan and Døving 2003).

Chemical attraction and feeding stimulation are two concepts to consider regarding chemosensory aspects of food and their potential effects on feeding behaviour (Morais 2017). They can affect aquaculture productivity in different ways. Feeding attractants in the feed may lead to faster feeding and reduced feed waste, but does not necessarily lead to improved growth and feeding efficiency. Feeding stimulants can affect satiation and modulate the total amount of ingested food. Feeding involves several sensory systems, but taste plays a more important role than olfaction in the feeding behavioural response of fish (Morais 2017; Goh and Tamura 1980). In salmonids, food search behaviour is initiated primarily by olfaction and completed by gustation (Morais 2017; Hara 2006). Ultimately, taste determines the actual level of consumption. There is a general belief that substances that act as potent attractants or feeding stimulants are usually low molecular weight metabolites that are important tissue components of the main prey items that constitute the species natural diet (Morais 2017).

Regulation of food intake

Taste receptors and signalling elements can also be found in epithelial cells other than taste buds, in different sites such as in the gastrointestinal tract, respiratory tissue and brain tissue, among others (Morais 2017; Li 2013). These systems probably evoke another response than the taste sensation and serve different functions depending on their location (Morais 2017; Finger and Kinnamon 2011). As in other vertebrates, the regulation of food intake in fish is mediated via the central nervous system by signals from neuropeptides that receive input from metabolic status and changes by energy homeostasis as well as signals from the digestive tract (Kousoulaki et al. 2013; Volkoff et al. 2005). The hypothalamus is continually informed about the body's nutritional, energetic and environmental status by messages of the central and peripheral systems (Da Silva et al. 2016). The brain interprets these signals and the brain responds with efferent signals that affect the energy balance. Neuropeptides from the hypothalamus then regulate the food intake with stimulation or inhibition of the appetite (Kousoulaki et al. 2013; Volkoff et al. 2005; Volkoff et al. 2010). These key factors that either stimulate or inhibit food intake can be directly related to the search for or the rejection of a particular food and are directly related to the feeding behaviour (Da Silva et al. 2016). It is likely that the primary mechanism proposed to control the intake of protein in mammals also controls the intake of protein in fish (Morais 2017; Da Silva et al. 2016; Murashita et al. 2011). Gastrointestinal receptors can detect protein during digestion, and amino acids can be detected in the liver after absorption. These receptors would then originate signals through neural and hormonal activity, informing the brain about the nutritional properties of the digested food and thereby modify feeding behaviour (Da Silva et al. 2016; Forbes 2001). Sensing nutrients and potentially hazardous compounds in the stomach and present throughout the gastrointestinal tract via taste receptors coupled to enteroendocrine responses enables the body to coordinate an adequate physiological response (Morais 2017). This makes the body able to prepare for optimal digestion and absorption of nutrients, neutralization and expulsion of potential toxins, signalling for satiety after a meal or signalling to prevent further ingestion if necessary.

Feeding behaviour in Atlantic salmon

Atlantic salmon are considered visual feeders and have higher feeding rates during daylight hours than at night. Salmon juveniles preferably eat from the water column during light conditions, but can also eat from the tank bottom during hours of darkness (Jørgensen and Jobling 1992). Even though they are considered visual feeders feeding on visually detected, moving particles, they can also locate food using the olfactory sense and feed from the bottom.

1.2.3 Feeding attractants

Compounds in the water-soluble fraction of marine protein sources are essential for feed intake in carnivorous fish, especially when the diet is low in fish meal (Kousoulaki et al. 2009). There has been reported suppressed feed intake when salmon has been fed plant protein-rich diets (Kousoulaki et al. 2018; Mundheim et al. 2004; Opstvedt et al. 2003; Kousoulaki et al. 2013). This can be linked both to low palatability and also that plant-based feed is less digestible for fish and, in some extreme cases, can even cause damage to the gastrointestinal epithelium in the fish (Morais 2017; Mundheim et al. 2004; Refstie et al. 2000). Including effective feeding stimulants may help increase growth performance in fish fed with low fish meal diets. Fish protein hydrolysates and other marine water-soluble compounds are commonly used as feeding attractants in the first feeding larval stages of fish (Kousoulaki et al. 2013; Berge and Storebakken 1996). Studies show that water-soluble proteins from fish protein hydrolysate stimulate feed intake, utilization and growth in Atlantic salmon, rainbow trout and Atlantic cod (Kousoulaki et al. 2018; Berge and Storebakken 1996; Kousoulaki et al. 2013, 2009).

Taste-signaling elements in the gastrointestinal tract can be regulated by dietary protein changes in fish. This suggests that highly palatable diet components that function as gustatory stimulants might also activate functional pathways via these signalling mechanisms (Morais 2017). Even though the causative links and mechanisms of action are still not entirely known, several studies show that the use of dietary feeding stimulants, such as protein hydrolysates or different amino acids, also have the potential to improve growth, feeding efficiency, digestive efficiency and maturation of the digestive system, as well as increasing the food intake. Nevertheless, the established view surrounding mechanisms such as the cephalic reflex to the sensorial characteristics of the food, including the anticipation of eating, can not be disregarded (Morais 2017; Forbes 2001).

Hydrolysates, in general, have excellent nutritional qualities (Sandbakken et al. 2023; Hou et al. 2017; Ramakrishnan et al. 2023; Siddik et al. 2021). During hydrolysis, the peptide bonds between amino acids in protein are cleaved. This results in free amino acids and small water-soluble peptides. Both enzymatic and chemical hydrolysis are possible, but enzymatic hydrolysis is often preferred for feed production because it gives a more specific cleavage of the peptide bond and a higher nutritional quality of the product (Sandbakken et al. 2023; Kristinsson and Rasco 2000; Zamora-Sillero et al. 2018). After enzymatic hydrolysis, the enzymes are inactivated by heat before the liquid is separated into three phases: oil, liquid protein hydrolysate and sediment fraction. Unhydrolyzed or insoluble proteins end up in the sediment fraction (Sandbakken et al. 2023).

Salmon protein hydrolysate

Salmon protein hydrolysate (LH) is made from slaughter by-products from farmed salmon. It is hydrolysed into peptides and free amino acids. Hydrolysates from fish by-products have generally been regarded as a promising nutritive supplement due to their content of amino acids (Idowu et al. 2019; Siddik et al. 2021; Nørgaard et al. 2012).

Feeding unhydrolyzed protein to the same species has caused prion disease in some mammals. (Sandbakken et al. 2023; Zhu and Aguzzi 2021). Homologous genes to the mammalian prion gene have been found in Atlantic salmon, but prion diseases have not been observed in fish. Due to this, it has been prohibited to reuse proteins within the same species. This EU legislation does not apply to hydrolyzed protein, and hydrolysates from approved process facilities can therefore be fed to the same species (Sandbakken et al. 2023; Mattilsynet 2023; Forskrift-om-TSE 2023; Animaliebiproduktforskriften 2023).

Salmon hydrolysate is a promising feed ingredient for Atlantic salmon due to its excellent amino acid profile and high digestibility. In a study where fish meal was partially replaced by salmon hydrolysate, the specific growth rate increased and no negative effect on gut health was found (Sandbakken et al. 2023). No prions were found in the salmon hydrolysate.

Krill

Krill meal has been used as an attractant in studies including salmonoids (Kousoulaki et al. 2013; Storebakken 1988). It has also been used as a high-quality protein source to replace other types of fish meals. There has been found strong stimulation on feed intake in salmon fed low fish meal diets supplemented with krill hydrolysate (Kousoulaki et al. 2013, 2018).

Krill protein hydrolysate (KH) is prepared from an aqueous extract of krill meal. This extract is cooked and cooled before undergoing enzymatic hydrolysis. The solids and fats are removed, and the water-soluble protein fraction is extracted and concentrated (Kaur et al. 2022).

KH contains high levels of several free amino acids known to have an appetite-regulative function in fish (Kaur et al. 2022). In Kousoulaki et al. (2013), the feed intake stimulatory effects of KH on Atlantic salmon smolts reared in seawater were studied. The study showed that supplementation of KH positively affected feed intake and growth performance of Atlantic salmon fed high plant protein and low fish meal diets.

The study from Kousoulaki et al. (2013) suggests that dietary inclusion of KH or a mix of amino acids reflecting the composition in krill has appetite-stimulating effects but could not demonstrate a consistent correlation between feed uptake and mRNA expression of orexigenic and anorexigenic neuropeptides comparable to those observed in mammals. The dynamic changes in appetite regulation that occur before, at the initiation and during a meal are a complicating factor in correlating the mRNA expression for the neuropeptides. This is because an initial hunger and appetite stimulation by a diet resulting in high feed intake will be followed by satiation and appetite downregulation. It is difficult to distinguish which of the specific soluble compounds in the marine raw material is responsible for the complex mechanisms for growth and feeding simulation (Kousoulaki et al. 2018).

1.2.4 Growth

The growth rate of salmon depends on several factors, such as feed availability, temperature and other environmental conditions. The growth rate is also size-dependent (Thorarensen and Farrell 2011).

Estimate growth rate

One common method to estimate salmonid growth rate is calculating the standard growth rate, SGR. This is calculated by

$$SGR(\%) = \left(\left(\frac{V_2}{V_1}\right)^{(1/day)} - 1\right) \times 100 \tag{1.1}$$

where V_1 is start weight and V_2 is end weight in grams, while day indicate number of days between start and end weight (Skretting 2012).

SGR decreases with an increase in body mass and increases with increasing water temperature up to an optimum temperature for growth before decreasing again. Comparison of growth performance of fish of different sizes and/or reared at different temperatures are difficult (Thorarensen and Farrell 2011). The benchmark study of Austreng et al. (1987) generated growth rate tables for Atlantic salmon of different sizes and at different temperatures (Thorarensen and Farrell 2011). The predicted growth rate from their tables was modelled by Forsberg (1995) as follows:

$$G_E = 0.9T^{0.97} \times W^{-0.34} \tag{1.2}$$

where T is water temperature in °C and W is fish weight in grams. The model is limited to salmon in size range between 50 and 3000 g and temperature between 4 and 14°C (Thorarensen and Farrell 2011).

Another method to predict the growth of fish is the thermal growth coefficient, TGC. TGC express growth rate independent of temperature and size of the fish. This makes TGC more flexible for production planning than SGR (Thorarensen and Farrell 2011). The calculation is as follows:

$$TGC = 1000 \times (W_2^{\frac{1}{3}} - W_1^{\frac{1}{3}})/(T \times t) \tag{1.3}$$

where W_1 is start weight in grams, W_2 is end weight in grams, T is temperature in °C and t is number of days.

The TGC model builds on the assumptions that growth rate increases linearly with temperature, that the relationship between length and weight is $W \alpha L^3$ and that the growth in length is constant over time for any temperature. These assumptions might be violated under some of the conditions for farmed fish (Thorarensen and Farrell 2011; Jobling 2003). Still, the maximum difference in TGC for fish of the same size reared at 4°C, or 14°C is 4%, and the maximum difference between 50 g fish at 4 °C and 3000 g fish at 14 °C is 6%. Therefore, the assumption holds fairly well within this range (Thorarensen and Farrell 2011). TGC should not be used for temperatures above the optimum since TGC will be reduced near optimum and above optimum temperatures, which is around 15-16 °C for salmon.

Reported TGC values are highly variable due to seasonal cycles and other environmental conditions, ranging from -0.2 to 4.8. TGC between 2.7 and 3.0 is expected for post-smolt salmon when conditions are optimal. Higher TGC is possible with long-term growth studies in containment systems, where the conditions can be controlled and optimized (Thorarensen and Farrell 2011).

A concern is that the models are based on data from the 1980s and 1990s (Thorarensen and Farrell 2011). Selective breeding of salmon has resulted in improved growth rates, and present-day TGC should be significantly higher. According to Gjøen and Bentsen (1997) and Gjedrem (2000), improved growth rates of about 10% per generation are obtained in selective breeding (Thorarensen and Farrell 2011). Genetic-based variations in feeding activities, growth, feeding patterns, nutrient utilization and body composition have been demonstrated in several species of fish in captivity (Volkoff et al. 2010). Selective breeding has clearly altered several production-related traits in farmed salmon compared to wild salmon, and growth rate is the trait with the clearest differences (Glover et al. 2009).

Oxygen saturation

The oxygen consumption of fish is variable and depends on factors such as body mass, temperature, growth rate, feeding rate, swimming velocity and stress level (Thorarensen and Farrell 2011). There are generated models to estimate the oxygen demand of salmon based on for example different temperatures or feed intake. However, because of the many complex interacting factors, these models will always have a large margin of error. Design of closed containment systems must consider fluctuations in oxygen consumption to avoid oxygen saturation that impairs the growth of the fish (Thorarensen and Farrell 2011).

Oxygen is poorly soluble in water, and the amount of oxygen contained in water also decreases with increasing temperature and salinity (Thorarensen and Farrell 2011). The oxygen content of the water sets the absolute availability of oxygen in the water. However, the oxygen partial pressure gradient determines how rapidly oxygen can move from water into the blood through diffusion across the fish's gills. Therefore, oxygen partial pressure is the most useful term for expressing oxygen levels and is given in per cent saturation. Data suggest that air saturation between 85% and 120% is required to maintain the maximum growth rate of Atlantic salmon (Thorarensen and Farrell 2011). Below this range, the growth rate will decrease. Too high air saturation (over 140%) may compromise fish welfare by causing hyperoxia.

1.2.5 Underwater cameras to monitor feeding behaviour

Underwater cameras have been used in research to quantify fish behaviour both in laboratory systems and in the wild for several years. They are also increasingly used for routine monitoring within commercial fish farms (Ellis et al. 2019; Stien et al. 2007; Saberioon et al. 2017). The standard method for monitoring the health and welfare of laboratory fish is by direct visual observations of physical appearance and behaviour at least once daily. For species held in opaque-walled tanks, the monitoring is by direct overhead observations (Ellis et al. 2019).

Overhead visual observations and underwater camera monitoring both have benefits and limitations. Some of the limitations of visual observation of fish are restricted view, poor visibility and provoked behaviour (Ellis et al. 2019). Behavioural changes during direct viewing might be an increase in activity, change in dept distribution and change in consecration within the tank. This would make it more difficult to identify abnormal appearance and behaviour.

Some benefits of underwater camera monitoring are that it enables a remote view of undisturbed behaviour, making it possible to observe, for example, feeding behaviour or subtle signs of disease. Underwater camera monitoring also provides clear, lateral views unaffected by water surface effects, which makes many clinical signs and identification marks more evident than from an overhead orientation (Ellis et al. 2019). In-tank camera monitoring also facilitates an increased frequency of checking, and recordings provide a resource for reference and retrospective analysis.

One of the disadvantages of underwater camera monitoring is that the camera and the associated equipment (for example camera housing, mounting, cabling) add to the tank furniture. Additional tank furniture reduces the available space for the fish and potentially presents an obstruction during swimming that can lead to abnormal swimming patterns, collision and injury (Ellis et al. 2019). Additional tank furniture can provide a landmark for territoriality and an additional site for detritus build-up. Another limitation with underwater camera monitoring in the tank is that the camera mounting is fixed, which restricts the range of view. The fish may not be observed if they are out of camera view, and it is impossible to track individual fish if they move out of view. Individual fish could also occupy a position in front of the camera, obscuring the view.

Video analysis

Many commercial fish farms use video to observe swimming and feeding behaviour, food consumption and visible health indicators (Stien et al. 2007). Fish farmers usually carry out these observations in real-time, and few recordings are made for retrospective analyses. Manual analysis of recordings is time-consuming. This makes it difficult to use as a method of documenting good welfare in commercial fish farms and as a scientific tool. Automation of video analyses for fish behaviour and fish welfare has the potential to improve fish welfare, be financially beneficial to commercial fish farms, and be a valuable scientific tool. It could make it possible to perform large-scale studies of fish behaviour (Stien et al. 2007)

Monitoring of fish behaviour and fish welfare during cultivation may help to improve both profitability and fish welfare in commercial fish farms, and traditional methods are usually both time-consuming, expensive, laborious and invasive (Saberioon et al. 2017).

Optical sensors and machine vision systems can be utilized to develop faster, cheaper, and less invasive methods for monitoring quality in aquaculture. The use of optical and imaging technologies has the potential to become a vital component to optimize the cost and improve the quality in aquaculture, as well as a vital scientific tool. To meet real-world requirements, there is a need for new algorithms, an increase in computer-based processing, and further development of sensors and camera technology (Saberioon et al. 2017)

Chapter 2

Method

2.1 Overview and experimental setup

The salmon smolts were delivered at NTNU Sealab on 28th October 2021, while the experiments in this thesis were conducted between 14th January and 18th February 2022.

There were, in total, nine fish tanks with a capacity of 400 litres. Three diets were tested in triplicate tanks. The diets were salmon hydrolysate (LH), a control feed (CTRL) and a positive control feed with krill hydrolysate (KH). There were ten salmon smolts in each tank.

The order of the tanks was not randomized due to different light conditions in the laboratory and possible disturbance from staff working with other tanks. There was one tank of each feed type on each row to minimize the impact of these factors. Tank setup regarding placement in the lab and which feed each tank was fed can be seen in figure 2.1. Figure 2.2 show an overview of the actual wet lab used in the experiment.

Statistical analysis, such as one-way ANOVA, was performed using Minitab. Minitab was also used to make the different graphs in this thesis. Further information about the statistical analysis and methods can be found in section 2.6. The raw data was put into different graphs to get an overview of the results and to determine the best ways to process the material further. Some of these graphs can be found in appendix K for those interested in more insight regarding the results from the different tanks and feeding times.

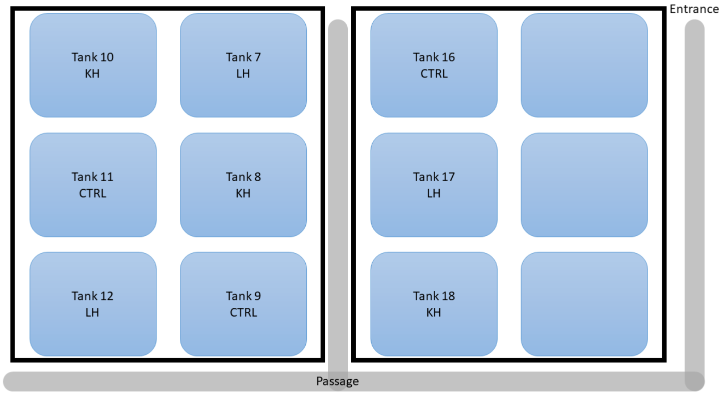

Figure 2.1: Tank setup including feed type and how the tanks were placed in the lab regarding to entrance and passage of staff.

Figure 2.2: Overview of the wet lab with several tanks, before the fish were moved to the experimental tanks. The feeders and cameras was not yet installed in the tanks.

2.2 Cultivation and registration

The salmon smolt was delivered from Lerøy Belsvik. The fish were transferred to acclimatization tanks on arrival at NTNU Sealab on 28th October. The fish were gradually adapted to seawater in the acclimatization tanks. The seawater was pumped from the sea bed in Trondheimsfjorden. The water quality was monitored daily from arrival to the end of the experiment as part of the daily husbandry, and the notes from the period 15th January to 17th February can be found in appendix A. Oxygen saturation and temperature were measured daily for the entire period, while salinity was only measured daily during the acclimatization period. Measures from November 2021 showed a stable salinity of approximately 33 ppt. In the form for routine monitoring of the health and welfare, relevant information about daily care was noted. This can be found in appendix B

Before this experiment, another similar experiment was conducted. The fish not included in that experiment were stored in three waiting tanks until this experiment was conducted. No fish from the previous experiment was reused in this experiment. This experiment is built on the same setup, with some minor changes.

This experiment began on 14th January 2022, when the fish were transferred from the three waiting tanks to the experimental tanks. The fish were weighed and measured, and a brief morphological examination was conducted. These results can be found in appendix C. A picture of the setup from the moving and measuring of the fish can be seen in figure 2.3.

The morphological examination was conducted to exclude unhealthy fish from the experiment to ensure fish welfare during the experiment. This also allowed us to assess the fish welfare during and at the end of the experiment to refine methods and experimental setup for later experiments. The morphological examination was based on a morphological scheme for classifying external injuries from Nofima (Noble et al. 2018) and included lesions and wounds, scale loss, snout injuries, fin damages and opercular damage or deformities. The morphological scoring sheet can be found in appendix D.

Figure 2.3: The setup from the weighing, measuring and morphological examination in conjunction with moving the fish from the waiting tanks to the experimental tanks. The tub was used for anaesthesia during the measuring and moving.

Cameras were installed in the experimental tanks on 3rd February while the fish were in the tanks. Before and at the beginning of the experiment, the fish were fed with the same feed as at the facility in Belsvik. The feed was changed when it was confirmed that the appetite was restored after being moved to the experimental tanks. This was done before the afternoon feeding on 8th February. Figure 2.4 shows a picture of the disassembled feeder.

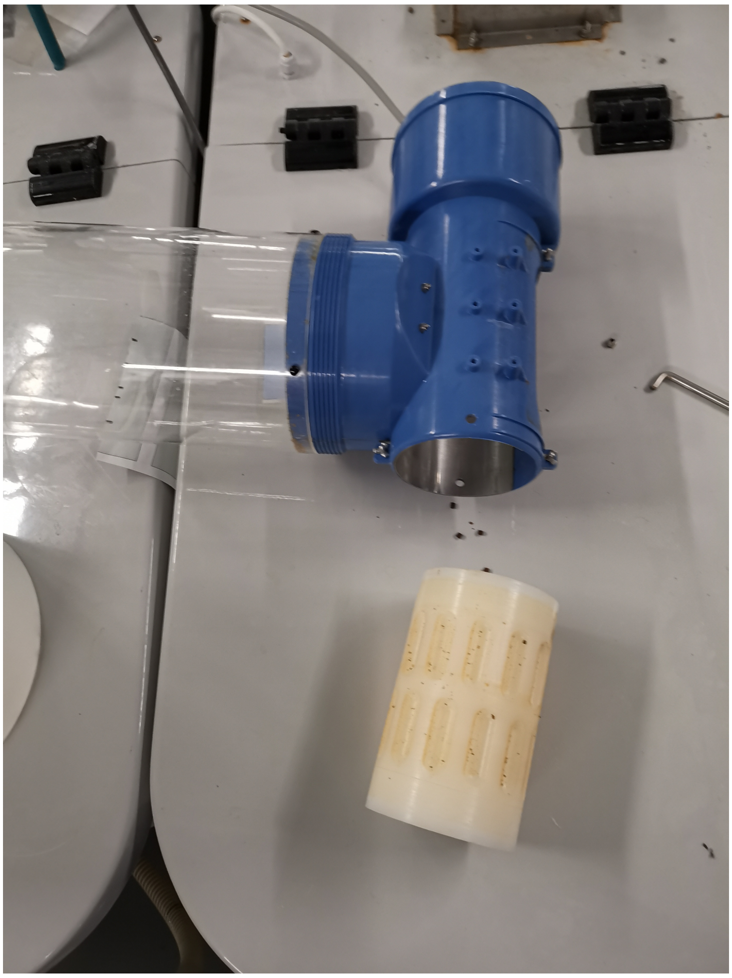

Figure 2.4: The feeder in conjunction with the feed change.

The experiment ended 18th February when the experimental tanks were emptied, and the fish again was weighed, measured and examined based on the morphological classification of external injuries. These results can be found in appendix C, together with the results from the beginning of the experiment. The fish number indicates the order in which the fish were measured, and there is no link between the fish number from 14th January and 18th February since the fish were not tagged in order to identify individuals.

The growth rate was calculated based on the results from 14th January and 18th February. SGR was calculated by using equation 1.1, and TGC was calculated by using equation 1.3 in section 1.2.4.

2.3 Coating of feed

The three different coating solutions were made based on the desired degree of inclusion. The desired degree of inclusion was 2% based on the dry weight (DW). The coating mixture was diluted in water to obtain the correct concentration and then mixed with the desired amount of standard feed pellets. After mixing, the coated feed was dried in a drying cabinet at 26°C until it reached the drying degree of 97-98%.

Nutrimar produced the salmon protein hydrolysate (LH) used in the coating for the experimental feed. Rimfrost produced the krill protein hydrolysate (KH) used in the coating solution for the positive control feed. Sparos produced the low-fat feed. Samples of all three diets were taken to be stored for potential further chemical analysis and characterization. The specifications of the different components can be seen in appendix G.

See Appendix E for further information about the coating process and Appendix F to see the calculations and information about the batches of feed used in the experiment.

2.4 Feeding and feed collection

The fish were fed during two periods each day, one in the morning (08:00-10:00) and one in the afternoon (13:30-15:30). The feed was given to the fish in pulses spread out during each feeding period. The amount of feed fed per tank according to the industrial control system (ISC) can be seen in table 2.1.

Table 2.1: Amount of feed fed per tank according to the data system in grams.

Date	**Feeding time (1=morning, 2=afternoon)**	**Amount of feed fed according to data system (g)**
08.02.2022	2	22.5
09.02.2022	1	22.5
	2	22.5
10.02.2022	1	22.5
	2	22.5
11.02.2022	1	22.5
	2	25
12.02.2022	1	25
	2	25
13.02.2022	1	25
	2	25
14.02.2022	1	25
	2	25
15.02.2022	1	25
	2	27.5
16.02.2022	1	27.5
	2	27.5
17.02.2022	1	30
	2	30
18.02.2022	1	30
	2	0
Total amount fed		**507.5**

Before feeding, the grate of the water outlet was emptied for faeces and other waste. Approximately 30 minutes after the end of the feeding period, the excess feed was collected to measure feed intake. Figure 2.5 shows an example of a grate before emptying. The excess feed was separated from the faeces, dried for 24 hours and weighed. The weight of the dried excess feed was used with the estimated amount of feed from the ICS to estimate how much feed the fish had eaten. The amount of feed collected can be found in appendix H. The drying cabinet with excess feed in aluminium cups can be seen in figure 2.6.

Figure 2.5: Grate with excess feed before emptying.

Figure 2.6: Drying cabinet with excess feed in aluminum cups.

2.5 Video sampling and analysis

The video sampling was conducted between 3rd February and 18th February 2022. The recordings were taken during the feeding periods two times a day (08:00-10:00 and 13:30-15:30). The specifications of the cameras can be seen in appendix I. Figure 2.7 shows a picture of the real-time video monitoring while recording the fish.

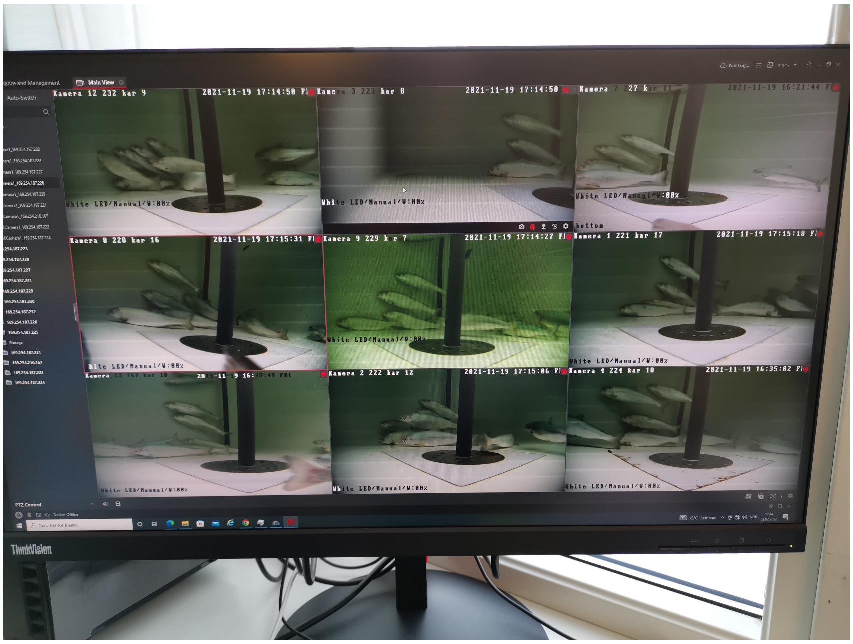

Figure 2.7: Real time video monitoring during recording of the fish in the experimental tanks. The time and date was not synced yet in this picture.

The feed was changed before the afternoon feeding on 8th February. Therefore, the videos recorded between 7th and 11th February were analysed. For each feeding period recorded, three feeding points were chosen: one early in the feeding period, one approximately in the middle of the feeding period and one near the end. The analysis started right before the feed pulse started and lasted for approximately 2 minutes until all feed was gone from the camera view or approximately 30 seconds after the last observed feed. The start and stop of the analysis were noted. Every video analysis took approximately 1 hour to conduct on average. With the vast number of video clips in this data material, this sums up to an estimated workload of 240 hours for the video analyses.

The number of fish in the camera view right before feeding, and the maximum number of fish in the camera view during feeding were counted to estimate whether or not all fish in the tank were visible. Figure 2.8 shows an example of a screenshot from a video clip right before the feed drop, with nine individuals visible. The head had to be visible to count the individual since the head had to be visible to know whether the individual ate any pellets. The number of fish who ate from the water column and the number of fish who ate from the tank bottom were counted, as well as the number of feed pellets eaten by the respective fish in the water column and on the tank bottom. The number of fish who showed no interest in the feed was also counted. Comments about the observations, such as shoaling, aggressive behaviour or events that made the counting more complicated, such as shadowing or fish in and out of camera view, were also noted. Figure 2.9 shows an example of a screenshot from a video clip right after the feed drop. It is important to note that some individuals are counted twice because they ate both from the water column and the bottom of the tank. This intersection is illustrated in figure 2.10.

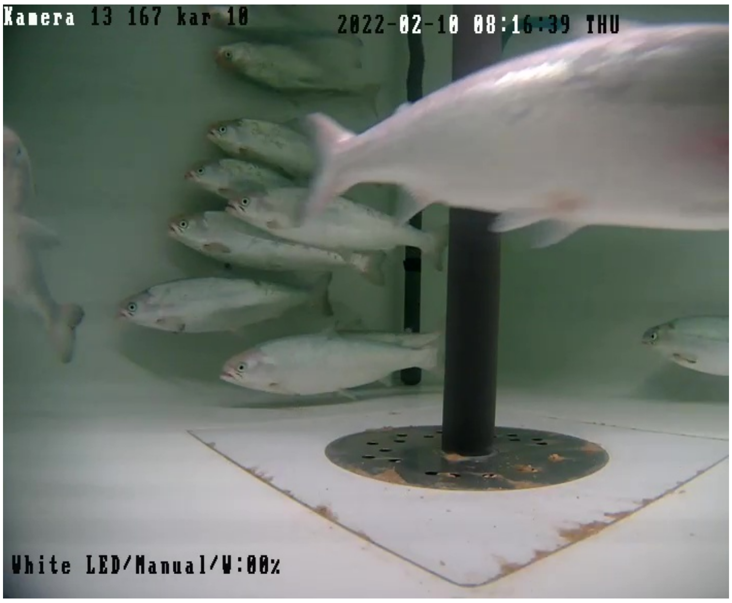

Figure 2.8: Screen shot from a video clip right before feed drop, with nine individuals visible. The fish partly obscuring the camera view is not counted, because the head is not visible.

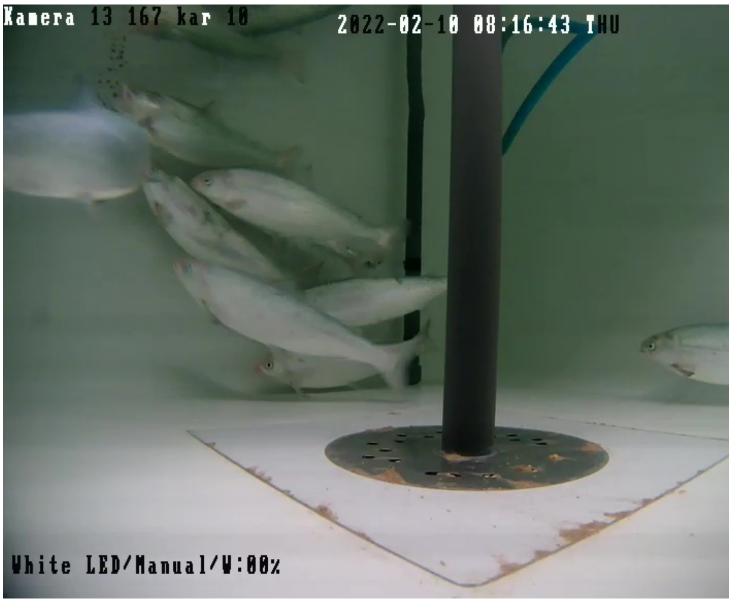

Figure 2.9: Screen shot from a video clip right after feed drop. Pellets can be seen in the upper left corner.

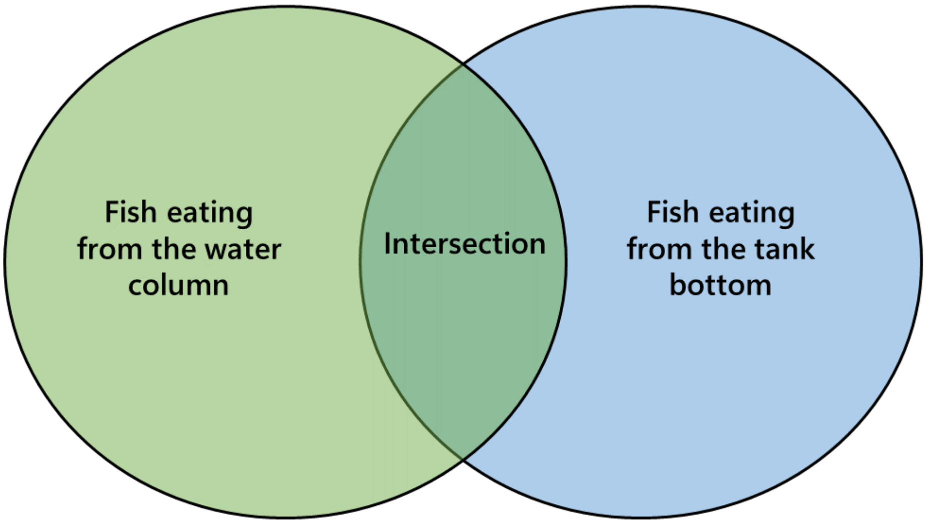

Figure 2.10: Venn diagram showing the interaction between number of individuals eating from the water column and number of individuals eating from the tank bottom

After an initial analysis of the data material, shown in figure K.1 and K.2 in appendix K, it was decided to focus on the data material from the first and fourth video clip of the day, at approximately 08:15 and 13:45. This decision was made because the box plots in figure K.1 and K.2 in appendix K showed that the appetite of the fish were best early in the feeding period. It also simplified the statistical analysis.

2.6 Statistical methods

The statistical software used for this thesis was Minitab (*Data Analysis, Statistical & Process Improvement Tools — Minitab* n.d.), and it was used both to perform the statistical analyses and to make the different graphs for this masters thesis. This section covers the statistical definitions and methods used in this masters thesis, including simple definitions and formulas, even though the software executed all the calculations.

2.6.1 Sample mean, median and sample variance

Measures of location are designed to provide some quantitative values of where the centre of the data is located (Walpole et al. 2011). One such measure is the sample mean, often referred to as the mean. This is simply a numerical average and is calculated as seen in equation 2.1. One of the disadvantages of using the sample mean alone is that it is influenced considerably by the presence of extreme observations, such as extreme values or outliers. Another measure of central tendency is the sample median. This is the centre of the data set when the data set is arranged in increasing order, and the calculation is shown in equation 2.2. The median is, therefore, uninfluenced by extreme values or outliers.

$$\overline{x} = \sum_{i=1}^{n} \frac{x_i}{n} = \frac{x_1 + x_2 + ... + x_n}{n} \tag{2.1}$$

$$\widetilde{x} = \begin{cases} x_{n+1/2} & \text{if n is odd} \\ \frac{1}{2}(x_{n/2} + x_{n/2+1}) & \text{if n is even} \end{cases} \tag{2.2}$$

Sample variability plays an important role in data analysis. Measures of location in a sample do not provide a proper summary of the nature of the data set(Walpole et al. 2011). The sample range is the simplest measure of spread or variability and is calculated by subtracting the minimum value from the maximum value ($X_{max} - X_{min}$). The sample variance is calculated as seen in equation 2.3.

$$s^2 = \sum_{i=1}^{n} \frac{(x_i - \overline{x})^2}{n-1} \tag{2.3}$$

Large variability in a data set produces relatively large values of $(x_i - \overline{x})^2$, and therefore a large sample variance. $n - 1$ is often called the degrees of freedom associated with the variance estimate, where n is the number of sample values.

2.6.2 Mean and variance of a random variable

The mean of a random variable X (the mean of the probability distribution of X, the mathematical expectation or the expected value of the random variable X) is denoted as μ or $E(X)$. It is used to calculate the average expected in the long run (Walpole et al. 2011). It is defined as seen in equation 2.4, where X is a random variable with probability distribution $f(x)$.

$$\mu = E(X) = \begin{cases} \sum_x xf(x) & \text{if X is discrete} \\ \int_{-\infty}^{\infty} xf(x)dx & \text{if X is continous} \end{cases} \tag{2.4}$$

The mean of a random variable X is important in statistics because it describes where the probability distribution is centred. However, by itself, it does not give an adequate description of the shape of the distribution (Walpole et al. 2011). The variability in the distribution must also be characterized. The variance of the random variable X, also known as variance of the probability distribution of X, is denoted by $\text{Var}(X)$ or σ^2. It is defined as seen in equation 2.5, where X is a random variable with probability distribution $f(x)$ and mean μ.

$$\sigma^2 = E[(X-\mu)^2] = \begin{cases} \sum_x (x-\mu)^2 f(x) & \text{if X is discrete} \\ \int_{-\infty}^{\infty} (x-\mu)^2 f(x)dx & \text{if X is continous} \end{cases} \tag{2.5}$$

2.6.3 Standard deviation

Standard deviation measure the spread of the data and tells how much the data values deviate from the mean value (Cuemath n.d.). A low standard deviation indicates that the values tend to be close to the mean, while a high standard deviation indicates that the values are far from the mean value. The standard deviation is the positive square root of the variance and is often denoted as σ, StDev or SD and calculated as seen in equation 2.6. How the variance is calculated depends on whether there is a data set, sample, population, random variable, probability distribution, etc.

$$\text{StDev} = \sigma = \sqrt{\sigma^2} \tag{2.6}$$

2.6.4 Statistical modeling and graphical display

The box plot, also known as the Box-and-Whiskers plot, is a display helpful for the reflection properties of a sample (Walpole et al. 2011). The plot encloses the interquartile range of the data in a box. It also displays the median within. The interquartile range has the upper (75th percentile) and lower (25th percentile) quartile as its extremes. It also shows the extreme observations in the sample as the "whiskers". For large samples, the box plot shows centres of location, variability, and degree of asymmetry. It can also provide the viewer with information regarding possible outliers, but it is not intended to be a formal test for outliers.

2.6.5 One-way analysis of variance

The one-way analysis of variance, also known as the one-way ANOVA, compares the means of two or more independent populations to determine whether there is a statistically significant difference between the population means.

In the procedure, it is assumed that whatever variation exists among populations is attributed either to within-sample variation or among-sample variation (Walpole et al. 2011). The within-sample variation can be due to a certain amount of heterogeneity, chance, or random variation. The goal of the analysis of variance is to determine if the difference between the sample means is due to random variation alone or due to variation between the populations, in this case, different types of feed.

Random samples of a given size are selected from each of the populations. The populations are classified based on a single criterion such as different treatment (Walpole et al. 2011). The populations are assumed to be independent and normally distributed with common variance. These assumptions are made more palatable by randomization. The null hypothesis is that the means of all populations are equal, while the alternative hypothesis is that at least the mean of one of the populations is not equal to the means of the other populations. The null hypothesis and the alternative hypothesis are often expressed as follows, where equation 2.7 is the null hypothesis and equation 2.8 is the alternative hypothesis:

$$H_0 : \mu_1 = \mu_2 = ... = \mu_k, \text{ where k indicate number of populations} \tag{2.7}$$

$$H_1 : \text{At least two of the means are not equal} \tag{2.8}$$

The p-value is compared to the significant level (α) to determine whether any of the differences between the means are statistically significant (*Interpret the key results for One-Way ANOVA* n.d.). The significance level indicates the risk of concluding that a difference exists when there is no difference. The significance level was set to $\alpha = 0.05$ for all one-way ANOVAs performed in this thesis. This indicates a 5 % risk of concluding that a difference exists when there is no actual difference (*Interpret the key results for One-Way ANOVA* n.d.). If the p-value is less or similar to α=0.05, it means that the difference between some of the means is statistically significant. If the p-value is greater than α=0.05, there is not enough evidence to reject the null hypothesis. This could be caused by the power of the test. It is possible to use a larger sample, make improvements to the process or use a higher significant level (α) to increase the power of the test, (*Increase power* n.d.). It is important to note that a higher significance level increases the risk of concluding that there is a difference when there is actually no difference between the means.

One-way ANOVA on growth

A one-way ANOVA was performed on the growth for each tank to determine whether there were any statistically significant differences between the different types of feed. One-way ANOVAs were also performed on the start and end biomass to determine whether there were any statistically significant differences between the biomass in the different tanks at the beginning and the end of the experiment.

One-way ANOVAs on feed collection

Several one-way ANOVAs were performed to determine whether there are any statistically significant differences between the estimated amount of feed eaten per estimated biomass for the different types of feed. Every one-way ANOVA was linked to the results from one day, and the factor was the type of feed.

One-way ANOVAs on results from the video analysis

There were performed several one-way ANOVAs to determine whether there were any statistically significant differences between the number of pellets eaten for the different types of feed, between the number of individuals eating for the different types of feed and between the number of pellets eaten per individual eating for the different types of feed. Every one-way ANOVA was linked to the results from one day, and the factor was the type of feed.

Chapter 3

Results

Table 3.1 shows the average, maximum and minimum values and standard deviation for oxygen saturation (in mg/L and per cent) and water temperature for all nine tanks between 15th January and 17th February. All data from the daily fish husbandry, such as the different parameters for water quality, can be found in Appendix A. The water temperature fluctuation was between days, not between tanks, and was influenced by the outdoor temperature in the period. The salinity was not measured in this period but is assumed to be stable at approximately 33 ppt based on the measures from November 2021 and knowledge of the stability of the water source.

Table 3.1: The average, maximum and minimum values and standard deviation for oxygen saturation (both in mg/L and percent) and water temperature for all tanks in the period between 15th January and 17th February.

	Oxygen, mg/L	Oxygen, %	Water temperature, °C
Average	9.4 ± 0.2	94.8 ± 1.3	6.9 ± 0.5
Max	9.93	97.9	8.5
Min	8.8	91.5	5.9

3.1 Growth

There were noted some incidents in the form for routine monitoring of the health and welfare that could affect the appetite and growth. This can be found in appendix B. Further studies of the data material for growth could not find an effect of these incidents.

Total start and end biomass in each tank, linked with feed type, the standard deviation of start and end biomass and SGR and TGC for each tank, can be seen in table 3.2. The mean growth and standard deviation of the growth of each type of feed can be seen in table 3.3, together with the average start and end biomass, the standard deviation of the start and end biomass, SGR and TGC for each type of feed. The p-value from the one-way ANOVA performed on the growth and the p-values from the one-way ANOVAs performed on start and end biomass can be found in table 3.3.

The start and end weight of each fish, as well as descriptive statistics such as mean, standard error mean, standard deviation, minimum and maximum, median, and the first and third quartile (Q1, Q3) of start weight and end weight for each tank can be found in appendix C.

Table 3.2: Total biomass in each tank at the beginning and end of the experiment, together with feed type, standard deviation of start and end weight and calculated SGR and TGC for each tank.

Tank	Feed	Biomass (g) start	Biomass (g) end	SGR	TGC
7	LH	2347.8 ± 25.6	3308.1 ± 35.4	0.98	6.57
12	LH	2253.8 ± 16.8	3329.0 ± 31.2	1.12	7.43
17	LH	2334.8 ± 26.4	3234.0 ± 42.5	0.94	6.21
10	KH	2433.4 ± 25.2	3314.8 ± 38.2	0.89	5.96
8	KH	2374.0 ± 24.6	3487.4 ± 38.2	1.10	7.45
18	KH	2345.2 ± 24.7	3314.4 ± 23.7	0.99	6.63
9	CTRL	2365.8 ± 16.8	3329.1 ± 25.2	0.98	6.56
11	CTRL	2281.3 ± 21.0	3253.1 ± 31.4	1.02	6.75
16	CTRL	2295.7 ± 30.7	3353.8 ± 44.8	1.09	7.25

Table 3.3: Average biomass of the fish sorted by type of feed at the beginning and end of the experiment, standard deviation of start and end biomass, SGR and TGC, mean growth and standard deviation of growth for each type of feed, together with the p-values from the one-way ANOVAs performed on start and end biomass, and growth.

Feed	Biomass (g) start	Biomass (g) end	SGR	TGC	Mean growth (g)
LH	2312.1 ± 50.9	3290.4 ± 49.9	1.01	6.74	978.2 ± 89.4
KH	2384.2 ± 45.0	3372.2 ± 99.8	1.00	6.68	988.0 ± 117.1
CTRL	2314.3 ± 45.2	3312.0 ± 52.5	1.03	6.85	997.7 ± 52.5
One-way ANOVA	$p = 0.184$	$p = 0.402$			$p = 0.966$

Data were analysed using one-way ANOVA.
[*] $p < 0.05$ denotes significant effect.
[**] $0.05 < p < 0.1$ denotes small p-value, but not significant effect.

3.2 Feed collection

Between 8th February and 18th February, each tank was supposed to get 507.5 grams of feed, according to the ICS. Table 2.1 shows the distribution between the feeding periods. The total feed fed in the period and the deviation between the expected amount of feed fed and the actual amount can be seen in table 3.4. For most tanks, the deviation was within ± 5%, but for tank 11, the deviation was as much as -24.6%. The raw data and the calculations, including the percentage of spill, can be found in appendix H.

Table 3.4: Actual amount of experimental feed fed for each tank in the period between afternoon 8th February and afternoon 18th February and deviation in percent from expected amount of feed fed (507.5 g).

Tank No & feed type	17 (LH)	7 (LH)	12 (LH)	18 (KH)	8 (KH)	10 (KH)	16 (CTRL)	9 (CTRL)	11 (CTRL)
Feed fed (g)	482.3	517.6	504.8	486.2	493.0	502.2	490.5	505.8	407.3
Deviation (%)	-5.2	+2.0	-0.5	-4.4	-2.9	-1.1	-3.5	-0.3	-24.6

There were noted some incidents in the form for routine monitoring of the health and welfare that could affect the appetite and feed collection. This can be found in appendix B. Further studies of the data material could indicate an effect in tank 10 from 11th to 14th February. This data material was therefore excluded from the feed collection analyses.

The line plot in figure 3.1 shows the development over time in estimated feed eaten in grams per estimated biomass in grams for each type of feed from 3rd to 17th February. The ICS line shows the estimated feed fed divided by the estimated average biomass. The p-values and mean from the one-way ANOVAs performed on the estimated amount of feed eaten per estimated biomass for all feed types from 7th to 11th February can be seen in table 3.5.

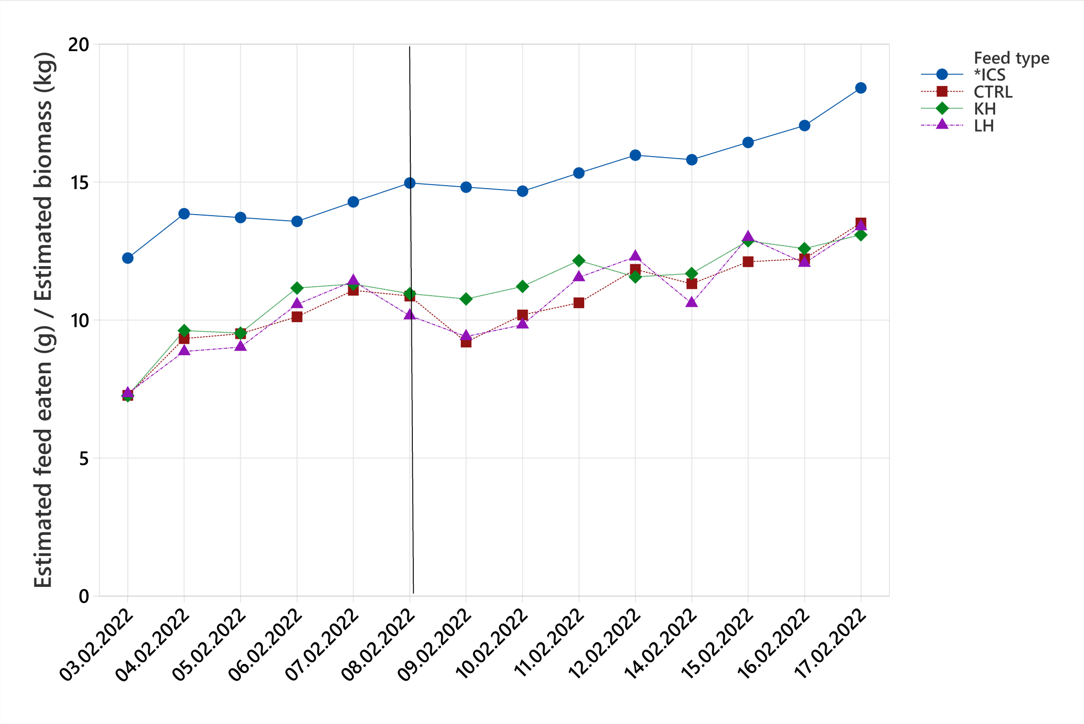

Figure 3.1: Line plot showing the estimated amount of feed eaten in grams per estimated biomass in kilograms, sorted by type of feed. The estimated amount of feed is based on data from ICS and DW of collected feed between 3rd and 17th February, while the estimated biomass is based on start weight, end weight and the SGR. The vertical line on 8th February indicates the feed change.

Table 3.5: P-values and mean for estimated amount of feed eaten in grams per estimated biomass in kilograms for all feed types from 7th February to 11th February. The feed was changed between morning and afternoon feeding 8th February.

Day	p-value	Mean CTRL	Mean KH	Mean LH
7th Feb	0.792	11.08 ± 0.70	11.31 ± 0.41	22.42 ± 0.52
8th Feb	0.138	10.87 ± 0.43	10.96 ± 0.34	10.16 ± 0.56
9th Feb	0.133	9.20 ± 0.11	10.76 ± 0.77	9.40 ± 1.29
10th Feb	0.430	10.19 ± 1.75	11.22 ± 0.39	9.83 ± 1.26
11th Feb	0.359	10.63 ± 0.52	12.16 ± 0.17	11.55 ± 1.63

Data were analysed using one-way ANOVA.
* $p < 0.05$ denotes significant effect.
** $0.05 < p < 0.1$ denotes small p-value, but not significant effect.

3.3 Video analysis

This section shows the results based on the data from the video analysis of the first and fourth video clips of the day at approximately 08:15 and 13:45. The last afternoon and morning before the feed change (afternoon feed 7th February and morning feed 8th February) is called Day 0, while the first day and night after the feed change (afternoon feed 8th February and morning feed 9th February) is called Day 1. The feedings are paired this way because the feed was changed between the morning and afternoon feeding. The camera in tank 7 had stopped working from 10th February. Therefore, there was no video material from tank 7 to analyse from the 10th and the 11th February.

Number of pellets eaten

The line plot in figure 3.2 shows the development over time in the number of pellets eaten. The p-values, mean, and standard deviation from the one-way ANOVAs performed on the number of pellets eaten for the different types of feed from Day 0 to Day 3 can be seen in table 3.6.

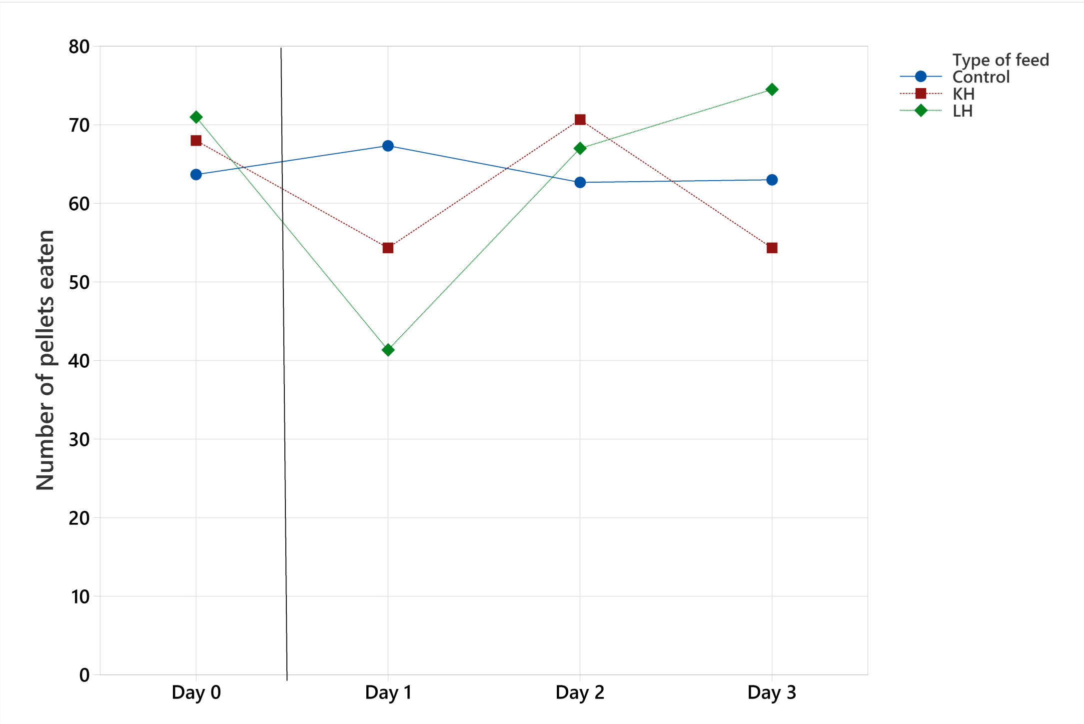

Figure 3.2: Line plot showing development over time in number of pellets eaten during analysis of the fourth and first video clip of the day in the period 7th to 11th February sorted by type of feed. One day include the afternoon feed and the following morning feed. The vertical line between Day 0 and Day 1 indicates the feed change.

Table 3.6: P-values, mean and standard deviation for number of pellets eaten for all feed types from Day 0 to Day 3. The feed was changed between Day 0 and Day 1.

Day	p-value	Mean CTRL	Mean KH	Mean LH
Day 0	0.509	63.7 ± 11.2	68.0 ± 2.0	71.0 ± 5.6
Day 1	0.253	67.3 ± 8.4	54.3 ± 20.4	41.3 ± 19.7
Day 2	0.661	62.7 ± 11.5	70.7 ± 11.6	67.0 ± 0.0
Day 3	0.045*	63.0 ± 8.9	54.3 ± 4.5	74.5 ± 0.7

Data were analysed using one-way ANOVA.
* $p < 0.05$ denotes significant effect.
** $0.05 < p < 0.1$ denotes small p-value, but not significant effect.

Number of individual fish eating

The line plot in figure 3.3 shows the development over time in the number of individuals eating. The p-values, mean, and standard deviation from the one-way ANOVAs performed on the number of individuals eating for the different types of feed from Day 0 to Day 3 can be seen in table 3.7. The number of individuals in the y-axis of the line plot is higher than the total number of fish in the tank because it is based on two feedings and the intersection between fish eating from the bottom of the tank and the water column. Therefore, the axis range is 0-40 instead of 0-10.

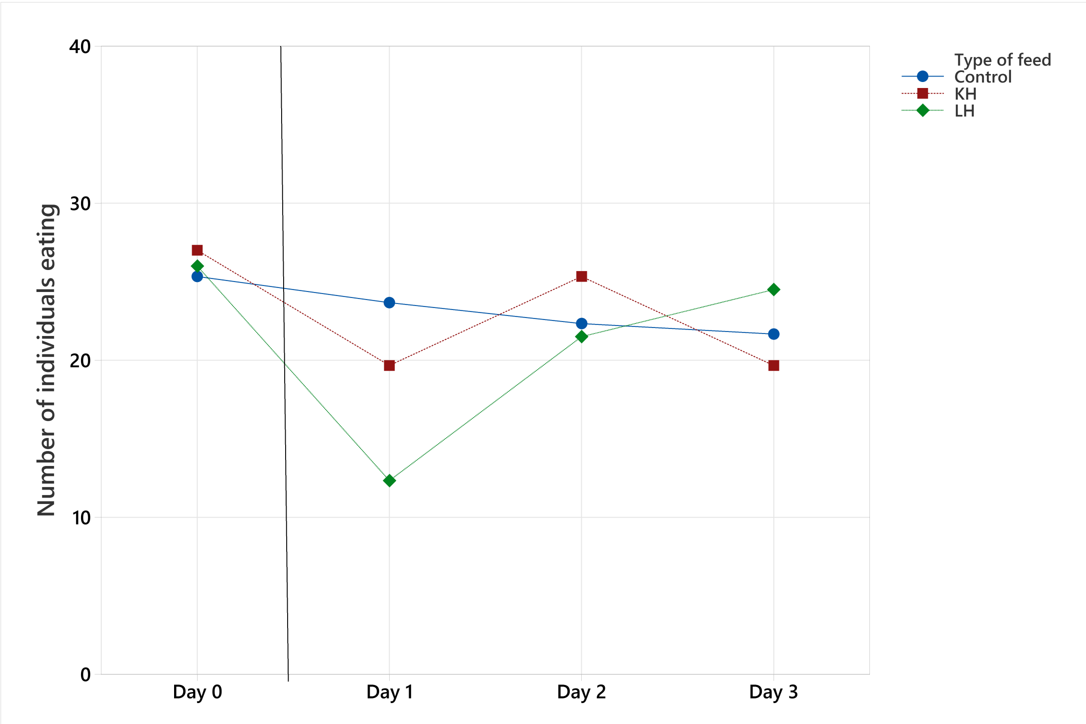

Figure 3.3: Line plot showing development over time in number of individuals eating during analysis of the fourth and first video clip of the day in the period 7th to 11th February sorted by type of feed. The vertical line between Day 0 and Day 1 indicates the feed change. The y-axis range is 0-40 instead of 0-10 because each day include the afternoon feed and the following morning feed, together with the intersection between fish feeding from the water column and tank bottom.

Table 3.7: P-values, mean and standard deviation for number of individuals eating for all feed types from Day 0 to Day 3. The feed was changed between Day 0 and Day 1.

Day	p-value	Mean CTRL	Mean KH	Mean LH
Day 0	0.779	25.3 ± 4.7	27.0 ± 1.0	26.0 ± 1.0
Day 1	0.075**	23.7 ± 2.5	19.7 ± 4.9	12.3 ± 6.4
Day 2	0.534	22.3 ± 4.6	25.3 ± 3.2	21.5 ± 3.5
Day 3	0.316	21.7 ± 3.5	19.7 ± 3.1	24.5 ± 2.1

Data were analysed using one-way ANOVA.
* $p < 0.05$ denotes significant effect.
** $0.05 < p < 0.1$ denotes small p-value, but not significant effect.

Number of pellets eaten per number of individual fish eating

The line plot in figure 3.4 shows the development over time in the relationship between the number of pellets eaten and the number of individuals eating. The p-values, mean, and standard deviation from the one-way ANOVAs performed on the number of pellets eaten per individual eating for the different types of feed from Day 0 to Day 3 can be seen in table 3.8.

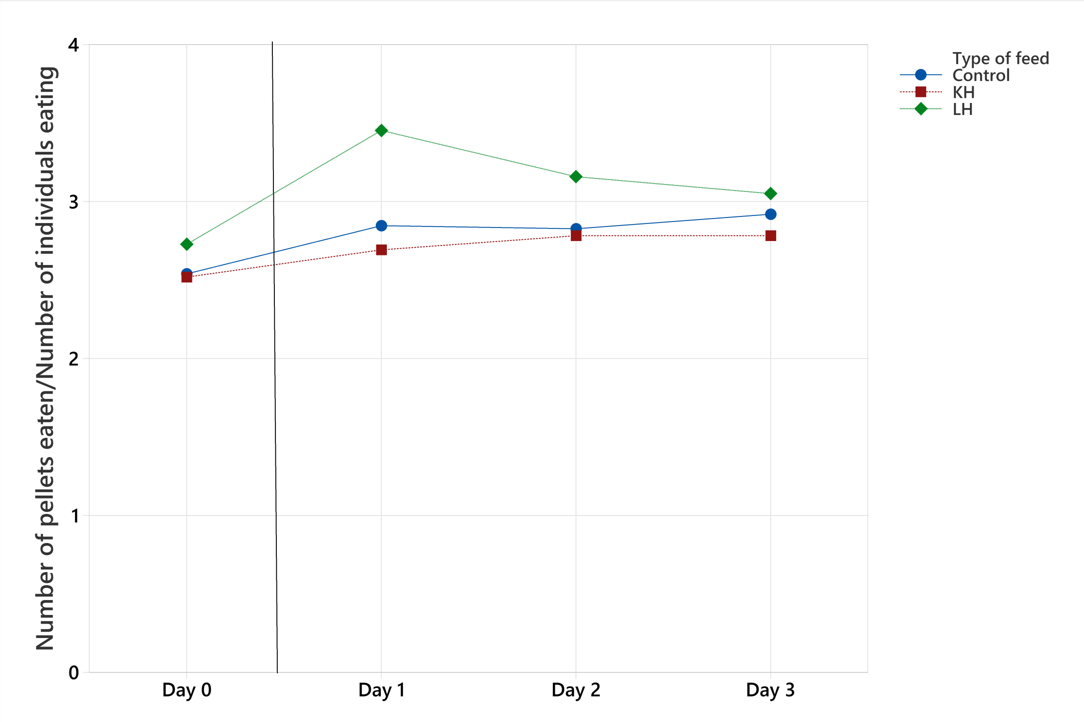

Figure 3.4: Line plot showing the development over time in number of pellets eaten per number of individuals eating. One day include the afternoon feed and the following morning feed. The vertical line between Day 0 and Day 1 indicates the feed change.

Table 3.8: P-values, mean and standard deviation for number of pellets eaten per individual eating for all feed types from Day 0 to Day 3. The feed was changed between Day 0 and Day 1.

Day	p-value	Mean CTRL	Mean KH	Mean LH
Day 0	0.511	2.5 ± 0.4	2.5 ± 0.0	2.7 ± 0.1
Day 1	0.057**	2.8 ± 0.2	2.7 ± 0.4	3.5 ± 0.3
Day 2	0.413	2.8 ± 0.3	2.8 ± 0.1	3.2 ± 0.5
Day 3	0.410	2.9 ± 0.2	2.8 ± 0.2	3.1 ± 0.2

Data were analysed using one-way ANOVA.
* $p < 0.05$ denotes significant effect.
** $0.05 < p < 0.1$ denotes small p-value, but not significant effect.

Chapter 4

Discussion

Disturbance in the tanks could affect the feeding behaviour, growth and fish welfare. There is no indication that the fish were disturbed or that there was trouble with any of the tanks between 7th and 10th February, according to appendixB. Some incidents were noted in the afternoon of 11th February that could affect appetite and feed consumption. Further studies of the data material could indicate an effect in tank 10 (fed KH) from 11th to 14th February. This data material was therefore excluded from the feed collection analyses.

4.1 Growth

Suboptimal environmental conditions can affect the growth and fish welfare. TGC take temperature into consideration, while SGR increases with increasing water temperature up to the optimum temperature for growth (Thorarensen and Farrell 2011). Low water temperature decreases the growth. Therefore, the growth is expected to be lower in the winter than in the summer and autumn unless there are other limiting conditions, such as low oxygen saturation or low feed availability. The water temperature fluctuated some degrees in the period, which is expected based on shifts in the outdoor temperature. The oxygen saturation was overall high and within optimal range, and there were no indications that oxygen was a limiting factor (Thorarensen and Farrell 2011). The assumed salinity and knowledge of the stability of the water source are within normal levels for seawater.

Low SGR and TGC could imply that the fish had suboptimal environmental conditions or too low feed availability (Thorarensen and Farrell 2011). To ensure sufficient feed availability, the amount of feed was calculated based on the estimated growth of 1.5% of biomass + 20% overfeeding (Glencross 2020). These calculations can be found in appendix H. In addition, there were daily inspections with feed collection to ensure that the fish had more than enough feed available.

Both SGR and TGC were sufficient for all tanks and all types of feed based on the models. This implies that the feed availability was sufficient in this period. It is important to note that the TGC tables are based on studies from the 1980s and 1990s. The combination of selective breeding to improve growth rate, as well as better knowledge and control over the environmental conditions and improved feed since the 1990s, should give significantly higher TGC today than what was expected when the models were made (Thorarensen and Farrell 2011; Glover et al. 2009). It is also expected that TGC will fluctuate through the year, based on the season. Therefore, the use of TGC has its limitations.

It is important to point out that the calculated SGR and TGC are based on the start weight from 14th January and the end weight from 18th February. The feed was changed on 8th February. In regular growth studies, the experimental period is longer because a longer experimental period makes the SGR and TGC more reliable. In this experiment, the growth was analysed to see if there were any significant differences in biomass and growth between the groups that could affect appetite and feed consumption. The p-values of the one-way ANOVAs performed on start and end biomass and growth indicate that there were no significant differences in growth or biomass between the populations before or at the end of the experiment.

4.2 Feed collection

The feed collection indicates that the feed availability was sufficient. The results from the feed collection were originally only supposed to be used to ensure that the fish were overfed during the experiment. Therefore, the data material has some weaknesses that have to be taken into consideration regarding the analyses. We can not rule out the possibility of flooding the grates, which would rinse away pellets. This could give a false result, indicating a higher appetite. There were also found some deviations between the actual amount of experimental feed fed and the expected amount of feed fed from the ICS. For most tanks, the deviation was acceptable, but for one of the tanks, it was high. These weaknesses could have been avoided by implementing some measures, but this was not considered necessary in advance.

Krill protein hydrolysate was chosen for the positive control feed because it was expected to have a positive effect on the appetite based on studies about feeding attractants and stimulants (Kousoulaki et al. 2013; Kaur et al. 2022; Kousoulaki et al. 2018). Therefore, a difference between the control and positive control feeds, independent of the LH feed, was expected to be seen. At first, it could seem like the fish fed the KH feed had a better appetite after the feed change than the fish fed LH and control feed. However, none of the p-values of the one-way ANOVAs performed on this data material indicates that these differences were statistically significant. Therefore, based on this data, it is not possible to conclude that there were any differences in feed consumption between the three feed types. It is possible that the coating method used in this experiment or the percentage of included protein hydrolysate was not sufficient to differentiate the feed types. However, it is also possible that this is due to the weaknesses of the data material from the feed collection itself.

4.3 Video analysis

4.3.1 Analysis of the data from the video analyses

Note that the data material was limited, especially after the camera in tank 7, fed LH, stopped working on 10th February. This limits the data from the LH from Day 2 and Day 3.

Number of pellets eaten

It was expected that the appetite would decrease in the days after the introduction of a new type of feed, resulting in a decrease in the number of pellets eaten (Refstie et al. 1998; Glencross 2020). At first, it could seem like there was a decrease for the KH and LH feed on Day 1, but further analyses using one-way ANOVA showed that the differences between the feed types were not statistically significant. Several of the standard deviations were high, indicating that there was a lot of variance between the different tanks within the same diet.

It was expected that the fish fed the positive control feed (KH) would eat more pellets than the fish fed control feed (CTRL) because krill protein hydrolysate has an appetite-stimulating effect on salmon (Kousoulaki et al. 2013; Storebakken 1988). As expected, the p-values from Day 0 indicate no difference between the different diets because this was before the feed change. Further one-way ANOVA analyses showed no statistically significant difference between the feed types on Day 1 and 2. Several of the standard deviations were high, indicating a lot of variance between the different tanks within the same diet. For Day 3, on the other hand, the one-way ANOVA showed a statistically significant difference between some of the feed types, but it was the LH feed that stood out with the highest mean and lowest standard deviation. The CTRL feed had a higher mean value than the KH feed, but the difference was not statistically significant. It is important to note that the data material for the LH feed was limited for Day 2 and 3 because of the missing data from tank 7 and that the numbers resulting in high standard deviation from Day 1 were related to the same tank.

Number of individual fish eating

It was expected that the appetite would decrease in the days after the introduction of a new type of feed, resulting in a decrease in the number of fish eating (Refstie et al. 1998; Glencross 2020). At first, it could seem like there was a decrease for the KH and LH feed on Day 1, but further analyses using one-way ANOVA showed that the differences between the feed types were not statistically significant. Several of the standard deviations were high, indicating a lot of variance between the different tanks within the same diet.

It was expected that there would be a higher number of individual fish eating the positive control feed (KH) than the control feed (CTRL) because krill protein hydrolysate has an appetite-stimulating effect on salmon (Kousoulaki et al. 2013; Storebakken 1988). As expected, the p-values from Day 0 indicate no difference between the diets because this was before the feed change. Further one-way ANOVA analyses showed no statistically significant difference between the feed types for any of the days after the feed change. Several of the standard deviations were high, indicating a lot of variance between the different tanks within the same diet.

Number of pellets eaten per number of individual fish eating

Based on the preliminary analysis, there was expected to be a correlation between the number of pellets eaten and number of individual fish eating. The analysis of the first and fourth video clips shows that the relative number between the number of pellets eaten and the number of individual fish eating is stable. There is no statistically significant difference between the three diets. This indicates that there is compliance between how much feed that was eaten and how many fish who ate, independently of diet and change of diet, in the four days where the video analysis took place.

Summary

It was expected that the appetite would decrease when the fish were given a new type of feed (Refstie et al. 1998; Glencross 2020). In this experiment, this was not detected clearly in the video analyses. There might have been a decrease in appetite for some feed types and tanks the first days after feed change, but the differences between the feed types were not statistically significant. This can result from the daily variation in feed intake, where the fish eat more one day than another or at one feeding time than another. Variations in feed intake between feeding times would not be detected in the video analyses because only two feed drops per day were analysed in this thesis. The feed was fed in several drops throughout each feeding period, and one feed drop is just a snapshot of the total feeding period. Another explanation could be the possibility that the fish were not overfed (Glencross 2020). Even though the results from the feed collection indicate that the fish were overfed overall, it is possible that the fish were not overfed in each feed drop. The fish might have been too hungry at the beginning of the feeding period. This could then influence both the numbers before and after the feed change and, therefore, obscure the effect of the feed change on the appetite. It is expected that the effect of palatability can be detected within days after introducing a new feed and that the fish may begin to adapt after approximately ten days (Glencross 2020). A weakness of the results from this experiment is that only videos from the first three days after the feed change were analysed. It is possible that an effect would have occurred in a later stage.

The positive control feed (KH) was expected to do better than the control feed (CTRL). Studies suggest that krill protein hydrolysate has an appetite-stimulating effect on salmon (Kousoulaki et al. 2013). No such effect could be found in the one-way ANOVA analyses. It is possible that the daily variation in feed intake, where the fish eat more one day than another or at one feeding time than another, obscured some differences between the feed. Another explanation could be that the fish were not overfed (Glencross 2020). Even though the results from the feed collection indicate that the fish were overfed overall, it is possible that the fish were not overfed in each feed drop. It is possible that the fish were too hungry at the beginning of the feeding period to be picky with the food, and the possibility that this obscured the effect of the feeding attractants can not be ruled out. Another possibility is that the coating method used in this experiment or the percentage of included protein hydrolysate was not sufficient to differentiate the feed types. At the same time, this can not explain why there was a statistically significant difference between the LH feed and the two control feeds in the number of pellets eaten for Day 3 after the feed change, where LH had significantly better results. At the same time, it is important to remember that none of the other analyses show any effect of any of the diets. It is also possible that the breeding programme of the salmon has influenced the feeding behaviour in some way, as well as growth (Volkoff et al. 2010; Glover et al. 2009).

4.3.2 Video analysis as method

Video analysis is a powerful tool that gives a lot of data material. It is very time-consuming if the material is processed without the use of AI or data programs made to automatise the process (Stien et al. 2007; Saberioon et al. 2017). Manual processing of video material can take as much as one hour per minute of video, depending on the complexity of the analysis. Knowing the limitations and setting clear frameworks when designing the experiment is essential. If not, it is possible to end up with a lot of data material with low power.

The use of underwater cameras made it possible to observe the feeding behaviour of the fish. This would not be possible with an overhead visual observation due to restricted view, poor visibility and provoked behaviour (Ellis et al. 2019). The feeding periods were recorded, which made retrospective analysis possible. The use of recordings made it possible to slow down the video. This was especially useful during the feed drops when it happened a lot simultaneously. The recordings also made it possible to rewind and see the same video clip several times to analyse different aspects of the behaviour. Rewinding, pausing and slowing down the recordings was time-consuming but improved the quality of the video analyses.

The restricted range and the limitations with a fixed camera mounting were known challenges (Ellis et al. 2019). The placement of the cameras before the beginning of the experiment was, therefore, essential to reduce the problem of restricted view. One of the challenges with the video analysis was when some of the fish swam in and out of the camera view. Even though measures were taken, some individual fish went in and out of camera view or were not observed during the feeding. This made it harder to follow individuals. It was impossible to know how the fish behaved nor whether they ate while in the blind spots. This could make the numbers more inaccurate. At the same time, it is important to mention that the camera was placed in the tank to give a good view of the feed drop and the initial feeding. Therefore, most of the pellets were in the camera view, and there is no reason to believe that the fish outside the camera view ate significant amounts of pellets. Another challenge with the video analysis was when individual fish occupied a position in front of the camera. This obscured the view and made it harder to count the number of pellets eaten and the number of individuals eating. If this happened at feed drop, the results from that recording were substantially influenced by the obscured view, and the data had less value. Therefore, this was mentioned in the comments when it occurred. If the view was obscured later, it had less impact on the results. Sometimes, the number of fish eating simultaneously from the water column was so great that they obscured each other and the pellets. When this was an issue, it was mentioned in the comments, found in appendix J.

In the raw data, it was distinguished whether the pellets were eaten from the water column or the tank bottom. This was initially done because it was expected, based on theory, that the fish would prefer eating from the water column. Whether the fish ate from the water column or the tank bottom was assumed to indicate interest in the feed (Jørgensen and Jobling 1992). During the video analysis, it was observed that most of the feed was eaten or sunken to the bottom in less than 10 seconds from the feed drop. The impression is that the fish did not have enough time to eat several pellets in the water column before they sank to the bottom. Therefore, a fair share of the pellets were eaten from the tank bottom. This was not expected. Therefore, only the total number of pellets was used in the statistical analysis in this thesis. As mentioned in section 2.5, some individuals were counted twice because they ate both from the water column and the bottom of the tank. This intersection makes these numbers less accurate in determining the appetite of the fish in the tank than the number of pellets eaten. However, it provides a more accurate indication of whether few or many fish were feeding than the number of fish feeding from the tank bottom or water column separately.

Even though several factors indicate that the numbers of pellets and individuals have some degree of inaccuracy, most of these had minor impacts on the results. In those cases where they had a more significant impact, this was noted in the comments (appendix J) and made removing these numbers from the statistical analysis possible. The results, therefore, indicate whether or not the fish were interested in the feed.

As mentioned in section 2.5, a preliminary analysis of all the video clips showed that the appetite was better early in the feeding period. This was applicable both for the morning and afternoon feeding. In the hope of more precise results and a simplified statistical analysis, it was decided to focus on the data material from the first and fourth video clips of the day for the rest of the analyses. One of the weaknesses of choosing the data material from the first and fourth video clips was that because the appetite was better early in the feeding period, the fish often ate all or most of the pellets during the early feed drops, even though they were overfed throughout the day. Because of this, it is possible to detect if the appetite was much lower than usual. The issue is that it is impossible to know if the fish would have eaten more if they had the chance. This issue makes it hard to assess the impact of the diet on palatability responses (Glencross 2020).

4.3.3 Feed collection vs video analysis as methods

Video analysis gives snapshots of the experimental period. Feed collection can give an indication of a shorter period, and with several collections over a longer period, it can be used to give a tendency over time. As with feed collection, it is possible to put the results from the snapshots together to get a tendency over time, but this will result in a massive amount of data material, even if the video clips are gathered for a couple of days. Without the use of AI and a powerful computer, this is not possible to conduct.

Chapter 5

Conclusion and Further work

5.1 Conclusion

This study aimed to determine whether LH negatively affected the palatability for Atlantic salmon smolt. This was studied by analysing feeding behaviour by retrospective video analysis and collecting excess feed to estimate the amount of feed eaten per biomass. The LH feed was tested against a control feed (CTRL) and a positive control feed (KH).

Statistical analysis of the feed collection showed no significant difference in the palatability of the three diets. The statistical analysis of the feeding behaviour did not either, except for one analysis showing that the fish fed LH feed did significantly better than the two other diets. The SGR and TGC were sufficient for all tanks and all types of feed, and there were no significant differences between the start biomass or growth in the tanks that could affect the appetite. Together with the results from the feed collection, this implies that the fish were overfed throughout the day. The lack of statistical difference in the analysis of the feed collection can, therefore, not be explained by low feed availability. The lack of significant difference between the control feed (CTRL) and the positive control feed (KH) was not expected. It is possible that the coating method used in this experiment or the percentage of included protein hydrolysate was insufficient to differentiate the feed types. However, this can not explain the one analysis that showed that the LH feed did significantly better than the two control diets. For the video analyses of the feeding behaviour, it is possible that the fish were not sufficiently overfed because the appetite was higher early in the feeding period than later. This might explain the lack of statistical differences in most of the analyses of the videos, but this can not explain the one analysis that showed that the LH feed did significantly better than the two control diets. No negative effect of LH on palatability in Atlantic salmon was found in this study, but further studies might be necessary.

5.2 Further work

This experiment resulted in a large data set, as well as several hours of video material. Some of the data from the analysed videos were not used in this thesis. All data from the analysed video clips can be found in appendix J. Some of the material was not used in order to limit this masters thesis. It is possible to do more statistical analysis on this data material. With the limitations of the data material in this thesis, it is possible that a type of statistical analysis other than the one-way ANOVA would have been better to detect whether or not there are statistical differences between the different types of feed.

There is also more video material from some of the days before and after the period that was analysed in this thesis. This could be compared or used together with the video analysis in this thesis. This video analysis was quantitative. It is also possible to use the video material to conduct qualitative behavioural analysis.

Software that could automate the quantitative video analysis would make the video analysis less time-consuming and give a more extensive data set for statistical analysis. Such software could also standardise the process better and reduce human error in manual video analysis. The use of several cameras in each tank could improve the video analysis by minimising the challenges with blind spots and fish obscuring the view by occupying the position in front of the camera, but this would only be possible with the help of a data program and a system to identify the individuals. Some kind of marking to identify each individual could also reduce the problem of losing track of fish swimming in and out of the camera view. At the same time, it must be noted that some of the physical identification marking methods might add more stress to the fish. Software that can distinguish and identify individuals could be a less invasive method of identification.

The results from the feed collection in this thesis were originally only supposed to be used to ensure that the fish were overfed during the experiment. Therefore, the data material from the feed collection in this thesis has some weaknesses that could have been avoided by implementing some measures. Feed collection as a method of evaluating the palatability of diets has several advantages. They can be used for shorter and longer experimental periods and give feedback in real time. This makes it possible to detect if the appetite decreases or increases and take measures to ensure the fish is overfed. How time-consuming a feed collection study is depends on the experimental period and how many feed collections are conducted each day. There are several possible sources of error with the feed collection, but the effect can be limited with a good standardised experimental method. One of the disadvantages and possible sources of error is that some of the feed might be rinsed away at the grates or disintegrate in the water, both in the grates and the tank. This could be avoided by more frequent feed collection and a fine mesh grate. It also has to be separated from the faeces properly. This can be time-consuming. How much the collected feed is dried also influences the weight and, therefore, the accuracy of the feed collection studies. It is also essential to know how much feed the fish is fed. To secure this, it is important to weigh all the feed put into the feeders and then again at the end of the experiment. It is also important to know how accurate the feeders are. As long as the method is standardised, these possible sources of error have less impact on the result and make feed collection studies useful to compare diets.

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Appendix A

Fish husbandry

Table A.1: Table showing notes from the daily fish husbandry, with date, tank number, oxygen saturation (both mg/L and %), water temperature, water flow (LPM), feed collection, number of dead fish and other observations such as skin damage and fish behaviour.

Date:15.01.2022			Time. sign: 10.30 MEA				
Tank	**Oxygen**		**Water temp (°C)**	**Water flow (LPM)**	**Feed collection**	**Dead fish**	**Observations. skin damage. fish behavior**
	mg/L	**%**					
10	9.25	95.1	7.5	10	Mye feces	0	Samlet i stim bakvegg. 1 sår snute
11	9.32	95.7	7.5	10	Mye feces	0	Mer urolig svømming. spredning. 2 sår snute
12	9.30	95.4	7.5	10	Mye feces	0	Noe spredning. «lavt» i vannet. 1 sår snute hoven
7	9.26	95.2	7.6	10	Mye feces	0	Noe spredning. «lavt» i vannet
8	9.34	95.9	7.5	13↓10	Mye feces	0	Spredning. «lavt» i vannet. 1 sår snute. 1 mørke felt skjelltap
9	9.24	94.9	7.5	9	Mye feces	0	Noe spredning
16	9.13	94.0	7.6	10	Mye feces	0	Spredning
17	9.02	92.9	7.6	10	Mye feces	0	Spredning. noe urolige
18	9.04	93.2	7.6	10	Mye feces	0	Spredning. 1 sår snute. 1 mørk (blå?) stripe venstre side
Date:16.01.2022			Time. sign: 10.00 MEA				
Tank	**Oxygen**		**Water temp (°C)**	**Water flow (LPM)**	**Feed collection**	**Dead fish**	**Observations. skin damage. fish behavior**
	mg/L	**%**					

Table A.1 continued from previous page

10	9.10	93.3	7.4	10	Mye forspill	0	Gul feces. 1 sår snute
11	9.17	93.9	7.4	10	Mye forspill	0	Gul feces. noen skjellskader
12	9.14	93.5	7.4	10	Mye forspill	0	Gul feces
7	9.03	92.5	7.4	10	Mye forspill	0	Gul feces. mye uro. 1 sår snute
8	9.09	93.1	7.4	9	Mye forspill	0	Gul feces. 1 mørk felt skjelltap
9	9.01	92.2	7.5	9	Mye forspill	0	Gul feces. 1 med mørk flekk ved venstre øye
16	8.97	92.3	7.6	10	Mye forspill	0	Gul feces. 1 sår snute
17	8.92	92.3	7.8	10	Mye forspill	0	Gul feces
18	8.75	91.5	7.7	10	Mye forspill	0	Gul feces. samlet stim bakvegg
Date:17.01.2022			Time. sign: 11.20 IHB				
Tank	**Oxygen**		**Water temp (°C)**	**Water flow (LPM)**	**Feed collection**	**Dead fish**	**Observations. skin damage. fish behavior**
	mg/L	**%**					
10	9.16	93.4	7.3	10	Ok. en del for	0	1 litt skjellskader
11	9.22	94.1	7.3	10	Ok. en del for	0	2 litt sår underkjeve?
12	9.26	94.4	7.2	10	Ok. en del for	0	1 sår snute
7	9.18	93.7	7.3	10	Ok. en del for	0	
8	9.18	93.8	7.3	9↑10	Ok. en del for	0	1 med skjelltap
9	9.12	93.2	7.3	9↑10	Ok. en del for	0	

Table A.1 continued from previous page

Tank	Oxygen mg/L	Oxygen %	Water temp (°C)	Water flow (LPM)	Feed collection	Dead fish	Observations. skin damage. fish behavior
16	9.09	92.7	7.4	10	Ok. en del for	0	Litt goggy .... [MEA1] 1 sår snute
17	9.09	93.0	7.4	10	Ok. en del for	0	1 litt sår snute
18	9.05	92.6	7.3	10	Ok. en del for	0	
Date:18.01.2022			Time. sign: 11.00 IHB				
Tank	**Oxygen mg/L**	**Oxygen %**	**Water temp (°C)**	**Water flow (LPM)**	**Feed collection**	**Dead fish**	**Observations. skin damage. fish behavior**
10	9.19	94.6	7.8	10	Ok	0	
11	9.26	95.6	7.7	10	Ok	0	2 sår underkjeve
12	9.25	95.3	7.7	10	Ok	0	
7	9.20	95.0	7.8	10	Ok	0	
8	9.27	95.7	7.7	12↓10	Ok	0	1 med svart stripe
9	9.25	95.3	7.7	10	Ok	0	1 blodig underkjeve
16	9.09	94.5	7.8	10	Lite for	0	Litt gult
17	9.10	94.0	7.8	10	Ok	0	1 sår underkjeve
18	9.11	93.8	7.9	10	Ok	0	
Date: 19.01.2022			Time. sign: 10.30 MEA				
Tank	**Oxygen mg/L**	**Oxygen %**	**Water temp (°C)**	**Water flow (LPM)**	**Feed collection**	**Dead fish**	**Observations. skin damage. fish behavior**
10	9.02	92.5	7.4	10	Ok	0	1 med skjelltap
11	9.19	94.2	7.5	10	Ok	0	
12	9.15	93.8	7.5	10	Ok	0	

Table A.1 continued from previous page

7	9.14	93.8	7.6	10	Ok	0	
8	9.22	94.8	7.5	12	Ok	0	
9	9.12	93.7	7.6	10	Ok	0	1 blødende sår snute
16	9.12	94.1	7.7	10	Ok	0	1 med skjellskader
17	9.00	93.4	8.0	10	Ok	0	Urolige. 2 skjellskader
18	8.85	92.8	8.5	10	Ok	0	1 med mørk flekk hode
Date: 20.01.2022			Time. sign: 10:40. MEA				
Tank	**Oxygen**		**Water temp (°C)**	**Water flow (LPM)**	**Feed collection**	**Dead fish**	**Observations. skin damage. fish behavior**
	mg/L	**%**					
10	9.40	96.1	7.3	10	Ok	0	
11	9.45	96.4	7.2	10	Ok	0	
12	9.37	95.7	7.3	10	Ok	0	Samlet stim. 1 med s vart stripe rygg
7	9.36	95.7	7.3	10	Ok	0	
8	9.43	96.4	7.3	12	Ok	0	Noe uro
9	9.38	96.1	7.4	10	Ok	0	
16	9.34	95.9	7.5	10	Ok	0	Uro. 1 med sår blødende snute
17	9.25	95.3	7.6	10	Ok	0	Uro
18	9.26	95.4	8.1	10	Ok	0	1 med mørk flekk hode
Date: 21.01.2022			Time. sign: IBH 9:20				
	Oxygen						

Table A.1 continued from previous page

Tank	mg/L	%	Water temp (°C)	Water flow (LPM)	Feed collection	Dead fish	Observations. skin damage. fish behavior
10	9.39	95.2	7.0	10	+ feces. litt for	0	
11	9.50	96.2	7.0	10	-	0	
12	9.49	96.2	7.0	10	-	0	
7	9.46	95.9	7.0	10	-	0	1 litt hoven underkjeve
8	9.53	96.7	7.0	12↓10	-	0	
9	9.45	95.	7.0	10	+ feces. litt for	0	Urolige
16	9.41	95.1	7.0	10	-	0	1 litt sår underkjeve
17	9.41	95.6	7.1	10	-	0	
18	9.44	96.1	7.1	10	+ feces	0	
Date: 22.01.2022			Time. sign: 10:00 MEA				
Tank	**Oxygen**		**Water temp (°C)**	**Water flow (LPM)**	**Feed collection**	**Dead fish**	**Observations. skin damage. fish behavior**
	mg/L	**%**					
10	9.34	95.1	7.2	10	Ok	0	Mye skjell på rista. skjellskader rundt hodet
11	9.49	96.6	7.1	10	Ok	0	Skjellskader
12	9.45	96.2	7.2	10	Ok	0	Samlet stim
7	9.45	96.2	7.2	10	Ok	0	1 sår snute
8	9.49	96 .5	7.2	12	Ok	0	
9	9.46	96.4	7.2	10	Ok	0	
16	9.29	95.0	7.4	10	Ok	0	Skjell på rist

Table A.1 continued from previous page

17	9.21	94.4	7.5	10	Ok	0	1 med mørk flekk hodet
18	9.19	95.5	8.2	10	Ok	0	1 med mørk flekk hodet
Date: 23.01.2022			Time. sign: 11:00 MEA				
Tank	**Oxygen**		**Water temp (°C)**	**Water flow (LPM)**	**Feed collection**	**Dead fish**	**Observations. skin damage. fish behavior**
	mg/L	**%**					
10	9.48	96.0	6.9	10	Ok	0	Skjell på rist
11	9.52	96.3	6.9	10	Ok	0	Skjell på rist
12	9.51	96.3	6.9	10	Ok	0	Skjellskader
7	9.48	96.0	6.9	10	Ok	0	
8	9.54	96.6	6.9	12	Ok	0	
9	9.49	96.1	6.9	10	Ok	0	1 sår snute. 1 mørk flekk hodet
16	9.40	95.4	7.0	10	Ok	0	Skjell på rist. 1 sår snute
17	9.41	95.9	7.2	10	Ok	0	1 sår snute. 1 mørk flekk hode. skjellskader
18	9.29	95.4	7.6	10	Ok	0	1 mørk flekk hodet. skjellskader
Date: 24.01.2022			Time. sign: 12.30 MEA				
Tank	**Oxygen**		**Water temp (°C)**	**Water flow (LPM)**	**Feed collection**	**Dead fish**	**Observations. skin damage. fish behavior**
	mg/L	**%**					

Table A.1 continued from previous page

10	9.51	95.8	6.7	10	Ok	0	Skjell på rist. 1 mørk flekk hode
11	9.56	96.2	6.7	10	Ok	0	Skjellskader
12	9.51	95.9	6.7	10	Ok	0	
7	9.54	95.9	6.7	10	Ok	0	
8	9.54	96.2	6.7	12	Ok	0	Skvetne
9	9.50	96.1	6.7	10	Ok	0	Skjell på rist. 1 sår snute. skjellskader. 1 merke hodet
16	9.44	95.5	6.9	10	Ok	0	Skjellskader
17	9.41	95.5	7.1	10	Ok	0	Skjell på rist. 2 med merke hode. skjellskader
18	9.14	94.3	7.8	10	Ok	0	1 sår snute. 1 merke hode. skjellskader
Date: 25.01.2022			Time. sign: 10:30 MEA				
Tank	**Oxygen**		**Water temp (°C)**	**Water flow (LPM)**	**Feed collection**	**Dead fish**	**Observations. skin damage. fish behavior**
	mg/L	**%**					
10	9.62	96.5	6.5	10	39	0	Skjell på rist. 1 med merke hode. skjellskader
11	9.71	97.3	6.5	10	40	0	
12	9.66	96.9	6.5	10	64	0	Skjell på rist. 1 sår snute. skjellskader
7	9.64	96.7	6.5	10	42	0	1 sår snute
8	9.69	97.2	6.5	12	52	0	1 sår snute

Table A.1 continued from previous page

9	9.65	97.0	6.5	10	83	0	Skjell på rist
16	9.61	96.7	6.6	10	27	0	1 sår snute
17	9.59	96.8	6.7	10	94	0	1 merke på hodet. skjellskader
18	9.49	96.5	7.1	10	81	0	1 med merke på hodet. 1 rød ved ryggfinne
Date: 26.01.2022			Time. sign: 10:00 MEA				
Tank	**Oxygen**		**Water temp (°C)**	**Water flow (LPM)**	**Feed collection**	**Dead fish**	**Observations. skin damage. fish behavior**
	mg/L	**%**					
10	9.37	95.0	7.0	10	76	0	1 merke hodet. skjellskader
11	9.37	94.8	6.9	10	84	0	
12	9.34	94.5	6.9	10	88	0	1 sår snute
7	9.15	92.6	6.9	10	100	0	Skjell på rist. 1 sår snute. skjellskader
8	9.38	94.8	6.9	12	41	0	Skjellskader
9	9.42	95.0	6.8	10	57	0	1 sår snute. skjellskader
16	9.22	93.4	6.9	10	48	0	1 sår snute
17	9.10	92.3	7.0	10	137	0	Skjellskader
18	9.22	94.2	7.4	10	94	0	2 med merke på hodet
Date: 27.01.2022			Time. sign: MEA 12.00				
	Oxygen						

Table A.1 continued from previous page

Tank	mg/L	%	Water temp (°C)	Water flow (LPM)	Feed collection	Dead fish	Observations. skin damage. fish behavior
10	9.39	96.4	6.6	10	Ok	0	Skjellskader. 1 med merke på hodet
11	9.42	94.7	6.6	10	Ok	0	Skjellskader
12	9.40	94.6	6.6	10	Ok	0	1 sår snute
7	9.39	94.5	6.6	10	Ok	0	1 sår snute
8	9.40	94.6	6.6	12	Ok	0	Skjellskader
9	9.36	94.3	6.7	10	Ok	0	Skjellskader
16	9.25	93.5	6.8	10	Ok	0	1 sår snute
17	9.21	93.6	7.1	10	Ok	0	1 sår snute. 1 merke hode. skjellskader
18	9.01	92.7	7.7	10	Ok	0	1 merke på hodet
Date: 28.01.2022			Time. sign: MEA 10.00				
Tank	Oxygen		Water temp (°C)	Water flow (LPM)	Feed collection	Dead fish	Observations. skin damage. fish behavior
	mg/L	%					
10	9.55	95.8	6.5	10	59	0	Skjell på rist. skjellskader. 1 merke hode
11	9.58	96.3	6.5	10	99	0	
12	9.55	95.8	6.5	10	65	0	1 sår snute
7	9.55	96.1	6.7	10	140	0	2 sår snute. skjellskader
8	9.54	96.3	6.7	12↓10	41	0	1 sår snute

Table A.1 continued from previous page

9	9.28	93.3	6.6	10	80	0	Skjell på rist. 1 sår snute. skjellskader
16	9.40	95.0	6.8	10	53	0	2 sår snute
17	9.16	92.5	6.8	10	196	0	Skjell på rist. 1 sår snute. 1 merke på hodet. skjellskader
18	9.28	94.2	7.0	10	69	0	1 merke på hodet
Date: 29.01.2022			Time. sign: MEA 10.00				
Tank	**Oxygen**		**Water temp (°C)**	**Water flow (LPM)**	**Feed collection**	**Dead fish**	**Observations. skin damage. fish behavior**
	mg/L	**%**					
10	9.42	93.9	6.3	10	88	0	Skjellskader
11	9.47	94.4	6.2	10	81	0	1 sår snute
12	9.45	94.2	6.2	10	71	0	
7	9.42	93.9	6.3	10	57	0	1 sår snute
8	9.48	94.5	6.2	13↓10	40	0	1 sår snute
9	9.49	94.7	6.3	10	111	0	Skjellskader
16	9.46	94.4	6.3	10	72	0	1 deformert gjellelokk. 1 sår snute. skjellskader
17	9.40	94.0	6.4	10	112	0	2 sår snute. 2 merke hodet. skjellskader
18	9.30	94.1	6.9	10	69	0	1 sår snute. 1 merke hodet

Table A.1 continued from previous page

Tank	Oxygen		Water temp (°C)	Water flow (LPM)	Feed collection	Dead fish	Observations. skin damage. fish behavior
	mg/L	%					
Date: 30.01.2022			Time. sign: 17.00 SNA				
10	9.76	97.1	6.0	10	Ok	0	Skjellskader
11	9.89	97.8	5.9	11	Ok	0	1 sår snute
12	9.84	97.4	6.0	10	Ok	0	
7	9.86	97.5	6.2	10	Ok	0	1 sår snute
8	9.73	96.4	6.1	9	Ok	0	1 sår snute
9	9.89	97.9	5.9	11	Ok	0	Skjellskader
16	9.71	97.0	6.0	10	Ok	0	1 deformert gjellelokk. 1 sår snute. skjellskader
17	9.63	95.2	6.0	10	Ok	0	2 sår snute. 2 merke hodet. skjellskader
18	9.83	97.3	6.0	11	Ok	0	1 sår snute. 1 merke hodet
Date: 31.01.2022			Time. sign: MFN 15.30				
Tank	**Oxygen mg/L**	**%**	**Water temp (°C)**	**Water flow (LPM)**	**Feed collection**	**Dead fish**	**Observations. skin damage. f ish behavior**
10	9.50	94.6	6.2	10	Ok	0	Snuteskader
11	9.61	95.7	6.2	10	Ok	0	Snuteskader
12	9.61	95.6	6.2	10	Ok	0	Snuteskader
7	9.56	95.2	6.2	10	Ok	0	Snuteskader

Table A.1 continued from previous page

8	9.42	94.0	6.2	10	Ok	0	Snuteskader
9	9.65	96.0	6.2	10	Ok	0	Snuteskader
16	9.53	94.9	6.2	10	Ok	0	Snuteskader
17	9.62	95.7	6.2	10	Ok	0	Snuteskader
18	9.62	96.1	6.2	10	Ok	0	Snuteskader
Date: 01.02.2022			Time. sign: MFN 9.30				
Tank	**Oxygen**		**Water temp (°C)**	**Water flow (LPM)**	**Feed collection**	**Dead fish**	**Observations. skin damage. fish behavior**
	mg/L	**%**					
10	9.54	95.0	6.2	10	Ok	0	
11	9.56	95.1	6.1	10	Ok	0	
12	9.61	95.8	6.2	10	Ok	0	
7	9.53	94.9	6.2	10	Ok	0	
8	9.56	95.2	6.2	10	Ok	0	
9	9.61	95.3	6.2	10	Ok	0	
16	9.51	94.8	6.3	10	Ok	0	
17	9.5	94.6	6.3	10	Ok	0	
18	9.4	94.0	6.3	10	Ok	0	
Date: 02.02.2022			Time. sign: 11:30 MEA				
Tank	**Oxygen**		**Water temp (°C)**	**Water flow (LPM)**	**Feed collection**	**Dead fish**	**Observations. skin damage. fish behavior**
	mg/L	**%**					

Table A.1 continued from previous page

10	9.14	94.4	7.0	10	Ok	0	Skjellskader
11	9.27	94.1	7.0	10	Ok	0	Løftet lokk pga ledning i klem. 1 snuteskade. skjellskader
12	9.44	95.3	6.8	10	Ok	0	1 snuteskade. skjellskader
7	9.47	95.5	6.7	10	Ok	0	
8	9.62	96.7	6.6	14	Ok	0	1 sår snute
9	9.50	95.8	6.7	10	Ok	0	Skjellskader
16	9.43	95.1	6.7	10	Ok	0	Skjellskader
17	9.47	95.4	6.7	10	Ok	0	Skjellskader. 1 sår snute
18	9.46	95.1	6.6	10	Ok	0	skjellskader
Date: 03.02.2022			Time. sign: MEA 10.45				
Tank	**Oxygen**		**Water temp (°C)**	**Water flow (LPM)**	**Feed collection**	**Dead fish**	**Observations. skin damage. fish behavior**
	mg/L	**%**					
10	9.65	96.3	6.3	10	Ok	0	
11	9.64	96.2	6.3	10	Ok	0	
12	9.63	96.3	6.3	10	Ok	0	1 sår snute
7	9.66	96.5	6.3	10	Ok	0	
8	9.69	96.8	6.3	14	Ok	0	2 sår snute
9	9.58	95.8	6.4	10	Ok	0	Skjellskader
16	9.58	95.9	6.4	10	Ok	0	Skjellskader

Table A.1 continued from previous page

17	9.52	95.7	6.8	10	Ok	0	1 sår snute. skjellskader
18	9.28	94.3	7.1	10	Ok	0	Skjellskader
Date: 04.02.2022			Time. sign: MEA 13.00				
Tank	**Oxygen**		**Water temp (°C)**	**Water flow (LPM)**	**Feed collection**	**Dead fish**	**Observations. skin damage. fish behavior**
	mg/L	**%**					
10	9.44	95.1	6.7	10	Ok	0	2 snuteskader. skjellskader
11	9.47	95.2	6.6	10	Ok	0	2 snuteskader
12	9.45	95.2	6.7	10	Ok	0	2 snuteskader
7	9.40	94.7	6.7	10	Ok	0	2 snuteskader
8	9.44	95.1	6.7	14↓10	Ok	0	1 snuteskade
9	9.40	94.7	6.7	10	Ok	0	Skjellskader
16	9.26	93.4	6.8	10	Ok	0	2 snuteskader
17	9.21	93.3	6.9	10	Ok	0	1 snuteskade. skjellskader
18	9.03	92.5	7.5	10	Ok	0	Skjellskader
Date: 05.02.2022			Time. sign: 10.30 MEA				
Tank	**Oxygen**		**Water temp (°C)**	**Water flow (LPM)**	**Feed collection**	**Dead fish**	**Observations. skin damage. fish behavior**
	mg/L	**%**					
10	9.42	94.6	6.6	11	Ok	0	Gul feces. skjellskader
11	9.48	95.1	6.5	11	Ok	0	Gul fecs. skvetne. 1 snuteskade
12	9.45	94.9	6.6	11	Ok	0	Gul feces. skjellskader. ligger igjen fôr i karet

Table A.1 continued from previous page

7	9.46	95.1	6.6	10	Ok	0	1 snuteskade. skjellskader
8	9.48	95.2	6.6	13	Ok	0	Gul feces. 1 snuteskade
9	9.47	94.9	6.5	11	Ok	0	Gul feces. skjellskader
16	9.33	93.9	6.6	10	Ok	0	Gul feces. 1 snuteskade. ligger fôr i kar
17	9.31	93.7	6.7	10	Ok	0	Skjellskader
18	9.10	92.6	7.2	10	Ok	0	
Date: 06.02.2022			Time. sign: 10.30 MEA				
Tank	**Oxygen**		**Water temp (°C)**	**Water flow (LPM)**	**Feed collection**	**Dead fish**	**Observations. skin damage. fish behavior**
	mg/L	**%**					
10	9.22	92.9	6.8	11	Ok	0	1 sår snute. skjellskader
11	9.13	92.5	6.9	11	Ok	0	Mye skjell på rist. skjellskader
12	9.19	93.2	7.0	11	Ok	0	Skjellskader
7	9.23	93.4	6.9	11	Ok	0	1 sår snute
8	9.28	93.8	6.9	14	Ok	0	2 sår snute
9	9.28	93.7	6.8	11	Ok	0	Skjellskader
16	9.18	92.7	6.8	10	Ok	0	1 sår snute. skjellskader. deformert gjellelokk
17	9.12	92.1	6.8	10	Ok	0	Skjellskader
18	9.10	91.8	6.8	10	Ok	0	
Date: 07.02.2022			Time. sign: IHB 11.00				

Table A.1 continued from previous page

Tank	Oxygen mg/L	Oxygen %	Water temp (°C)	Water flow (LPM)	Feed collection	Dead fish	Observations. skin damage. fish behavior
10	9.68	96.1	6.1	11↓10	Ok	0	1 sår snute. skjellskader (Likt som dagen før på alt)
11	9.73	96.0	6.0	11↓10	Ok	0	Mye skjell på rist. skjellskader
12	9.68	95.9	6.0	11↓10	Ok	0	Skjellskader
7	9.64	95.6	6.0	10	Ok	0	1 sår snute
8	9.71	96.2	6.0	13↓10	Ok	0	2 sår snute
9	9.73	96.3	6.0	11↓10	Ok	0	Skjellskader
16	9.51	94.3	6.0	10	Ok	0	1 sår snute. skjellskader. deformert gjellelokk
17	9.51	94.2	6.0	10	Ok	0	Skjellskader
18	9.48	93.9	6.0	10↑12	Ok	0	
Date: 08.02.2022			Time. sign: IHB 16.30				
Tank	**Oxygen mg/L**	**Oxygen %**	**Water temp (°C)**	**Water flow (LPM)**	**Feed collection**	**Dead fish**	**Observations. skin damage. fish behavior**
10	9.42	94.6	6.6	10	Ok	0	1 litt sår underkjeve
11	9.45	94.9	6.6	10	Ok	0	
12	9.93	94.7	6.5	10	Ok	0	1 sår rød underkjeve. 2 litt sår underkjeve
7	9.37	94.1	6.6	11↓10	Ok	0	1 litt sår underkjeve

Table A.1 continued from previous page

8	9.28	93.1	6.6	9↑10	Ok	0	2 litt sår underkjeve
9	9.47	95.1	6.5	10.5↓10	Ok	0	Skjellskader
16	9.24	92.7	6.5	10	Ok	0	1 sår rød underkjeve. 1 deformert gjellelokk
17	9.25	92.8	6.5	10	Ok	0	3 skjellskader. 2 litt sår underkjeve. 1 rød underkjeve
18	9.30	93.4	6.5	12	Ok	0	2 litt sår underkjeve
Date: 09.02.2022			Time. sign: MEA 10.30. MYE FÔR I KAR 30 MIN ETTER ENDT FÔRING				
Tank	**Oxygen**		**Water temp (°C)**	**Water flow (LPM)**	**Feed collection**	**Dead fish**	**Observations. skin damage. fish behavior**
	mg/L	**%**					
10	9.51	95.3	6.5	10	Ok	0	1 sår snute. mye fôr i kar (både på rista i karet og i hjørnet ved vanninntak)
11	9.52	95.3	6.5	10	Ok	0	Skjellskader
12	9.51	95.3	6.5	10	Ok	0	Skjellskader. 2 sår snute
7	9.50	95.2	6.5	10	Ok	0	2 sår snute. ligger fôr i karet
8	9.53	95.4	6.5	12	Ok	0	2 sår snute
9	9.52	95.4	6.5	10	Ok	0	Skjellskader. ligger fôr i karet
16	9.37	94.1	6.5	10	Ok	0	2 sår snute. skjellskader. fôr i karet

Table A.1 continued from previous page

17	9.33	93.9	6.7	10	Ok	0	1 ligger og trykker på bunnen (obs. på kamera). skjellskader. 1 sår snute
18	9.20	93.9	7.3	12	Ok	0	Skjellskader. mye fôr i kar (både på rista i karet og i hjørnet ved vanninntak)
Date: 10.02.2022			Time. sign: MEA. 10:30. FECES HAR BEGYNT Å ENDRE FARGE SELV OM DET FORTSATT ER LITE				
Tank	**Oxygen**		**Water temp (°C)**	**Water flow (LPM)**	**Feed collection**	**Dead fish**	**Observations. skin damage. fish behavior**
	mg/L	**%**					
10	9.48	95.2	6.6	10	lite feces	0	2 sår snute
11	9.61	96.6	6.6	10	lite feces	0	skjellskader
12	9.51	95.5	6.6	10	lite feces	0	2 sår snute. fôr i kar (på rista i karet)
7	9.52	95.7	6.6	10	lite feces	0	3 sår snute. fôr i kar (på rista i karet)
8	9.53	95.7	6.6	12	lite feces	0	3 sår snute
9	9.41	94.6	6.6	10	lite feces	0	1 sår snute. skjellskader
16	9.46	95	6.6	10	lite feces	0	1 deformert gjellelokk. 1 sår snute. mye fôr i kar (både på rista i karet og i hjørnet ved vanninntak)
17	9.43	94.7	6.6	10	lite feces	0	skjellskader. 1 sår snute. fôr i kar (på rista i karet)

Table A.1 continued from previous page

18	9.44	94.9	6.6	12	lite feces	0	1 sår snute. skjellskader. fôr i kar (på rista i karet)
Date: 11.02.2022			Time. sign: IHB. 11:20. NESTEN KUN NY FECES. LITE FECES I FORSPILL MORGEN				
Tank	**Oxygen**		**Water temp (°C)**	**Water flow (LPM)**	**Feed collection**	**Dead fish**	**Observations. skin damage. fish behavior**
	mg/L	**%**					
10	9.46	95.9	7	10	10:45	0	Oksygenator i kar løsnet. åpnet og feset
11	9.53	96.6	7	10	-	0	1 litt snuteskade
12	9.5	96.3	7	10	-	0	litt for i hjørne. 1-2 litt snuteskade
7	9.43	95.9	7	10	-	0	2 litt sår snute
8	9.47	96.1	7	10	-	0	1 litt sår snute
9	9.55	96.7	7	12↓11	-	0	ett par skjellskader. 1 litt sår snute
16	9.26	94.2	7.1	10	-	0	1 såt rød snute. forspill i hjørne
17	9.14	92.8	7.1	10	-	0	1 sår rød underkjeve
18	9.28	94.4	7.1	12	-	0	skittent kar. vasket etter morgenforing 11:30. masse forspill
Date: 12.02.2022			Time. sign: IHB 18:10 *Ikke tømt rister. fylt fôr				
Tank	**Oxygen**		**Water temp (°C)**	**Water flow (LPM)**	**Feed collection**	**Dead fish**	**Observations. skin damage. fish behavior**
	mg/L	**%**					

Table A.1 continued from previous page

10	9.48	95.6	6.8	10	18.00	0	skjellskader. fôr i rist
11	9.42	95	6.7	10	-	0	1 sår snute (underkjeve)
12	9.43	95	6.7	10	-	0	for i hjørne
7	9.4	94.9	6.7	10	-	0	2 sår snute. for i rist
8	9.31	93.8	6.8	10	-	0	sår underkjeve. for i rist
9	9.45	95.4	6.7	10	-	0	
16	9.22	93.2	6.8	10	-	0	sår underkjeve. for i kar ->flushet kar
17		93.1	6.8	10	-	0	1 sår underkjeve. skjellskader
18		94.2	6.8	12	-	0	skittent i kar. pellets på rist
Date: 13.02.2022			Time. sign: IHB 10.30 *foroppsamling kun morgen				
Tank	**Oxygen**		**Water temp (°C)**	**Water flow (LPM)**	**Feed collection**	**Dead fish**	**Observations. skin damage. fish behavior**
	mg/L	**%**					
10	9.35	95	7	10	Ok. morgen	0	
11	9.3	94.3	6.9	10	-	0	1 sår underkjeve
12	9.34	94.5	6.9	10	-	0	for i hjørne. 2 sår underkjeve (blemme)
7	9.37	94.8	7	10	-	0	1 sår snute. for i hjørne
8	9.28	94.4	7	10	-	0	1 litt sår snute
9	9.4	95.2	7	10	-	0	skjellskader

Table A.1 continued from previous page

Tank	Oxygen mg/L	Oxygen %	Water temp (°C)	Water flow (LPM)	Feed collection	Dead fish	Observations. skin damage. fish behavior
16	9.14	93.4	7.1	10↑11	-	0	skittent i kar. i snuteskade
17	9.21	93.2	7.1	10	-	0	skjellskader
18	9.03	91.9	7.2	12	-	0	litt for i kar
Date: 14.02.2022			Time. sign: IHB 10:45				
Tank	**Oxygen mg/L**	**Oxygen %**	**Water temp (°C)**	**Water flow (LPM)**	**Feed collection**	**Dead fish**	**Observations. skin damage. fish behavior**
10	9.35	95	7	10	Ok. skjell på rist	0	litt for i rist
11	9.42	95.5	7	10	-	0	for i rist. 2 litt sår underkjeve
12	9.38	95.1	7	10	-	0	forspill i hjørnet. 1 sår underkjeve (blemme)
7	9.42	95.5	7	10	-	0	2 litt sår underkjeve. for i hull i rist
8	9.29	94.2	7	10	-	0	1 litt sår underkjeve. for i 2 hull i rist
9	9.48	95.7	7	10	-	0	1 litt sår underkjeve
16	9.32	95.2	7	11	-	0	1 snute. for i kar
17	9.26	93.9	7	10	-	0	skjellskader. 1-2 snuteskader. litt skittent i kar. en del for
18	9.32	94	7	12	-	0	skittent. for i kar
Date: 15.02.2022			Time. sign: 11:15. ASB				
	Oxygen						

Table A.1 continued from previous page

Tank	**mg/L**	**%**	**Water temp (°C)**	**Water flow (LPM)**	**Feed collection**	**Dead fish**	**Observations. skin damage. fish behavior**
10	9.34	94.7	7	10		0	1-2 med litt sår underkjeve
11	9.37	95.1	7	10		0	2 med litt sår underkjeve
12	9.35	94.6	7	10		0	1-2 mer litt sår underkjeve
7	9.35	94.9	7	10		0	2 med litt sår underkjeve
8	9.23	93.6	7	10		0	
9	9.37	95	7	10		0	1 med litt sår underkjeve. 1 med litt risttap
16	9.23	93.7	7	11		0	for i karet. 3 med sår underkjeve
17	9.18	93.3	7	10		0	for i karet. Skjelltap. 2 med sår underkjeve
18	9.24	93.4	7	12		0	
Date: 16.02.2022			Time. sign: IHB. 10:30 *flushet alle kar etter morgenoppsamling				
Tank	**Oxygen**		**Water temp (°C)**	**Water flow (LPM)**	**Feed collection**	**Dead fish**	**Observations. skin damage. fish behavior**
	mg/L	**%**					
10	9.29	94	6.9	10	M en del. E lite	0	skittent. for i hjørne. 1 litt sår underkjeve
11	9.22	93	6.8	10	M lite. E 0	0	litt skittent. 2 litt sår underkjeve
12	9.25	93.3	6.8	10	M lite. 40	0	for i hjørne. 1-2 litt sår underkjeve

Table A.1 continued from previous page

7	9.28	93.7	6.8	10	M lite. E 0	0	2 litt sår underkjeve. litt skittent
8	9.16	92.5	6.8	10	M lite. E 0	0	2 sår underkjeve. skittent
9	9.34	94.1	6.8	10	M lite. E <10	0	1 sår underkjeve. skittent
16	9.19	93	6.8	11	M en del. E litt	0	2 sår underkjeve med blemme. skittent. deformert gjellelokk
17	9.08	91.7	6.8	10	M en del. E <10	0	2 sår underkjeve. skittent
18	9.18	92.4	6.8	12	M lite. E <10	0	skittent i kar
Date: 17.02.2022			Time. sign: IHB				
Tank	**Oxygen**		**Water temp (°C)**	**Water flow (LPM)**	**Feed collection**	**Dead fish**	**Observations. skin damage. fish behavior**
	mg/L	**%**					
10	9.31	93.9	6	10	M: en del. E: lite	0	skittent
11	9.34	93.9	6.7	10	M: en del. E: lite	0	2 sår underkjeve. skittent
12	9.28	93.6	6.7	10	M: en del. E: lite	0	for i hjørne. skittent
7	9.22	93.1	6.8	10	M: lite. E lite	0	2-3 litt sår underkjeve. skittent
8	9.12	92	6.8	10	M: lite. E lite	0	for i kar
9	9.31	93.9	6.7	10	M: lite. E lite	0	skittent
16	9.17	92.7	6.9	11	M: en del. E: lite	0	1 blemme underkjeve. 1 sår
17	9.14	92.1	6.8	10	M: en del. E: <10	0	2 sår underkjeve. skittent

Table A.1 continued from previous page

18	9.19	92.6	6.7	12	M: litt. E: litt	0	skittent i kar

Appendix B

Monitoring of health and welfare

Table B.1: Form 1 for routine monitoring of health and welfare

Dato	**Kommentar**
11.jan	Endret foring kl 11 til 100 til 1 og 4, og 120 gram til 2 og 5 - endret foringsregime til 8-9 og 1330-1430
12.jan	
13.jan	Flytte fisk?
14.jan	Fisk flyttet 20g dagsrasjon på alle kar (foringsautomat ikke snudd) - foring starter i morgen - prøvde å telle i akklim kar 2=9, 1=∼31, 4=∼45 - avlivet 17 fisk under flytting (90 fisk til forsøkskar)
15.jan	
16.jan	
17.jan	Bengt tar ut 2 fisk til blodprøvetaking - justert foring på kar 4 og 1 til 65 g (justert til bedre estimat på fiskeantall + størrelse)
18.jan	Skrudd opp til 25 g dagsrasjon forsøk - skrudd opp kar 1 og 2 til 70 og 20 g
19.jan	
20.jan	
21.jan	
22.jan	
23.jan	
24.jan	
25.jan	Oppjustert foring FØR ettermiddagsforing til 30 g for forsøkskar
26.jan	
27.jan	
28.jan	

29.jan	
30.jan	
31.jan	Justert opp foring til 35 g for forsøkskar før ettermiddagsforing
01.feb	Starte med fôroppsamling? - sette dato for bytte fôr
02.feb	Måtte åpne lokket delvis i kar 11 pga kameraledning i klem
03.feb	Rigget opp kamera (ca 11.30) - filmet kamera nedi- skrudd opp foring ettermiddag til 40 g på forsøkskar
04.feb	Rist ikke tømt før morgenforing, foroppsamling tatt først kl 11.30. likevel flere pellets på rist etter foroppsamling, særlig i kar 16, 18 og 12
05.feb	Rist ikke tømt før foringene lørdag
06.feb	Rist ikke tømt før foringene søndag
07.feb	Skrudd opp foring til 45 gr på forsøkskar mellom foringer - tømt rister 08:02
08.feb	**Fôrbytte før ettermiddagsfôring**
09.feb	**Forspill ved risttømming morgen (litt på kar 10,11,8,16,17,18 og under 10 pellets på kar 12,9,7).** **Forspill ved risttømming ettermiddag (litt i kar 18, 16, 7, 11, lite i kar 17, 8, 9, 10 og 12).** **Mye fôr i karene 30 min etter endt fôring**
10.feb	**Kamera i kar 7 har sluttet å fungere fom morgen 10.2. Telling formiddag:** **Feces har begynt å endre farge, selv om det enn så lenge er lite feces på ristene.** **Forspill ved risttømming ettermiddag (litt for 10, 11, 12, 17, 18, 7, 8 veldig lite for 9, mye for 16)**
11.feb	**justert opp foring til 50 g før ettermiddagsforing - ved morgentømming** **(>10 pellets kar 9, en del pellets kar 18,16 - resten litt pellets) .** **vasket i kar 18 og justerte oksygenator i kar 10 under røkting, forventet økt forspill ettermiddag**
12.feb	Foroppsamling for hele dagen 18:00 uten tømte rister
13.feb	Kun foroppsamling morgen

14.feb	Tømte rister 08:10
15.feb	tømt rister 08:04 - skrudd opp foring til 55 g før ettermiddag
16.feb	Oppjustert foring til i morgen 60 g
17.feb	
18.feb	Skrudd av foring etter morgenforing - avslutter forsøk med veiing og måling + kalibrering

Appendix C

Start and end weight

C.0.1 Start weight

Table C.1: Start weight and morphological scoring from 14th January 2022

Fish no	From tank	To tank	Length (cm)	Weight (g)	Scale loss	Snout damage	Fin damage	Opercular damage	Wounds	Comments
1	1	16	27.8	244.4	1	1	1	0	0	
2	1	16	27.0	226.6	1	1	1	0	0	
3	1	16	24.8	168.5	1	1	1	0	0	
4	1	17	27.2	245.0	1	2	1	0	0	
5	1	17	28.5	276.2	2	2	2	0	0	
6	1	17	25.5	207.7	2	1	1	0	0	
7	1	18	28.5	277.7	2	2	1	0	0	
8	1	18	27.5	247.0	2	1	1	0	0	
9	1	18	27.0	240.0	2	1	1	0	0	
10	5	7	28.2	269.3	2	2	1	0	0	
11	5	7	28.1	276.4	2	1	1	0	0	
12	5	7	26.8	221.6	1	0	1	0	0	
13	5	8	26.3	217.3	2	1	1	0	0	
14	5	8	25.7	201.0	2	2	1	0	0	
15	5	8	27.8	264.0	2	1	1	0	0	
16	5	9	26.4	231.0	2	2	1	0	0	
17	5	9	27.7	259.9	2	1	1	0	0	
18	5	9	26.0	218.9	2	0	1	0	0	
19	5	10	25.4	204.6	2	2	1	0	0	

Table C.1 : Start weight and morphological scoring from 14th January 2022

Fish no	From tank	To tank	Length (cm)	Weight (g)	Scale loss	Snout damage	Fin damage	Opercular damage	Wounds	Comments
20	5	10	28.0	270.6	2	0	1	0	0	
21	5	10	27.5	256.0	2	1	1	0	0	
22	5	11	26.5	253.5	2	2	1	0	0	
23	5	11	26.5	220.5	2	2	1	0	0	
24	5	11	27.6	253.2	2	1	1	0	0	
25	5	12	27.3	248.5	2	2	1	0	0	
26	5	12	25.5	200.9	2	1	1	0	0	
27	5	12	26.3	210.6	2	2	1	0	0	
28	5	16	26.2	227.5	2	2	1	0	0	
29	5	16	27.9	271.7	2	2	1	0	0	
30	5	16	27.2	235.7	2	1	1	0	0	
31	5	16	25.7	203.7	2	1	1	0	0	
32	5	17	26.2	222.8	2	1	1	0	0	
33	5	17	26.2	211.4	2	2	1	0	0	
34	5	17	27.6	276.3	2	1	1	0	0	
35	5	17	27.1	245.2	2	1	1	0	0	
36	5	18	27.3	264.6	2	1	1	0	0	
37	5	18	26.6	212.1	2	1	1	0	0	
38	5	18	25.9	207.0	2	1	1	0	0	

Table C.1 : Start weight and morphological scoring from 14th January 2022

Fish no	From tank	To tank	Length (cm)	Weight (g)	Scale loss	Snout damage	Fin damage	Opercular damage	Wounds	Comments
39	5	18	26.5	219.8	2	1	1	0	0	
40	4	7	25.9	209.1	2	1	1	0	0	
41	4	7	25.7	204.6	2	1	1	0	0	
42	4	7	26.1	230.9	2	2	1	0	0	
43	4	7	27.5	253.0	2	2	2	0	0	
44	4	8	27.0	236.5	2	1	1	0	0	
45	4	8	28.2	268.5	2	1	1	0	0	
46	4	8	26.7	223.9	2	2	1	0	0	
47	4	8	27.6	260.3	2	2	1	0	0	
48	4	9	25.9	219.9	2	1	1	0	0	
49	4	9	26.8	246.8	2	2	2	0	0	Dorsal fin
50	4	9	27.7	264.3	2	1	2	0	0	Dorsal fin
51	4	9	27.2	246.0	2	2	1	0	0	
52	4	10	26.8	233.7	2	2	1	0	0	
53	4	10	25.0	204.4	2	2	1	0	0	
54	4	10	28.7	281.2	2	1	1	0	0	
55	4	10	27.9	245.5	2	1	2	0	0	Pectoral fin deformed
56	4	11	26.8	211.5	2	2	1	0	0	
57	4	11	27.3	242.1	2	1	1	0	0	

Table C.1 : Start weight and morphological scoring from 14th January 2022

Fish no	From tank	To tank	Length (cm)	Weight (g)	Scale loss	Snout damage	Fin damage	Opercular damage	Wounds	Comments
58	4	11	25.2	209.2	2	2	1	0	0	
59	4	11	27.0	222.3	2	1	1	0	0	
60	2	12	27.0	220.1	2	1	1	0	0	
61	2	12	26.2	225.1	2	1	1	0	0	
62	2	12	27.2	229.4	2	1	1	0	0	
63	2	12	26.8	207.5	2	1	1	0	0	
64	2	16	27.7	257.9	2	1	1	0	0	
65	2	16	27.8	254.7	2	1	1	0	0	
66	2	16	26.1	205.0	2	1	1	0	0	
67	2	17	26.3	226.6	2	1	1	0	0	
68	2	17	27.6	218.7	2	1	1	0	0	
69	2	17	26.2	204.9	2	1	1	0	0	Mark on head
70	2	18	27.4	238.2	2	1	1	0	0	
71	2	18	26.5	202.0	2	1	1	0	0	
72	2	18	26.9	236.8	2	1	1	0	0	
73	2	7	27.2	248.8	2	1	1	0	0	Split caudal fin to peduncle
74	2	7	25.5	210.9	2	1	1	0	0	
75	2	7	26.7	223.2	2	1	1	0	0	
76	2	8	26.2	220.7	2	1	1	0	0	

Table C.1 : Start weight and morphological scoring from 14th January 2022

Fish no	From tank	To tank	Length (cm)	Weight (g)	Scale loss	Snout damage	Fin damage	Opercular damage	Wounds	Comments
77	2	8	28.3	263.8	2	1	1	0	0	Slightly split caudal fin
78	2	8	26.5	218.0	2	1	1	0	0	
79	2	9	27.4	231.5	2	1	1	0	0	
80	2	9	27.2	228.8	2	1	1	0	0	
81	2	9	26.2	218.7	2	1	2	0	0	Short pectoral fin
82	2	10	27.5	238.2	2	1	1	0	0	
83	2	10	27.5	240.4	2	2	1	0	0	
84	2	10	27.4	258.8	2	1	1	0	0	
85	2	11	28.4	255.8	2	1	1	1	0	Small fold operculum. deformity
86	2	11	25.8	200.9	2	1	1	0	0	
87	2	11	26.8	212.3	2	1	1	0	0	
88	2	12	27.7	250.6	2	1	1	0	0	
89	2	12	27.6	222.1	2	2	1	0	0	
90	2	12	27.7	239.0	2	1	1	0	0	

C.0.2 End weight

Table C.2: End weight and morphological scoring from 18th February 2022

Fish no	Tank	Lenght (cm)	Weight (g)	Scale loss	Snout damage	Fin damage	Opercular damage	Wounds	Comments
1	7	28.3	311.6	2	2	1	0	0	
2	7	29.9	361.2	2	2	1	0	0	
3	7	29	293.6	2	2	1	0	0	
4	7	27.4	281.1	2	1	1	0	0	
5	7	28.9	310.1	2	3	1	0	0	Euthanized due to snout damage
6	7	30.1	350.5	2	1	1	0	0	
7	7	30.3	350.8	2	2	1	0	0	Healed shout damage. but has been serious
8	7	31.5	388.2	2	1	1	0	0	
9	7	29.5	301.9	2	1	1	1	0	
10	7	30.9	359.1	2	3	1	0	0	Euthanized due to snout damage
11	8	29	310.9	2	2	1	1	0	
12	8	31.4	412.2	2	2	1	0	0	Euthanized after experiment. Too big for reuse purpose
13	8	30.8	362	2	3	1	0	0	Euthanized due to snout damage
14	8	30.9	396.7	2	1	1	0	0	”Hunchback”
15	8	28.4	295.1	2	2	1	2	0	Euthanized due to opercular damage. Healed snout injury
16	8	29.5	339.7	2	2	1	0	0	Euthanized due to snout damage
17	8	29.8	329.3	2	2	1	0	0	

Table C.2: End weight and morphological scoring from 18th February 2022

Fish no	Tank	Lenght (cm)	Weight (g)	Scale loss	Snout damage	Fin damage	Opercular damage	Wounds	Comments
18	8	29	313.7	2	1	1	0	0	
19	8	30.4	354.4	2	1	1	0	0	
20	8	30.6	373.4	2	2	1	0	0	
21	9	30.1	345.5	2	1	1	0	0	
22	9	28.2	320.5	3	2	1	0	0	Euthanized do to scale loss
23	9	30.2	379.9	3	2	1	0	0	
24	9	30.3	341.9	3	2	1	0	0	
25	9	29.2	321.7	3	3	1	0	0	Euthanized due to snout damage and scale loss
26	9	29.3	335.9	2	2	1	0	0	Euthanized due to snout damage
27	9	30.1	357.4	2	1	1	1	0	
28	9	28.3	298.6	3	1	1	0	0	
29	9	28.5	298.6	3	1	1	0	0	
30	9	30.3	329.1	3	1	1	0	1	Euthanized due to scale loss with abrasions that bled slightly.
31	10	30.5	327.5	2	2	1	0	0	Healed shout damage, but has been serious
32	10	30.6	334.5	2	1	1	1	0	
33	10	30.7	379	2	1	1	0	0	

Table C.2: End weight and morphological scoring from 18th February 2022

Fish no	Tank	Lenght (cm)	Weight (g)	Scale loss	Snout damage	Fin damage	Opercular damage	Wounds	Comments
34	10	28.3	285.3	2	2	1	0	0	Euthanized due to snout damage
35	10	28.3	280.5	2	3	1	0	0	Euthanized due to snout damage
36	10	29	354.2	2	1	1	0	0	
37	10	29.9	357.1	3	2	1	0	0	Euthanized due to snout damage and scale loss
38	10	28.2	277.2	3	1	1	0	0	
39	10	30.5	345.4	2	1	1	0	0	
40	10	31	374.1	3	2	1	0	0	Euthanized due to snout damage and scale loss
41	11	28.9	303.9	3	1	1	0	0	
42	11	30.7	362.9	2	2	1	0	0	Slightly bleeding on snout, new, possibly in connectrion with handling.
43	11	28.8	284.8	2	2	1	0	0	Euthanized due to snout damage. healed but serious
44	11	29.8	321.2	2	1	1	0	0	
45	11	27.8	302.7	2	2	1	0	0	
46	11	27.9	314.8	3	1	1	0	0	"Hunchback"
47	11	29.4	300.9	3	3	1	0	0	Euthanized do to snout damage and scale loss

Table C.2: End weight and morphological scoring from 18th February 2022

Fish no	Tank	Lenght (cm)	Weight (g)	Scale loss	Snout damage	Fin damage	Opercular damage	Wounds	Comments
48	11	30.5	365.5	3	3	1	2	0	Euthanized due to snout injury, shell loss and opercular damage
49	11	31.4	375.1	2	3	1	0	0	
50	11	29.5	321.3	2	1	1	0	0	
51	12	29	342.2	2	1	1	0	0	
52	12	27.9	270.8	2	1	1	0	0	
53	12	30	340.6	2	3	1	0	0	Euthanized due to snout damage
54	12	30.9	349.5	3	3	1	0	0	Euthanized due to snout damage and scale loss
55	12	30.8	380.8	2	1	1	0	0	
56	12	29.9	345.5	2	2	1	0	0	Euthanized due to snout damage
57	12	30.2	338.3	2	2	1	0	0	
58	12	30.4	351.9	2	1	1	0	0	
59	12	28.9	299.6	2	1	1	0	0	
60	12	28.85	309.8	2	0	1	0	0	
61	16	30.8	367.1	2	1	1	0	0	
62	16	31	411.3	2	1	1	0	0	Relatively good shape
63	16	30.4	364.8	2	1	1	1	0	
64	16	30.3	353.4	1	2	1	0	0	Euthanized due to snout damage

Table C.2: End weight and morphological scoring from 18th February 2022

Fish no	Tank	Lenght (cm)	Weight (g)	Scale loss	Snout damage	Fin damage	Opercular damage	Wounds	Comments
65	16	29.8	324.9	2	1	1	0	0	
66	16	28.4	288.9	2	1	1	0	0	
67	16	29.3	317.7	2	2	1	0	0	Euthanized due to snout damage
68	16	27.4	249.1	2	3	1	0	0	Euthanized due to snout damage
69	16	29.8	331.5	1	2	1	0	0	Euthanized due to snout damage
70	16	29.4	345.1	2	1	1	0	0	
71	17	30.3	311	2	2	1	1	0	
72	17	28.9	326.7	2	1	1	0	0	
73	17	29.4	308.4	2	1	1	0	0	
74	17	27.3	254.5	3	1	1	0	0	
75	17	31.3	381.9	2	2	1	0	0	Split caudal fin
76	17	29.5	338.9	3	1	1	0	0	
77	17	28.5	300.5	2	2	1	0	0	
78	17	28.8	284.9	2	2	1	0	0	
79	17	30.5	397	2	2	1	0	0	
80	17	29.6	330.2	3	2	1	0	0	Euthanized due to snout damage
81	18	29.6	326.3	2	1	1	0	0	
82	18	29.8	318.7	2	1	1	0	0	
83	18	30	335	2	1	1	0	0	

Table C.2: End weight and morphological scoring from 18th February 2022

Fish no	Tank	Lenght (cm)	Weight (g)	Scale loss	Snout damage	Fin damage	Opercular damage	Wounds	Comments
84	18	30	349.4	2	2	1	0	0	Split caudal fin
85	18	29.8	335.6	2	2	1	0	0	
86	18	28.6	288.9	2	2	1	0	0	Euthanized due to snout damage
87	18	29.7	327.7	3	2	1	0	0	Euthanized due to snout damage
88	18	29.4	345.5	2	1	1	0	0	Euthanized due to snout damage
89	18	31.2	376.6	2	3	1	0	0	Euthanized due to snout damage
90	18	29.7	310.7	2	0	1	0	0	

C.0.3 Descriptive statistics weight

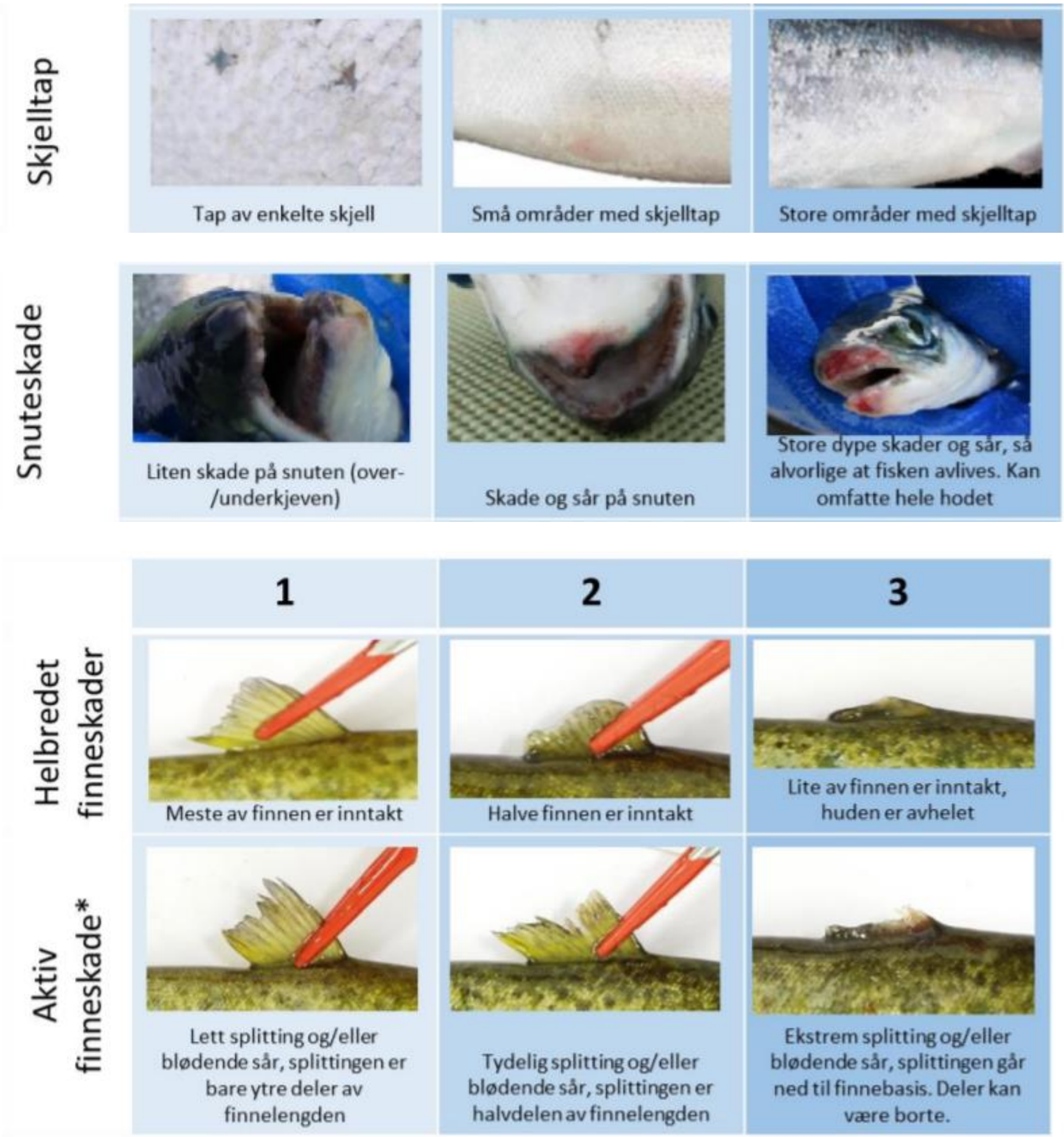
Table C.3: Table showing mean, standard error mean, standard deviation, minimum and maximum, median and the first and third quartile (Q1, Q3) of start weight and end weight.

	Tank	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
Weight (g) start	7	234.78	8.11	25.64	204.6	210.45	227.05	257.07	276.4
	8	237.4	7.79	24.64	201	217.82	230.2	263.85	268.5
	9	236.58	5.31	16.78	218.7	219.65	231.25	250.08	264.3
	10	243.34	7.98	25.22	204.4	226.42	242.95	261.75	281.2
	11	228.13	6.63	20.96	200.9	210.93	221.4	253.27	255.8
	12	225.38	5.32	16.83	200.9	209.82	223.6	241.38	250.6
	16	229.57	9.71	30.7	168.5	204.68	231.6	255.5	271.7
	17	233.48	8.35	26.41	204.9	210.48	224.7	252.95	276.3
	18	234.52	7.82	24.74	202	210.82	237.5	251.4	277.7
Weight (g) end	7	330.8	11.2	35.4	281.1	299.8	331.1	359.6	388.2
	8	348.7	12.1	38.2	295.1	313	347	379.2	412.2
	9	332.91	7.96	25.18	298.6	315.02	332.5	348.48	379.9
	10	331.5	12.1	38.2	277.2	284.1	339.9	361.4	379
	11	325.31	9.92	31.37	284.8	302.25	318	363.55	375.1
	12	332.9	9.87	31.2	270.8	307.25	341.4	350.1	380.8
	16	335.4	14.2	44.8	249.1	310.5	338.3	365.4	411.3
	17	323.4	13.4	42.5	254.5	296.6	318.9	349.6	397
	18	331.44	7.48	23.65	288.9	316.7	331.35	346.48	376.6

Appendix D

Morphological scoring sheet

Tabell 3.2.13-2-del 1. *Morfologisk scoresystem for diagnostikk og klassifisering av viktige eksterne morfologiskeskader. Nivå 0: Liten eller ingen tegn på negativ tilstedeværelsen av denne VI, det vil si normal (ikke vist). Nivå 1-3; VI gradvis blir verre. (Figur: C. Noble, D. Izquierdo-Gomez, L. H. Stien, J. F. Turnbull, K. Gismervik, J. Nilsson. Foto: K. Gismervik, L. H. Stien, J. Nilsson, J. F. Turnbull, P. A. Sæther, I.K. Nerbøvik, I. Simeon, B. Tørud, B. Klakegg)*



	1	2	3
Gjellelokk-skade	 Gjellelokkene dekker bare delvis gjellene	 Gjellelokket på en side er fraværende (gjellene eksponert)	 Begge gjellelokkene er fraværende (gjellene eksponert)
Sår	 Et lite sår, ikke ned til muskel (intakt underhud)	 Flere små sår	 Store, betydelige ofte åpne sår

Appendix E

Protokoll coating og tørking av fôrpellets

Coating

Utstyrsliste:

- Bakemaskin (bolle + eltekrok)
- Aluminiumsformer (1 pr 2-300 g fôr som skal lages)
- Røreskjeer
- Brett til transport av beholdere
- Vekt
- Fôr
- Coating konsentrat
- Destvann
- Beholder til blanding av coating
- Begerglass til utveiing av coating
- Beholder til ferdig tørket fôr
- Tørkeskap

1. Se i skjema «Coating» under «Info Coating» hvilke mengder - sjekk at beregning for total mengde fôr stemmer.
2. Lag et fôr av gangen. Kun et fôr i tørkeskapet av gangen.
3. Forhåndsvei og merk aluminiumsbeger før du starter.
4. Lag coating-blanding: vei ut i samme forhold som beregnet i skjema. Lag gjerne mer coating enn du trenger, men med rett konsentrasjon.
5. Vei ut fôr: vei ut en mengde fôr som får plass i bakebollen. (det kan være du må coate samme fôr i flere omganger gr. Bolle-kapasiteten.
6. Beregn hvor mange gram coating blanding som skal tilsettes for rett inkluderingsrate.
7. Tilsett coatingblandingen gradvis mens fôret omrøres (laveste hastighet). Følg med på dekningsgrad og at det ikke klumper seg.
8. Fordel det coatede fôret i aluminiumsformene. NB! Formene bør ikke være for fulle, gjerne kun dekke bunnen i et lag på 1-2 cm. Prøv å fordele jevnt mellom fôrmene, også slik at eventuell rest-coating som har sunket til bunn også fordeles (dette kan du også justere under startveiing).
9. Startveiing: ta startvekt for alle formene. Eventuelt juster slik at det er ca. lik mengde i alle beger.

Tørking

1. Sett på tørkeskapet for rett temperatur regime - se til at skapet er rent før start

2. Fôret skal tørke på 26 grader (for å unngå harskning) – litt avhengig av mengde kan det ta 2-3 døgn før det er tørt nok.
3. Plasser aluminiumsformene i skapet - rør om ca. hvert kvarter de første 2 timene (eller til du merker at fôret skiller seg godt).
4. Vei formene med jevne mellomrom - om du lar dem stå i tørkeskap over natt, bør de veies morgenen etter. Før inn vekt-tallene for å følge med på tørkingsgraden.
5. Et ferdig fôr skal ha en tørkingsgrad på 97-98
6. Ferdig fôr bør oppbevares i merket lufttett beholder på fôrlageret.

Tips: For å bidra til tørkingen kan det legges et brett med silica-gel i bunnen av tørkeskapet. Dersom du ikke ønsker at fôret skal tørkes over natt, kan du legge hver enkelt aluminiumsform i en zip-lockpose og sette dem på fôrlageret over natten.

Appendix F

Coating

F.0.1 Calculations

Table F.1: Table showing information about the different types of coating and the calculations to get the desired amount and consentration for the different coating solutions.

Component	LH (Nutrimar)	KH (Rimfrost)	Control
Consentration dry matter in consentrate (%)	97 %	55 %	0 %
Type of substance in consentrate	Protein	Protein+salt+fat	None
Water content (%)	3 %	45 %	100 %
Other ingredients		Salt (16%) + protein (39%)	None
Solubility	Very soluble ("100%")	Very soluble ("100%")	Very soluble ("100%")
Desired degree of inclusion	0.02	0.02	0.02
Desired amount of feed (uncoatet. g)	3000	3000	3000
Desired amount coating (dry matter. g)	60	60	0
Required amount raw coating (g)	61.8556701	109.0909091	0
Required total amount of liquid for degree of inclusion (g)	510	510	510
Required amount of destilled water (g)	448.1443299	400.9090909	510
Consentration coating solution (g/L)	0.117647059	0.117647059	0

F.0.2 Information about coating process

Table F.2: Table showing information about the coating process of LH feed.

	Total: Coating solution: LH	Feed (during coating)	Ratio wet coat:feed
Amount of feed uncoated (g)		2501.3	
Amount of coating (g)	61.9	50.13984977	
Amount of destilled water (g)	448.0		
Total amount of coating solution added (g)		425.8	
Total wet weight (g)		2927.1	0.17023148
Number of trays		12	

Table F.3: Table showing information about the coating process of KH feed.

	Total: Coating solution: KH	Feed (during coating)	Ratio wet coat:feed
Amount of feed uncoated (g)		2502.2	
Amount of coating (g)	109.6	50.30807361	
Amount of destilled water (g)	401.2		
Total amount of coating solution added (g)		426.3	
Total wet weight (g)		2928.5	0.170370074
Number of trays		12	

Table F.4: Table showing information about the coating process of batch 1 of the control feed.

	Total: Coating solution: control	Feed (during coating)	Ratio wet coat:feed
Amount of feed uncoated (g)		1256.6	
Amount of coating (g)		0	
Amount of destilled water (g)	510		
Total amount of coating solution added (g)		220.8	
Total wet weight (g)		1477.4	0.175712239
Number of trays		6	

Table F.5: Table showing information about the coating process of batch 2 of the control feed.

	Total: Coating solution: control	Feed (during coating)	Ratio wet coat:feed
Amount of feed uncoated (g)		1250.5	
Amount of coating (g)		0	
Amount of destilled water (g)	510		
Total amount of coating solution added (g)		212.8	
Total wet weight (g)		1463.3	0.170171931
Number of trays		6	

Appendix G

Specifications for feed and coating solutions

G.0.1 Low fat feed from Sparos

Table G.1: Ingredients in the low fat feed from Sparos (pellet size 4mm, slow sinking)

Ingredients (%)	LF (%)
Fishmeal LT70	15.00
Fish protein hydrolysate	2.50
Soy protein concentrate	9.00
Pea protein concentrate	6.00
Wheat gluten	15.00
Wheat meal	36.35
Wheat starch (raw)	2.35
Vit & Min Premix PV01	1.00
Vitamin E50	0.05
Antioxidant	0.20
Sodium propionate	
MAP (Monoammonium phosphate)	1.50
Carophyll Pink 10% - Astaxanthin	0.05
L-Histidine	0.10
L-Lysine HCl 99%	0.60
L-Tryptophan	0.10
DL-Methionine	0.10
Fish oil	7.00
Rapeseed oil	3.10
Total	**100.000**

Table G.2: Nutritions in the low fat feed from Sparos (pellet size 4mm, slow sinking)

As fed basis (8%)	LF
Crude protein. % feed	40.0
Crude fat. % feed	12.5
Fiber. % feed	0.6
Starch. % feed	26.4
Ash. % feed	5.8
Gross energy. MJ/kg feed	20.0
Arg. % feed	2.06
His. % feed	0.89
Ile. % feed	1.42
Leu. % feed	2.71
Lys. % feed	2.37
Thr. % feed	1.29
Trp. % feed	0.44
Val. % feed	1.62
Met. % feed	0.76
Cys. % feed	0.55
Met + Cys. % feed	1.31
Phe. % feed	1.77
Tyr. % feed	1.13
Phe + Tyr. % feed	2.90
Asx. % feed	2.78
Glx. % feed	9.05
Ala. % feed	1.62
Gly. % feed	1.86
Pro. % feed	2.92
Ser. % feed	1.84
Tau. % feed	0.07
Total P. % feed	1.0
Digestible P. %	0.62
EPA+DHA. % feed	2.2

G.0.2 Krill Protein Hydrolysate

OlyPep
Krill protein hydrolysate from antarctic Krill (*Euphausia Superba*)

Marketing and sales:
Olympic Seafood AS, P.O. Box 234, N-6099 Fosnavåg
post@olympic.no

Production:
Produced at sea by M/V JUVEL (M-361-HØ)
Emerald Fisheries AS
P.O. Box 234, N-6099 Fosnavåg

Batch No: 16112

Ingredients:
Krill protein hydrolysate, antioxidants: Rosemary extract (E392), tocopherol-rich extract (E306), emulsifiers and carriers

G.0.3 Salmon Protein Hydrolysate

Nutrimar AS
12.08.21
S-2691

Appendix H

Feeding and feed collection

H.0.1 Calculated amount of feed based on biomass

Table H.1: Table showing biomass and calculated amount of feed after transfer to experimental tanks, based on feeding 1.5% of bio mass + 20% overfeeding.

Tank	Biomass (g)	Amount feed (g) (1.5% biomass + 20% overfeeding)
16	2295.7	41.3
17	2334.8	42.0
18	2345.2	42.2
7	2347.8	42.3
8	2374.0	42.7
9	2365.8	42.6
10	2433.4	43.8
11	2281.3	41.1
12	2253.8	40.6

Table H.2: Table showing estimated growth per tank with SGR 1.5.

	Estimated growth pr tank SGR 1.5								
Date	16	17	18	7	8	9	10	11	12
14.01.2022	2295.7	2334.8	2345.2	2347.8	2374.0	2365.8	2433.4	2281.3	2253.8
15.01.2022	2330.1	2369.8	2380.4	2383.0	2409.6	2401.3	2469.9	2315.5	2287.6
16.01.2022	2365.1	2405.4	2416.1	2418.8	2445.8	2437.3	2506.9	2350.3	2321.9
17.01.2022	2400.6	2441.4	2452.3	2455.0	2482.4	2473.9	2544.6	2385.5	2356.7
18.01.2022	2436.6	2478.1	2489.1	2491.9	2519.7	2511.0	2582.7	2421.3	2392.1
19.01.2022	2473.1	2515.2	2526.4	2529.2	2557.5	2548.6	2621.5	2457.6	2428.0
20.01.2022	2510.2	2553.0	2564.3	2567.2	2595.8	2586.9	2660.8	2494.5	2464.4
21.01.2022	2547.9	2591.3	2602.8	2605.7	2634.8	2625.7	2700.7	2531.9	2501.4
22.01.2022	2586.1	2630.1	2641.9	2644.8	2674.3	2665.1	2741.2	2569.9	2538.9
23.01.2022	2624.9	2669.6	2681.5	2684.5	2714.4	2705.0	2782.3	2608.4	2577.0
24.01.2022	2664.3	2709.6	2721.7	2724.7	2755.1	2745.6	2824.1	2647.5	2615.6
25.01.2022	2704.2	2750.3	2762.5	2765.6	2796.5	2786.8	2866.4	2687.3	2654.9
26.01.2022	2744.8	2791.5	2804.0	2807.1	2838.4	2828.6	2909.4	2727.6	2694.7
27.01.2022	2786.0	2833.4	2846.0	2849.2	2881.0	2871.0	2953.1	2768.5	2735.1
28.01.2022	2827.7	2875.9	2888.7	2891.9	2924.2	2914.1	2997.4	2810.0	2776.1
29.01.2022	2870.2	2919.0	2932.0	2935.3	2968.1	2957.8	3042.3	2852.2	2817.8
30.01.2022	2913.2	2962.8	2976.0	2979.3	3012.6	3002.2	3087.9	2894.9	2860.0
31.01.2022	2956.9	3007.3	3020.7	3024.0	3057.8	3047.2	3134.3	2938.4	2902.9
01.02.2022	3001.3	3052.4	3066.0	3069.4	3103.6	3092.9	3181.3	2982.4	2946.5
02.02.2022	3046.3	3098.2	3112.0	3115.4	3150.2	3139.3	3229.0	3027.2	2990.7
03.02.2022	3092.0	3144.6	3158.6	3162.1	3197.4	3186.4	3277.4	3072.6	3035.5
04.02.2022	3138.4	3191.8	3206.0	3209.6	3245.4	3234.2	3326.6	3118.7	3081.1
05.02.2022	3185.4	3239.7	3254.1	3257.7	3294.1	3282.7	3376.5	3165.4	3127.3
06.02.2022	3233.2	3288.3	3302.9	3306.6	3343.5	3331.9	3427.1	3212.9	3174.2
07.02.2022	3281.7	3337.6	3352.5	3356.2	3393.6	3381.9	3478.6	3261.1	3221.8
08.02.2022	3330.9	3387.7	3402.8	3406.5	3444.5	3432.6	3530.7	3310.0	3270.1
09.02.2022	3380.9	3438.5	3453.8	3457.6	3496.2	3484.1	3583.7	3359.7	3319.2
10.02.2022	3431.6	3490.1	3505.6	3509.5	3548.7	3536.4	3637.4	3410.1	3369.0
11.02.2022	3483.1	3542.4	3558.2	3562.1	3601.9	3589.4	3692.0	3461.2	3419.5
12.02.2022	3535.3	3595.5	3611.6	3615.6	3655.9	3643.3	3747.4	3513.2	3470.8
13.02.2022	3588.4	3649.5	3665.7	3669.8	3710.8	3697.9	3803.6	3565.9	3522.9

14.02.2022	3642.2	3704.2	3720.7	3724.8	3766.4	3753.4	3860.7	3619.3	3575.7
15.02.2022	3696.8	3759.8	3776.5	3780.7	3822.9	3809.7	3918.6	3673.6	3629.3
16.02.2022	3752.3	3816.2	3833.2	3837.4	3880.3	3866.9	3977.3	3728.7	3683.8
17.02.2022	3808.6	3873.4	3890.7	3895.0	3938.5	3924.9	4037.0	3784.7	3739.0
18.02.2022	3865.7	3931.5	3949.0	3953.4	3997.5	3983.7	4097.6	3841.4	3795.1

Table H.3: Table showing amount of feed calculated based on estimated growth per tank with SGR 1.5

	Amount feed (1.5% biomass + 20% overfeeding)								
Date	16	17	18	7	8	9	10	11	12
14.01.2022	41.3	42.0	42.2	42.3	42.7	42.6	43.8	41.1	40.6
15.01.2022	41.9	42.7	42.8	42.9	43.4	43.2	44.5	41.7	41.2
16.01.2022	42.6	43.3	43.5	43.5	44.0	43.9	45.1	42.3	41.8
17.01.2022	43.2	43.9	44.1	44.2	44.7	44.5	45.8	42.9	42.4
18.01.2022	43.9	44.6	44.8	44.9	45.4	45.2	46.5	43.6	43.1
19.01.2022	44.5	45.3	45.5	45.5	46.0	45.9	47.2	44.2	43.7
20.01.2022	45.2	46.0	46.2	46.2	46.7	46.6	47.9	44.9	44.4
21.01.2022	45.9	46.6	46.9	46.9	47.4	47.3	48.6	45.6	45.0
22.01.2022	46.5	47.3	47.6	47.6	48.1	48.0	49.3	46.3	45.7
23.01.2022	47.2	48.1	48.3	48.3	48.9	48.7	50.1	47.0	46.4
24.01.2022	48.0	48.8	49.0	49.0	49.6	49.4	50.8	47.7	47.1
25.01.2022	48.7	49.5	49.7	49.8	50.3	50.2	51.6	48.4	47.8
26.01.2022	49.4	50.2	50.5	50.5	51.1	50.9	52.4	49.1	48.5
27.01.2022	50.1	51.0	51.2	51.3	51.9	51.7	53.2	49.8	49.2
28.01.2022	50.9	51.8	52.0	52.1	52.6	52.5	54.0	50.6	50.0
29.01.2022	51.7	52.5	52.8	52.8	53.4	53.2	54.8	51.3	50.7
30.01.2022	52.4	53.3	53.6	53.6	54.2	54.0	55.6	52.1	51.5
31.01.2022	53.2	54.1	54.4	54.4	55.0	54.8	56.4	52.9	52.3
01.02.2022	54.0	54.9	55.2	55.2	55.9	55.7	57.3	53.7	53.0
02.02.2022	54.8	55.8	56.0	56.1	56.7	56.5	58.1	54.5	53.8
03.02.2022	55.7	56.6	56.9	56.9	57.6	57.4	59.0	55.3	54.6
04.02.2022	56.5	57.5	57.7	57.8	58.4	58.2	59.9	56.1	55.5
05.02.2022	57.3	58.3	58.6	58.6	59.3	59.1	60.8	57.0	56.3
06.02.2022	58.2	59.2	59.5	59.5	60.2	60.0	61.7	57.8	57.1
07.02.2022	59.1	60.1	60.3	60.4	61.1	60.9	62.6	58.7	58.0
08.02.2022	60.0	61.0	61.2	61.3	62.0	61.8	63.6	59.6	58.9
09.02.2022	60.9	61.9	62.2	62.2	62.9	62.7	64.5	60.5	59.7
10.02.2022	61.8	62.8	63.1	63.2	63.9	63.7	65.5	61.4	60.6
11.02.2022	62.7	63.8	64.0	64.1	64.8	64.6	66.5	62.3	61.6
12.02.2022	63.6	64.7	65.0	65.1	65.8	65.6	67.5	63.2	62.5

13.02.2022	64.6	65.7	66.0	66.1	66.8	66.6	68.5	64.2	63.4
14.02.2022	65.6	66.7	67.0	67.0	67.8	67.6	69.5	65.1	64.4
15.02.2022	66.5	67.7	68.0	68.1	68.8	68.6	70.5	66.1	65.3
16.02.2022	67.5	68.7	69.0	69.1	69.8	69.6	71.6	67.1	66.3
17.02.2022	68.6	69.7	70.0	70.1	70.9	70.6	72.7	68.1	67.3
18.02.2022	69.6	70.8	71.1	71.2	72.0	71.7	73.8	69.1	68.3

Table H.4: Table showing amount of feed fed by the ICS and percent feeding relative to biomass based on estimated growth per tank with SGR 1.5

		% feeding relative to biomass								
Date	Feeding ICS	16	17	18	7	8	9	10	11	12
14.01.2022	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15.01.2022	20	0.86	0.84	0.84	0.84	0.83	0.83	0.81	0.86	0.87
16.01.2022	20	0.85	0.83	0.83	0.83	0.82	0.82	0.80	0.85	0.86
17.01.2022	20	0.83	0.82	0.82	0.81	0.81	0.81	0.79	0.84	0.85
18.01.2022	25	1.03	1.01	1.00	1.00	0.99	1.00	0.97	1.03	1.05
19.01.2022	25	1.01	0.99	0.99	0.99	0.98	0.98	0.95	1.02	1.03
20.01.2022	25	1.00	0.98	0.97	0.97	0.96	0.97	0.94	1.00	1.01
21.01.2022	25	0.98	0.96	0.96	0.96	0.95	0.95	0.93	0.99	1.00
22.01.2022	25	0.97	0.95	0.95	0.95	0.93	0.94	0.91	0.97	0.98
23.01.2022	25	0.95	0.94	0.93	0.93	0.92	0.92	0.90	0.96	0.97
24.01.2022	25	0.94	0.92	0.92	0.92	0.91	0.91	0.89	0.94	0.96
25.01.2022	27.5	1.02	1.00	1.00	0.99	0.98	0.99	0.96	1.02	1.04
26.01.2022	30	1.09	1.07	1.07	1.07	1.06	1.06	1.03	1.10	1.11
27.01.2022	30	1.08	1.06	1.05	1.05	1.04	1.04	1.02	1.08	1.10
28.01.2022	30	1.06	1.04	1.04	1.04	1.03	1.03	1.00	1.07	1.08
29.01.2022	30	1.05	1.03	1.02	1.02	1.01	1.01	0.99	1.05	1.06
30.01.2022	30	1.03	1.01	1.01	1.01	1.00	1.00	0.97	1.04	1.05
31.01.2022	32.5	1.10	1.08	1.08	1.07	1.06	1.07	1.04	1.11	1.12
01.02.2022	35	1.17	1.15	1.14	1.14	1.13	1.13	1.10	1.17	1.19
02.02.2022	35	1.15	1.13	1.12	1.12	1.11	1.11	1.08	1.16	1.17
03.02.2022	35	1.13	1.11	1.11	1.11	1.09	1.10	1.07	1.14	1.15
04.02.2022	40	1.27	1.25	1.25	1.25	1.23	1.24	1.20	1.28	1.30
05.02.2022	40	1.26	1.23	1.23	1.23	1.21	1.22	1.18	1.26	1.28
06.02.2022	40	1.24	1.22	1.21	1.21	1.20	1.20	1.17	1.24	1.26
07.02.2022	42.5	1.30	1.27	1.27	1.27	1.25	1.26	1.22	1.30	1.32
08.02.2022	45	1.35	1.33	1.32	1.32	1.31	1.31	1.27	1.36	1.38
09.02.2022	45	1.33	1.31	1.30	1.30	1.29	1.29	1.26	1.34	1.36
10.02.2022	45	1.31	1.29	1.28	1.28	1.27	1.27	1.24	1.32	1.34
11.02.2022	47.5	1.36	1.34	1.33	1.33	1.32	1.32	1.29	1.37	1.39

12.02.2022	50	1.41	1.39	1.38	1.38	1.37	1.37	1.33	1.42	1.44
13.02.2022	50	1.39	1.37	1.36	1.36	1.35	1.35	1.31	1.40	1.42
14.02.2022	50	1.37	1.35	1.34	1.34	1.33	1.33	1.30	1.38	1.40
15.02.2022	52.5	1.42	1.40	1.39	1.39	1.37	1.38	1.34	1.43	1.45
16.02.2022	55	1.47	1.44	1.43	1.43	1.42	1.42	1.38	1.48	1.49
17.02.2022	60	1.58	1.55	1.54	1.54	1.52	1.53	1.49	1.59	1.60
18.02.2022	30	0.78	0.76	0.76	0.76	0.75	0.75	0.73	0.78	0.79

H.0.2 Feed collection

Table H.5: Table showing feed collection from 2nd to 18th February. Feeding period indicate morning (1) or afternoon (2).

Date	Tank	Feed given (g) SD facility	Feeding period	Spill DW (g)	Feed eaten (g)	%Spill	Comment
02.02.2022	7	17.5	2	5.4189	12.0811	31.0	
02.02.2022	8	17.5	2	1.1863	16.3137	6.8	
02.02.2022	9	17.5	2	2.3279	15.1721	13.3	
02.02.2022	10	17.5	2	1.8664	15.6336	10.7	
02.02.2022	11	17.5	2	4.1295	13.3705	23.6	
02.02.2022	12	17.5	2	1.1053	16.3947	6.3	
02.02.2022	16	17.5	2	2.6516	14.8484	15.2	
02.02.2022	17	17.5	2	2.1266	15.3734	12.2	
02.02.2022	18	17.5	2	1.3427	16.1573	7.7	
03.02.2022	7	17.5	1	3.2569	14.2431	18.6	
03.02.2022	8	17.5	1	2.8485	14.6515	16.3	
03.02.2022	9	17.5	1	4.2415	13.2585	24.2	
03.02.2022	10	17.5	1	3.9045	13.5955	22.3	
03.02.2022	11	17.5	1	4.4257	13.0743	25.3	
03.02.2022	12	17.5	1	3.9280	13.5720	22.4	
03.02.2022	16	17.5	1	1.3816	16.1184	7.9	
03.02.2022	17	17.5	1	2.1075	15.3925	12.0	
03.02.2022	18	17.5	1	1.0557	16.4443	6.0	
03.02.2022	7	17.5	2	11.3876	6.1124	65.1	

Table H.5: Table showing feed collection from 2nd to 18th February. Feeding period indicate morning (1) or afternoon (2).

Date	Tank	Feed given (g) SD facility	Feeding period	Spill DW (g)	Feed eaten (g)	%Spill	Comment
03.02.2022	8	17.5	2	12.0274	5.4726	68.7	
03.02.2022	9	17.5	2	12.1326	5.3674	69.3	
03.02.2022	10	17.5	2	10.0737	7.4263	57.6	
03.02.2022	11	17.5	2	9.9544	7.5456	56.9	
03.02.2022	12	17.5	2	12.5063	4.9937	71.5	
03.02.2022	16	17.5	2	10.9546	6.5454	62.6	
03.02.2022	17	17.5	2	9.5557	7.9443	54.6	
03.02.2022	18	17.5	2	11.8332	5.6668	67.6	
04.02.2022	7	20	1	8.0282	11.9718	40.1	
04.02.2022	8	20	1	5.1774	14.8226	25.9	
04.02.2022	9	20	1	6.6370	13.3630	33.2	
04.02.2022	10	20	1	6.6048	13.3952	33.0	
04.02.2022	11	20	1	11.0553	8.9447	55.3	
04.02.2022	12	20	1	5.4738	14.5262	27.4	
04.02.2022	16	20	1	6.9824	13.0176	34.9	
04.02.2022	17	20	1	8.0104	11.9896	40.1	
04.02.2022	18	20	1	6.9048	13.0952	34.5	
04.02.2022	7	20	2	9.4294	10.5706	47.147	
04.02.2022	8	20	2	6.4689	13.5311	32.3445	

Table H.5: Table showing feed collection from 2nd to 18th February. Feeding period indicate morning (1) or afternoon (2).

Date	Tank	Feed given (g) SD facility	Feeding period	Spill DW (g)	Feed eaten (g)	%Spill	Comment
04.02.2022	9	20	2	5.0167	14.9833	25.0835	
04.02.2022	10	20	2	5.2041	14.7959	26.0205	
04.02.2022	11	20	2	4.9412	15.0588	24.706	
04.02.2022	12	20	2	7.061	12.939	35.305	
04.02.2022	16	20	2	4.9962	15.0038	24.981	
04.02.2022	17	20	2	6.081	13.919	30.405	
04.02.2022	18	20	2	4.9646	15.0354	24.823	
05.02.2022	7	20	1	6.4802	13.5198	32.401	
05.02.2022	8	20	1	2.8764	17.1236	14.382	
05.02.2022	9	20	1	7.0854	12.9146	35.427	
05.02.2022	10	20	1	7.178	12.822	35.89	
05.02.2022	11	20	1	6.654	13.346	33.27	
05.02.2022	12	20	1	5.9774	14.0226	29.887	
05.02.2022	16	20	1	5.3692	14.6308	26.846	
05.02.2022	17	20	1	7.5349	12.4651	37.6745	
05.02.2022	18	20	1	7.5052	12.4948	37.526	
05.02.2022	7	20	2	6.3905	13.6095	31.9525	
05.02.2022	8	20	2	7.0246	12.9754	35.123	
05.02.2022	9	20	2	4.7303	15.2697	23.6515	

Table H.5: Table showing feed collection from 2nd to 18th February. Feeding period indicate morning (1) or afternoon (2).

Date	Tank	Feed given (g) SD facility	Feeding period	Spill DW (g)	Feed eaten (g)	%Spill	Comment
05.02.2022	10	20	2	5.2978	14.7022	26.489	
05.02.2022	11	20	2	5.969	14.031	29.845	
05.02.2022	12	20	2	7.5666	12.4334	37.833	
05.02.2022	16	20	2	7.5146	12.4854	37.573	
05.02.2022	17	20	2	7.9451	12.0549	39.7255	
05.02.2022	18	20	2	5.3456	14.6544	26.728	
06.02.2022	7	20	1	6.8216	13.1784	34.108	
06.02.2022	8	20	1	2.1954	17.8046	10.977	
06.02.2022	9	20	1	4.2733	15.7267	21.3665	
06.02.2022	10	20	1	4.5703	15.4297	22.8515	
06.02.2022	11	20	1	8.4506	11.5494	42.253	
06.02.2022	12	20	1	4.3198	15.6802	21.599	
06.02.2022	16	20	1	2.4483	17.5517	12.2415	
06.02.2022	17	20	1	5.251	14.749	26.255	
06.02.2022	18	20	1	3.8225	16.1775	19.1125	
06.02.2022	7	20.0	2	5.1957	14.8043	26.0	weighed next morning
06.02.2022	8	20.0	2	2.2571	17.7429	11.3	weighed next morning
06.02.2022	9	20.0	2	4.3440	15.6560	21.7	weighed next morning
06.02.2022	10	20.0	2	4.2076	15.7924	21.0	weighed next morning

Table H.5: Table showing feed collection from 2nd to 18th February. Feeding period indicate morning (1) or afternoon (2).

Date	Tank	Feed given (g) SD facility	Feeding period	Spill DW (g)	Feed eaten (g)	%Spill	Comment
06.02.2022	11	20.0	2	8.6496	11.3504	43.2	weighed next morning
06.02.2022	12	20.0	2	3.7328	16.2672	18.7	weighed next morning
06.02.2022	16	20.0	2	2.7699	17.2301	13.8	weighed next morning
06.02.2022	17	20.0	2	2.3106	17.6894	11.6	weighed next morning
06.02.2022	18	20.0	2	2.6536	17.3464	13.3	weighed next morning
07.02.2022	7	20.0	1	6.2339	13.7661	31.2	
07.02.2022	8	20.0	1	4.2529	15.7471	21.3	
07.02.2022	9	20.0	1	6.1553	13.8447	30.8	
07.02.2022	10	20.0	1	5.1785	14.8215	25.9	
07.02.2022	11	20.0	1	5.2722	14.7278	26.4	
07.02.2022	12	20.0	1	4.4788	15.5212	22.4	
07.02.2022	16	20.0	1	4.8594	15.1406	24.3	
07.02.2022	17	20.0	1	7.2353	12.7647	36.2	
07.02.2022	18	20.0	1	1.6769	18.3231	8.4	
07.02.2022	7	22.5	2	3.4511	19.0489	15.3	
07.02.2022	8	22.5	2	1.8815	20.6185	8.4	
07.02.2022	9	22.5	2	4.4655	18.0345	19.8	
07.02.2022	10	22.5	2	4.2363	18.2637	18.8	
07.02.2022	11	22.5	2	2.6573	19.8427	11.8	

Table H.5: Table showing feed collection from 2nd to 18th February. Feeding period indicate morning (1) or afternoon (2).

Date	**Tank**	**Feed given (g) SD facility**	**Feeding period**	**Spill DW (g)**	**Feed eaten (g)**	**%Spill**	**Comment**
07.02.2022	12	22.5	2	3.3249	19.1751	14.8	
07.02.2022	16	22.5	2	5.8069	16.6931	25.8	
07.02.2022	17	22.5	2	5.9014	16.5986	26.2	
07.02.2022	18	22.5	2	7.6511	14.8489	34.0	
08.02.2022	7	22.5	1	5.9237	16.5763	26.3	
08.02.2022	8	22.5	1	1.1503	21.3497	5.1	
08.02.2022	9	22.5	1	6.3340	16.1660	28.2	
08.02.2022	10	22.5	1	3.5899	18.9101	16.0	
08.02.2022	11	22.5	1	7.8676	14.6324	35.0	
08.02.2022	12	22.5	1	3.3344	19.1656	14.8	
08.02.2022	16	22.5	1	4.1781	18.3219	18.6	
08.02.2022	17	22.5	1	5.0278	17.4722	22.3	
08.02.2022	18	22.5	1	2.1791	20.3209	9.7	
08.02.2022	7	22.5	2	10.5299	11.9701	46.8	New feed
08.02.2022	8	22.5	2	8.4955	14.0045	37.8	New feed
08.02.2022	9	22.5	2	6.7286	15.7714	29.9	New feed
08.02.2022	10	22.5	2	9.1618	13.3382	40.7	New feed
08.02.2022	11	22.5	2	5.7603	16.7397	25.6	New feed
08.02.2022	12	22.5	2	10.5248	11.9752	46.8	New feed

Table H.5: Table showing feed collection from 2nd to 18th February. Feeding period indicate morning (1) or afternoon (2).

Date	Tank	Feed given (g) SD facility	Feeding period	Spill DW (g)	Feed eaten (g)	%Spill	Comment
08.02.2022	16	22.5	2	6.6153	15.8847	29.4	New feed
08.02.2022	17	22.5	2	9.0200	13.4800	40.1	New feed
08.02.2022	18	22.5	2	10.0020	12.4980	44.5	New feed
09.02.2022	7	22.5	1	12.2257	10.2743	54.3	
09.02.2022	8	22.5	1	6.2902	16.2098	28.0	
09.02.2022	9	22.5	1	10.4136	12.0864	46.3	
09.02.2022	10	22.5	1	5.1556	17.3444	22.9	
09.02.2022	11	22.5	1	8.9125	13.5875	39.6	
09.02.2022	12	22.5	1	5.6622	16.8378	25.2	
09.02.2022	16	22.5	1	8.2915	14.2085	36.9	
09.02.2022	17	22.5	1	9.1586	13.3414	40.7	
09.02.2022	18	22.5	1	4.9431	17.5569	22.0	
09.02.2022	7	22.5	2	8.2996	14.2004	36.9	
09.02.2022	8	22.5	2	6.6634	15.8366	29.6	
09.02.2022	9	22.5	2	6.7724	15.7276	30.1	
09.02.2022	10	22.5	2	7.6454	14.8546	34.0	
09.02.2022	11	22.5	2	8.3801	14.1199	37.2	
09.02.2022	12	22.5	2	7.2779	15.2221	32.3	
09.02.2022	16	22.5	2	8.8538	13.6462	39.4	

Table H.5: Table showing feed collection from 2nd to 18th February. Feeding period indicate morning (1) or afternoon (2).

Date	Tank	Feed given (g) SD facility	Feeding period	Spill DW (g)	Feed eaten (g)	%Spill	Comment
09.02.2022	17	22.5	2	7.6307	14.8693	33.9	
09.02.2022	18	22.5	2	4.7892	17.7108	21.3	
10.02.2022	7	22.5	1	8.9213	13.5787	39.7	
10.02.2022	8	22.5	1	5.8108	16.6892	25.8	
10.02.2022	9	22.5	1	10.2394	12.2606	45.5	
10.02.2022	10	22.5	1	6.0856	16.4144	27.0	
10.02.2022	11	22.5	1	7.8714	14.6286	35.0	
10.02.2022	12	22.5	1	8.8209	13.6791	39.2	
10.02.2022	16	22.5	1	3.1445	19.3555	14.0	
10.02.2022	17	22.5	1	4.3930	18.1070	19.5	
10.02.2022	18	22.5	1	5.6957	16.8043	25.3	
10.02.2022	7	22.5	2	10.0283	12.4717	44.6	
10.02.2022	8	22.5	2	3.9034	18.5966	17.3	
10.02.2022	9	22.5	2	9.5241	12.9759	42.3	
10.02.2022	10	22.5	2	5.1190	17.3810	22.8	
10.02.2022	11	22.5	2	4.5338	17.9662	20.2	
10.02.2022	12	22.5	2	5.9264	16.5736	26.3	
10.02.2022	16	22.5	2	6.4899	16.0101	28.8	
10.02.2022	17	22.5	2	7.4978	15.0022	33.3	

Table H.5: Table showing feed collection from 2nd to 18th February. Feeding period indicate morning (1) or afternoon (2).

Date	Tank	Feed given (g) SD facility	Feeding period	Spill DW (g)	Feed eaten (g)	%Spill	Comment
10.02.2022	18	22.5	2	3.5732	18.9268	15.9	
11.02.2022	7	22.5	1	3.7823	18.7177	16.8	
11.02.2022	8	22.5	1	3.9753	18.5247	17.7	
11.02.2022	9	22.5	1	9.6503	12.8497	42.9	
11.02.2022	10	22.5	1	8.6923	13.8077	38.6	
11.02.2022	11	22.5	1	8.1177	14.3823	36.1	
11.02.2022	12	22.5	1	2.5608	19.9392	11.4	
11.02.2022	16	22.5	1	6.6513	15.8487	29.6	
11.02.2022	17	22.5	1	8.7206	13.7794	38.8	
11.02.2022	18	22.5	1	3.7747	18.7253	16.8	
11.02.2022	7	25.0	2	7.3351	17.6649	29.3	
11.02.2022	8	25.0	2	4.6539	20.3461	18.6	
11.02.2022	9	25.0	2	6.4849	18.5151	25.9	
11.02.2022	10	25.0	2	15.4968	9.5032	62.0	*
11.02.2022	11	25.0	2	7.0534	17.9466	28.2	
11.02.2022	12	25.0	2	4.7633	20.2367	19.1	
11.02.2022	16	25.0	2	6.2640	18.7360	25.1	
11.02.2022	17	25.0	2	9.0562	15.9438	36.2	
11.02.2022	18	25.0	2	5.7487	19.2513	23.0	*

Table H.5: Table showing feed collection from 2nd to 18th February. Feeding period indicate morning (1) or afternoon (2).

Date	Tank	Feed given (g) SD facility	Feeding period	Spill DW (g)	Feed eaten (g)	%Spill	Comment
12.02.2022	16	50.0	2	10.3562	39.6438	20.7	Only collected in the afternoon
12.02.2022	17	50.0	2	15.6748	34.3252	31.3	Only collected in the afternoon
12.02.2022	18	50.0	2	14.8474	35.1526	29.7	Only collected in the afternoon
12.02.2022	7	50.0	2	8.0790	41.9210	16.2	Only collected in the afternoon
12.02.2022	8	50.0	2	11.2231	38.7769	22.4	Only collected in the afternoon
12.02.2022	9	50.0	2	12.3326	37.6674	24.7	Only collected in the afternoon
12.02.2022	10	50.0	2	22.4311	27.5689	44.9	Only collected in the afternoon
12.02.2022	11	50.0	2	16.6105	33.3895	33.2	Only collected in the afternoon
12.02.2022	12	50.0	2	11.9528	38.0472	23.9	Only collected in the afternoon
13.02.2022	7	25.0	1	8.4166	16.5834	33.7	
13.02.2022	8	25.0	1	9.3007	15.6993	37.2	
13.02.2022	9	25.0	1	6.9249	18.0751	27.7	
13.02.2022	10	25.0	1	11.5289	13.4711	46.1	
13.02.2022	11	25.0	1	9.6835	15.3165	38.7	
13.02.2022	12	25.0	1	5.1231	19.8769	20.5	
13.02.2022	16	25.0	1	7.3037	17.6963	29.2	
13.02.2022	17	25.0	1	5.0857	19.9143	20.3	
13.02.2022	18	25.0	1	6.9114	18.0886	27.6	
14.02.2022	7	25.0	1	13.2282	11.7718	52.9	

Table H.5: Table showing feed collection from 2nd to 18th February. Feeding period indicate morning (1) or afternoon (2).

Date	Tank	Feed given (g) SD facility	Feeding period	Spill DW (g)	Feed eaten (g)	%Spill	Comment
14.02.2022	8	25.0	1	5.5567	19.4433	22.2	
14.02.2022	9	25.0	1	9.3692	15.6308	37.5	
14.02.2022	10	25.0	1	12.4868	12.5132	49.9	
14.02.2022	11	25.0	1	7.1977	17.8023	28.8	
14.02.2022	12	25.0	1	5.8208	19.1792	23.3	
14.02.2022	16	25.0	1	5.8259	19.1741	23.3	
14.02.2022	17	25.0	1	5.9250	19.0750	23.7	
14.02.2022	18	25.0	1	7.2542	17.7458	29.0	
14.02.2022	7	25.0	2	6.4888	18.5112	26.0	
14.02.2022	8	25.0	2	3.9506	21.0494	15.8	
14.02.2022	9	25.0	2	7.0961	17.9039	28.4	
14.02.2022	10	25.0	2	8.3500	16.6500	33.4	
14.02.2022	11	25.0	2	5.6624	19.3376	22.6	
14.02.2022	12	25.0	2	5.3784	19.6216	21.5	
14.02.2022	16	25.0	2	6.9792	18.0208	27.9	
14.02.2022	17	25.0	2	12.5540	12.4460	50.2	
14.02.2022	18	25.0	2	6.9241	18.0759	27.7	
15.02.2022	7	25.0	1	9.9872	15.0128	39.9	
15.02.2022	8	25.0	1	3.5267	21.4733	14.1	

Table H.5: Table showing feed collection from 2nd to 18th February. Feeding period indicate morning (1) or afternoon (2).

Date	Tank	Feed given (g) SD facility	Feeding period	Spill DW (g)	Feed eaten (g)	%Spill	Comment
15.02.2022	9	25.0	1	7.8887	17.1113	31.6	
15.02.2022	10	25.0	1	4.4580	20.5420	17.8	
15.02.2022	11	25.0	1	8.1751	16.8249	32.7	
15.02.2022	12	25.0	1	4.5317	20.4683	18.1	
15.02.2022	16	25.0	1	4.2856	20.7144	17.1	
15.02.2022	17	25.0	1	1.9991	23.0009	8.0	
15.02.2022	18	25.0	1	6.9146	18.0854	27.7	
15.02.2022	7	27.5	2	6.4327	21.0673	23.4	
15.02.2022	8	27.5	2	6.3036	21.1964	22.9	
15.02.2022	9	27.5	2	10.1215	17.3785	36.8	
15.02.2022	10	27.5	2	5.2485	22.2515	19.1	
15.02.2022	11	27.5	2	5.0712	22.4288	18.4	
15.02.2022	12	27.5	2	3.4800	24.0200	12.7	
15.02.2022	16	27.5	2	5.2382	22.2618	19.0	
15.02.2022	17	27.5	2	6.6553	20.8447	24.2	
15.02.2022	18	27.5	2	4.6805	22.8195	17.0	
16.02.2022	7	27.5	1	11.3684	16.1316	41.3	
16.02.2022	8	27.5	1	4.5909	22.9091	16.7	
16.02.2022	9	27.5	1	8.6113	18.8887	31.3	

Table H.5: Table showing feed collection from 2nd to 18th February. Feeding period indicate morning (1) or afternoon (2).

Date	Tank	Feed given (g) SD facility	Feeding period	Spill DW (g)	Feed eaten (g)	%Spill	Comment
16.02.2022	10	27.5	1	6.7905	20.7095	24.7	
16.02.2022	11	27.5	1	11.1797	16.3203	40.7	
16.02.2022	12	27.5	1	6.6164	20.8836	24.1	
16.02.2022	16	27.5	1	4.9315	22.5685	17.9	
16.02.2022	17	27.5	1	11.4522	16.0478	41.6	
16.02.2022	18	27.5	1	9.9188	17.5812	36.1	
16.02.2022	7	27.5	2	7.8240	19.6760	28.5	
16.02.2022	8	27.5	2	3.6331	23.8669	13.2	
16.02.2022	9	27.5	2	7.7805	19.7195	28.3	
16.02.2022	10	27.5	2	6.3974	21.1026	23.3	
16.02.2022	11	27.5	2	4.3340	23.1660	15.8	
16.02.2022	12	27.5	2	5.8552	21.6448	21.3	
16.02.2022	16	27.5	2	9.1972	18.3028	33.4	
16.02.2022	17	27.5	2	5.1639	22.3361	18.8	
16.02.2022	18	27.5	2	8.6058	18.8942	31.3	
17.02.2022	7	30.0	1	11.5401	18.4599	38.5	
17.02.2022	8	30.0	1	4.9991	25.0009	16.7	
17.02.2022	9	30.0	1	14.8278	15.1722	49.4	
17.02.2022	10	30.0	1	10.6495	19.3505	35.5	

Table H.5: Table showing feed collection from 2nd to 18th February. Feeding period indicate morning (1) or afternoon (2).

Date	**Tank**	**Feed given (g) SD facility**	**Feeding period**	**Spill DW (g)**	**Feed eaten (g)**	**%Spill**	**Comment**
17.02.2022	11	30.0	1	9.5097	20.4903	31.7	
17.02.2022	12	30.0	1	5.8729	24.1271	19.6	
17.02.2022	16	30.0	1	6.4041	23.5959	21.3	
17.02.2022	17	30.0	1	10.3490	19.6510	34.5	
17.02.2022	18	30.0	1	11.6441	18.3559	38.8	
17.02.2022	7	30.0	2	8.7478	21.2522	29.2	
17.02.2022	8	30.0	2	9.5905	20.4095	32.0	
17.02.2022	9	30.0	2	5.1170	24.8830	17.1	
17.02.2022	10	30.0	2	4.4495	25.5505	14.8	
17.02.2022	11	30.0	2	5.7605	24.2395	19.2	
17.02.2022	12	30.0	2	6.7996	23.2004	22.7	
17.02.2022	16	30.0	2	5.4249	24.5751	18.1	
17.02.2022	17	30.0	2	5.8394	24.1606	19.5	
17.02.2022	18	30.0	2	7.5032	22.4968	25.0	
18.02.2022	16	30.0	1	11.4837	18.5163	38.3	Collected 11:00. dried for 3 days
18.02.2022	17	30.0	1	15.5369	14.4631	51.8	Collected 11:00. dried for 3 days
18.02.2022	18	30.0	1	8.0505	21.9495	26.8	Collected 11:00. dried for 3 days
18.02.2022	7	30.0	1	12.1619	17.8381	40.5	Collected 11:00. dried for 3 days
18.02.2022	8	30.0	1	9.6106	20.3894	32.0	Collected 11:00. dried for 3 days

Table H.5: Table showing feed collection from 2nd to 18th February. Feeding period indicate morning (1) or afternoon (2).

Date	Tank	Feed given (g) SD facility	Feeding period	Spill DW (g)	Feed eaten (g)	%Spill	Comment
18.02.2022	9	30.0	1	11.7627	18.2373	39.2	Collected 11:00. dried for 3 days
18.02.2022	10	30.0	1	3.6406	26.3594	12.1	Collected 11:00. dried for 3 days
18.02.2022	11	30.0	1	13.8988	16.1012	46.3	Collected 11:00. dried for 3 days
18.02.2022	12	30.0	1	8.2635	21.7365	27.5	Collected 11:00. dried for 3 days

Table H.6: Table showing feed collection per day from 3rd to 17th February.

Date	Tank	Feed given pr day (SD)	Spill DW pr day	Feed eaten pr day	% spill pr day
03.02.2022	7	35.0	14.6	20.4	41.8
03.02.2022	8	35.0	14.9	20.1	42.5
03.02.2022	9	35.0	16.4	18.6	46.8
03.02.2022	10	35.0	14.0	21.0	39.9
03.02.2022	11	35.0	14.4	20.6	41.1
03.02.2022	12	35.0	16.4	18.6	47.0
03.02.2022	16	35.0	12.3	22.7	35.2
03.02.2022	17	35.0	11.7	23.3	33.3
03.02.2022	18	35.0	12.9	22.1	36.8
04.02.2022	7	40.0	17.5	22.5	43.6
04.02.2022	8	40.0	11.6	28.4	29.1
04.02.2022	9	40.0	11.7	28.3	29.1
04.02.2022	10	40.0	11.8	28.2	29.5
04.02.2022	11	40.0	16.0	24.0	40.0
04.02.2022	12	40.0	12.5	27.5	31.3
04.02.2022	16	40.0	12.0	28.0	29.9
04.02.2022	17	40.0	14.1	25.9	35.2
04.02.2022	18	40.0	11.9	28.1	29.7
05.02.2022	7	40.0	12.9	27.1	32.2
05.02.2022	8	40.0	9.9	30.1	24.8
05.02.2022	9	40.0	11.8	28.2	29.5
05.02.2022	10	40.0	12.5	27.5	31.2
05.02.2022	11	40.0	12.6	27.4	31.6
05.02.2022	12	40.0	13.5	26.5	33.9
05.02.2022	16	40.0	12.9	27.1	32.2
05.02.2022	17	40.0	15.5	24.5	38.7
05.02.2022	18	40.0	12.9	27.1	32.1
06.02.2022	7	40.0	12.0	28.0	30.0
06.02.2022	8	40.0	4.5	35.5	11.1
06.02.2022	9	40.0	8.6	31.4	21.5
06.02.2022	10	40.0	8.8	31.2	21.9

Table H.6: Table showing feed collection per day from 3rd to 17th February.

Date	Tank	Feed given pr day (SD)	Spill DW pr day	Feed eaten pr day	% spill pr day
06.02.2022	11	40.0	17.1	22.9	42.8
06.02.2022	12	40.0	8.1	31.9	20.1
06.02.2022	16	40.0	5.2	34.8	13.0
06.02.2022	17	40.0	7.6	32.4	18.9
06.02.2022	18	40.0	6.5	33.5	16.2
07.02.2022	7	42.5	9.7	32.8	22.8
07.02.2022	8	42.5	6.1	36.4	14.4
07.02.2022	9	42.5	10.6	31.9	25.0
07.02.2022	10	42.5	9.4	33.1	22.2
07.02.2022	11	42.5	7.9	34.6	18.7
07.02.2022	12	42.5	7.8	34.7	18.4
07.02.2022	16	42.5	10.7	31.8	25.1
07.02.2022	17	42.5	13.1	29.4	30.9
07.02.2022	18	42.5	9.3	33.2	21.9
08.02.2022	7	45.0	16.5	28.5	36.6
08.02.2022	8	45.0	9.6	35.4	21.4
08.02.2022	9	45.0	13.1	31.9	29.0
08.02.2022	10	45.0	12.8	32.2	28.3
08.02.2022	11	45.0	13.6	31.4	30.3
08.02.2022	12	45.0	13.9	31.1	30.8
08.02.2022	16	45.0	10.8	34.2	24.0
08.02.2022	17	45.0	14.0	31.0	31.2
08.02.2022	18	45.0	12.2	32.8	27.1
09.02.2022	7	45.0	20.5	24.5	45.6
09.02.2022	8	45.0	13.0	32.0	28.8
09.02.2022	9	45.0	17.2	27.8	38.2
09.02.2022	10	45.0	12.8	32.2	28.4
09.02.2022	11	45.0	17.3	27.7	38.4
09.02.2022	12	45.0	12.9	32.1	28.8
09.02.2022	16	45.0	17.1	27.9	38.1
09.02.2022	17	45.0	16.8	28.2	37.3

Table H.6: Table showing feed collection per day from 3rd to 17th February.

Date	Tank	Feed given pr day (SD)	Spill DW pr day	Feed eaten pr day	% spill pr day
09.02.2022	18	45.0	9.7	35.3	21.6
10.02.2022	7	45.0	18.9	26.1	42.1
10.02.2022	8	45.0	9.7	35.3	21.6
10.02.2022	9	45.0	19.8	25.2	43.9
10.02.2022	10	45.0	11.2	33.8	24.9
10.02.2022	11	45.0	12.4	32.6	27.6
10.02.2022	12	45.0	14.7	30.3	32.8
10.02.2022	16	45.0	9.6	35.4	21.4
10.02.2022	17	45.0	11.9	33.1	26.4
10.02.2022	18	45.0	9.3	35.7	20.6
11.02.2022	7	47.5	11.1	36.4	23.4
11.02.2022	8	47.5	8.6	38.9	18.2
11.02.2022	9	47.5	16.1	31.4	34.0
11.02.2022	10	47.5	24.2	23.3	50.9
11.02.2022	11	47.5	15.2	32.3	31.9
11.02.2022	12	47.5	7.3	40.2	15.4
11.02.2022	16	47.5	12.9	34.6	27.2
11.02.2022	17	47.5	17.8	29.7	37.4
11.02.2022	18	47.5	9.5	38.0	20.0
12.02.2022	16	50.0	10.4	39.6	20.7
12.02.2022	17	50.0	15.7	34.3	31.3
12.02.2022	18	50.0	14.8	35.2	29.7
12.02.2022	7	50.0	8.1	41.9	16.2
12.02.2022	8	50.0	11.2	38.8	22.4
12.02.2022	9	50.0	12.3	37.7	24.7
12.02.2022	10	50.0	22.4	27.6	44.9
12.02.2022	11	50.0	16.6	33.4	33.2
12.02.2022	12	50.0	12.0	38.0	23.9
14.02.2022	7	50.0	19.7	30.3	39.4
14.02.2022	8	50.0	9.5	40.5	19.0
14.02.2022	9	50.0	16.5	33.5	32.9

Table H.6: Table showing feed collection per day from 3rd to 17th February.

Date	Tank	Feed given pr day (SD)	Spill DW pr day	Feed eaten pr day	% spill pr day
14.02.2022	10	50.0	20.8	29.2	41.7
14.02.2022	11	50.0	12.9	37.1	25.7
14.02.2022	12	50.0	11.2	38.8	22.4
14.02.2022	16	50.0	12.8	37.2	25.6
14.02.2022	17	50.0	18.5	31.5	37.0
14.02.2022	18	50.0	14.2	35.8	28.4
15.02.2022	7	52.5	16.4	36.1	31.3
15.02.2022	8	52.5	9.8	42.7	18.7
15.02.2022	9	52.5	18.0	34.5	34.3
15.02.2022	10	52.5	9.7	42.8	18.5
15.02.2022	11	52.5	13.2	39.3	25.2
15.02.2022	12	52.5	8.0	44.5	15.3
15.02.2022	16	52.5	9.5	43.0	18.1
15.02.2022	17	52.5	8.7	43.8	16.5
15.02.2022	18	52.5	11.6	40.9	22.1
16.02.2022	7	55.0	19.2	35.8	34.9
16.02.2022	8	55.0	8.2	46.8	15.0
16.02.2022	9	55.0	16.4	38.6	29.8
16.02.2022	10	55.0	13.2	41.8	24.0
16.02.2022	11	55.0	15.5	39.5	28.2
16.02.2022	12	55.0	12.5	42.5	22.7
16.02.2022	16	55.0	14.1	40.9	25.7
16.02.2022	17	55.0	16.6	38.4	30.2
16.02.2022	18	55.0	18.5	36.5	33.7
17.02.2022	7	60.0	20.3	39.7	33.8
17.02.2022	8	60.0	14.6	45.4	24.3
17.02.2022	9	60.0	19.9	40.1	33.2
17.02.2022	10	60.0	15.1	44.9	25.2
17.02.2022	11	60.0	15.3	44.7	25.5
17.02.2022	12	60.0	12.7	47.3	21.1
17.02.2022	16	60.0	11.8	48.2	19.7

Table H.6: Table showing feed collection per day from 3rd to 17th February.

Date	Tank	Feed given pr day (SD)	Spill DW pr day	Feed eaten pr day	% spill pr day
17.02.2022	17	60.0	16.2	43.8	27.0
17.02.2022	18	60.0	19.1	40.9	31.9

Appendix I

Camera specifications

I.0.1 Specifications for the cameras

Barlus IP68 Underwater IP camera
SKU:UW-S2-2PCX10
Lens: 2.0 MM
Image resolution: 2MP
Focused: 2M

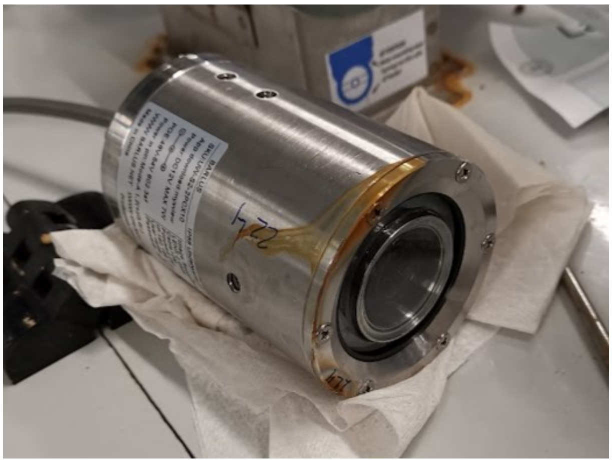


Figure I.1: Barlus camera used for video sampling

Figure I.2: The underwater camera housing used to connect the cameras to the tank and protect both camera and fish from injuries

Appendix J

Video analysis

Note that empty cells from the raw data was removed. Some feeding were not recorded due to technical trouble and therefore some feedings in the period 7th to 11th February are not analysed. There are more recordings from the period 12th to 17th February, but they are not analysed due to massive work load.

J.0.1 Raw data from video analysis

Table J.1: Raw data from the video analysis without empty cells. Includes total number of individuals feeding and total number of pellets eaten.

Date	Camera ID	Tank	No	Time from	Time to	Total # feeding	Total # pellets eaten
07.02.2022	229	7	4	13:46:40	13:49:02	12	30
07.02.2022	229	7	5	14:02:10	14:04:54	11	41
07.02.2022	229	7	6	14:33:12	14:35:38	11	25
07.02.2022	223	8	4	13:46:40	13:48:30	14	35
07.02.2022	223	8	5	14:02:10	14:04:20	13	43
07.02.2022	223	8	6	14:33:12	14:35:40	14	32
07.02.2022	232	9	4	13:46:40	13:48:10	16	27
07.02.2022	232	9	5	14:02:10	14:03:30	15	36
07.02.2022	232	9	6	14:33:12	14:35:46	11	24
07.02.2022	167	10	4	13:46:40	13:48:50	13	37
07.02.2022	167	10	5	14:02:10	14:04:59	13	28
07.02.2022	167	10	6	14:33:12	14:35:44	9	21
07.02.2022	227	11	4	13:46:40	13:48:22	13	33
07.02.2022	227	11	5	14:02:10	14:03:54	10	33
07.02.2022	227	11	6	14:33:13	14:36:10	10	39
07.02.2022	222	12	4	13:46:40	13:48:44	12	39
07.02.2022	222	12	5	14:02:11	14:04:51	13	37
07.02.2022	222	12	6	14:33:12	14:36:07	11	38
07.02.2022	228	16	4	13:46:40	13:49:00	13	35
07.02.2022	228	16	5	14:02:10	14:04:32	15	24
07.02.2022	228	16	6	14:33:12	14:35:46	15	39
07.02.2022	221	17	4	13:46:40	13:49:40	12	30
07.02.2022	221	17	5	14:02:10	14:04:43	13	34
07.02.2022	221	17	6	14:33:12	14:35:30	13	38
07.02.2022	224	18	4	13:46:40	13:48:46	13	35
07.02.2022	224	18	5	14:02:11	14:04:47	10	23
07.02.2022	224	18	6	14:33:13	14:36:33	10	26
08.02.2022	229	7	1	08:16:40	08:18:13	13	35
08.02.2022	229	7	2	09:03:13	09:05:26	14	44

Table J.1: Raw data from the video analysis without empty cells. Includes total number of individuals feeding and total number of pellets eaten.

Date	Camera ID	Tank	No	Time from	Time to	Total # feeding	Total # pellets eaten
08.02.2022	229	7	3	09:49:46	09:51:48	7	17
08.02.2022	229	7	4	13:46:40	13:48:49	1	1
08.02.2022	229	7	5	14:33:12	14:35:29	3	11
08.02.2022	229	7	6	15:19:46	15:22:01	3	3
08.02.2022	223	8	1	08:16:40	08:28:51	14	35
08.02.2022	223	8	2	09:03:13	09:05:07	12	25
08.02.2022	223	8	3	09:49:46	09:53:23	11	26
08.02.2022	223	8	4	13:46:40	13:49:15	7	16
08.02.2022	223	8	5	14:33:12	14:35:25	2	2
08.02.2022	223	8	6	15:19:46	15:22:06	5	13
08.02.2022	232	9	1	08:16:40	08:17:37	13	34
08.02.2022	232	9	2	09:03:13	09:05:16	8	19
08.02.2022	232	9	3	09:49:46	09:51:57	7	23
08.02.2022	232	9	4	13:46:40	13:48:48	14	46
08.02.2022	232	9	5	14:33:12	14:35:18	11	31
08.02.2022	232	9	6	15:19:46	15:21:45	9	20
08.02.2022	167	10	1	08:16:40	08:27:58	13	29
08.02.2022	167	10	2	09:03:13	09:05:06	13	28
08.02.2022	167	10	3	09:49:46	09:52:05	10	21
08.02.2022	167	10	4	13:46:40	13:49:07	10	29
08.02.2022	167	10	5	14:33:12	14:35:28	4	4
08.02.2022	167	10	6	15:19:46	15:21:46	4	4
08.02.2022	227	11	1	08:16:40	08:18:45	7	21
08.02.2022	227	11	2	09:03:13	09:05:43	5	17
08.02.2022	227	11	3	09:49:46	09:51:38	5	9
08.02.2022	227	11	4	13:46:40	13:48:54	9	32
08.02.2022	227	11	5	14:33:12	14:35:30	9	24
08.02.2022	227	11	6	15:19:46	15:22:07	1	11
08.02.2022	222	12	1	08:16:40	08:17:52	14	33
08.02.2022	222	12	2	09:03:13	09:05:28	13	26

Table J.1: Raw data from the video analysis without empty cells. Includes total number of individuals feeding and total number of pellets eaten.

Date	Camera ID	Tank	No	Time from	Time to	Total # feeding	Total # pellets eaten
08.02.2022	222	12	3	09:49:46	09:52:55	9	25
08.02.2022	222	12	4	13:46:40	13:48:56	6	16
08.02.2022	222	12	5	14:33:12	14:35:30	7	14
08.02.2022	222	12	6	15:19:46	15:21:52	6	7
08.02.2022	228	16	1	08:16:40	08:18:33	14	41
08.02.2022	228	16	2	09:03:13	09:05:30	12	32
08.02.2022	228	16	3	09:49:46	09:52:21	9	24
08.02.2022	228	16	4	13:46:40	13:49:02	10	31
08.02.2022	228	16	5	14:33:12	14:35:39	8	19
08.02.2022	228	16	6	15:19:46	15:21:55	3	4
08.02.2022	221	17	1	08:16:40	08:18:35	15	46
08.02.2022	221	17	2	09:03:13	09:05:28	13	28
08.02.2022	221	17	3	09:49:46	09:52:07	13	44
08.02.2022	221	17	4	13:46:40	13:48:45	7	23
08.02.2022	221	17	5	14:33:12	14:35:33	8	16
08.02.2022	221	17	6	15:19:46	15:22:10	4	9
08.02.2022	224	18	1	08:16:40	08:18:04	14	33
08.02.2022	224	18	2	09:03:13	09:05:30	11	28
08.02.2022	224	18	3	09:49:46	09:52:03	9	21
08.02.2022	224	18	4	13:46:40	13:48:46	8	16
08.02.2022	224	18	5	14:33:12	14:35:15	2	2
08.02.2022	224	18	6	15:19:46	15:21:51	4	3
09.02.2022	229	7	1	08:16:40	08:18:45	4	18
09.02.2022	229	7	2	09:03:13	09:05:17	3	6
09.02.2022	229	7	4	13:46:40	13:48:43	6	17
09.02.2022	229	7	5	14:33:12	14:35:40	9	33
09.02.2022	223	8	1	08:16:40	08:19:23	7	15
09.02.2022	223	8	2	09:03:13	09:06:05	7	27
09.02.2022	223	8	4	13:46:40	13:48:42	9	22
09.02.2022	223	8	5	14:33:12	14:34:46	10	25

Table J.1: Raw data from the video analysis without empty cells. Includes total number of individuals feeding and total number of pellets eaten.

Date	Camera ID	Tank	No	Time from	Time to	Total # feeding	Total # pellets eaten
09.02.2022	223	8	6	15:19:46	15:21:47	8	14
09.02.2022	232	9	1	08:16:40	08:19:00	12	31
09.02.2022	232	9	2	09:03:13	09:05:28	9	16
09.02.2022	232	9	4	13:46:40	13:48:50	12	35
09.02.2022	232	9	5	14:33:12	14:35:36	12	38
09.02.2022	232	9	6	15:19:46	15:21:49	8	16
09.02.2022	167	10	1	08:16:40	08:19:00	13	40
09.02.2022	167	10	2	09:03:13	09:05:21	8	12
09.02.2022	167	10	4	13:46:40	13:48:51	8	27
09.02.2022	167	10	5	14:33:12	14:35:43	4	6
09.02.2022	167	10	6	15:19:46	15:21:54	7	13
09.02.2022	227	11	1	08:16:40	08:19:10	12	30
09.02.2022	227	11	2	09:03:13	09:05:30	4	12
09.02.2022	227	11	4	13:46:40	13:48:50	7	11
09.02.2022	227	11	5	14:33:12	14:35:24	6	27
09.02.2022	227	11	6	15:19:46	15:21:47	4	4
09.02.2022	222	12	1	08:16:40	08:18:52	9	33
09.02.2022	222	12	2	09:03:13	09:06:43	7	31
09.02.2022	222	12	4	13:46:40	13:49:54	8	27
09.02.2022	222	12	5	14:33:12	14:35:49	8	18
09.02.2022	222	12	6	15:19:46	15:21:54	5	9
09.02.2022	228	16	1	08:16:40	08:19:30	14	32
09.02.2022	228	16	2	09:03:13	09:06:05	8	25
09.02.2022	228	16	4	13:46:40	13:49:18	12	28
09.02.2022	228	16	5	14:33:12	14:35:34	8	17
09.02.2022	228	16	6	15:19:46	15:21:56	3	3
09.02.2022	221	17	1	08:16:40	08:18:53	10	33
09.02.2022	221	17	2	09:03:13	09:05:26	9	17
09.02.2022	221	17	4	13:46:40	13:48:48	10	33
09.02.2022	221	17	5	14:33:12	14:36:02	8	33

Table J.1: Raw data from the video analysis without empty cells. Includes total number of individuals feeding and total number of pellets eaten.

Date	Camera ID	Tank	No	Time from	Time to	Total # feeding	Total # pellets eaten
09.02.2022	221	17	6	15:19:46	15:21:56	6	10
09.02.2022	224	18	1	08:16:40	08:19:10	14	47
09.02.2022	224	18	2	09:03:13	09:06:07	10	27
09.02.2022	224	18	4	13:46:40	13:48:30	12	30
09.02.2022	224	18	5	14:33:12	14:35:28	5	9
09.02.2022	224	18	6	15:19:46	15:21:52	5	17
10.02.2022	223	8	1	08:16:40	08:18:39	15	41
10.02.2022	223	8	2	09:03:13	09:05:31	14	30
10.02.2022	223	8	4	13:46:40	13:48:38	11	31
10.02.2022	223	8	5	14:33:12	14:35:26	12	27
10.02.2022	223	8	6	15:19:46	15:21:56	9	23
10.02.2022	232	9	1	08:16:40	08:18:50	13	39
10.02.2022	232	9	2	09:03:13	09:05:49	9	19
10.02.2022	232	9	4	13:46:40	13:48:55	9	27
10.02.2022	232	9	5	14:33:12	14:35:28	7	15
10.02.2022	232	9	6	15:19:46	15:22:07	4	12
10.02.2022	167	10	1	08:16:40	08:18:27	15	38
10.02.2022	167	10	2	09:03:13	09:05:30	8	21
10.02.2022	167	10	4	13:46:40	13:48:48	11	34
10.02.2022	167	10	5	14:33:12	14:35:53	8	32
10.02.2022	167	10	6	15:19:46	15:21:52	2	6
10.02.2022	227	11	1	08:16:40	08:19:11	10	40
10.02.2022	227	11	2	09:03:13	09:05:30	6	8
10.02.2022	227	11	4	13:46:40	13:48:25	10	28
10.02.2022	227	11	5	14:33:12	14:35:57	8	23
10.02.2022	227	11	6	15:19:46	15:22:01	5	17
10.02.2022	222	12	1	08:16:40	08:18:44	11	40
10.02.2022	222	12	2	09:03:13	09:05:41	6	13
10.02.2022	222	12	4	13:46:40	13:48:48	12	33
10.02.2022	222	12	5	14:33:12	14:36:05	9	34

Table J.1: Raw data from the video analysis without empty cells. Includes total number of individuals feeding and total number of pellets eaten.

Date	Camera ID	Tank	No	Time from	Time to	Total # feeding	Total # pellets eaten
10.02.2022	228	16	1	08:16:40	08:18:00	13	35
10.02.2022	228	16	2	09:03:13	09:05:31	10	29
10.02.2022	228	16	4	13:46:40	13:48:53	12	42
10.02.2022	228	16	5	14:33:12	14:35:30	7	12
10.02.2022	228	16	6	15:19:46	15:21:51	7	12
10.02.2022	221	17	1	08:16:40	08:18:35	14	34
10.02.2022	221	17	2	09:03:13	09:05:36	11	35
10.02.2022	221	17	4	13:46:40	13:48:39	10	29
10.02.2022	221	17	5	14:33:12	14:36:25	11	46
10.02.2022	221	17	6	15:19:46	15:21:27	5	7
10.02.2022	224	18	1	08:16:40	08:18:50	17	54
10.02.2022	224	18	2	09:03:13	09:06:08	9	33
10.02.2022	224	18	4	13:46:40	13:48:58	10	34
10.02.2022	224	18	5	14:33:12	14:35:41	12	34
10.02.2022	224	18	6	15:19:46	15:22:06	5	9
11.02.2022	223	8	1	08:16:40	08:18:00	12	28
11.02.2022	223	8	2	09:03:13	09:05:16	9	19
11.02.2022	223	8	3	09:49:46	09:51:50	5	22
11.02.2022	223	8	4	13:45:14	13:47:22	9	40
11.02.2022	223	8	5	14:27:08	14:29:17	10	30
11.02.2022	223	8	6	15:22:59	15:25:01	1	1
11.02.2022	232	9	1	08:16:40	08:19:12	13	33
11.02.2022	232	9	2	09:03:13	09:05:27	7	13
11.02.2022	232	9	3	09:49:46	09:52:02	4	6
11.02.2022	232	9	4	13:45:10	13:47:21	11	39
11.02.2022	232	9	5	14:27:04	14:29:40	9	23
11.02.2022	232	9	6	15:22:59	15:25:28	7	14
11.02.2022	167	10	1	08:16:40	08:29:02	8	20
11.02.2022	167	10	2	09:03:13	09:05:26	5	7
11.02.2022	167	10	3	09:49:46	09:52:11	3	5

Table J.1: Raw data from the video analysis without empty cells. Includes total number of individuals feeding and total number of pellets eaten.

Date	Camera ID	Tank	No	Time from	Time to	Total # feeding	Total # pellets eaten
11.02.2022	167	10	4	13:45:10	13:47:19	2	3
11.02.2022	167	10	5	14:27:04	14:29:09	3	4
11.02.2022	167	10	6	15:22:59	15:25:11	2	2
11.02.2022	227	11	1	08:16:40	08:19:26	8	28
11.02.2022	227	11	2	09:03:13	09:05:21	7	16
11.02.2022	227	11	3	09:49:46	09:51:48	4	6
11.02.2022	227	11	4	13:45:10	13:47:53	9	29
11.02.2022	227	11	5	14:27:04	14:29:06	10	29
11.02.2022	227	11	6	15:22:59	15:25:23	4	6
11.02.2022	222	12	1	08:16:40	08:19:01	14	42
11.02.2022	222	12	2	09:03:13	09:05:34	10	28
11.02.2022	222	12	3	09:49:46	09:51:44	1	2
11.02.2022	222	12	4	13:45:14	13:46:55	9	32
11.02.2022	222	12	5	14:27:08	14:29:28	7	20
11.02.2022	222	12	6	15:22:59	15:25:58	7	15
11.02.2022	228	16	1	08:16:40	08:28:59	13	31
11.02.2022	228	16	2	09:03:13	09:05:21	6	8
11.02.2022	228	16	3	09:49:46	09:52:18	5	24
11.02.2022	228	16	4	13:45:10	13:47:27	14	38
11.02.2022	228	16	5	14:27:04	14:29:07	14	28
11.02.2022	228	16	6	15:22:59	15:25:01	4	15
11.02.2022	221	17	1	08:16:40	08:19:37	13	45
11.02.2022	221	17	2	09:03:13	09:06:06	9	21
11.02.2022	221	17	3	09:49:46	09:51:58	8	15
11.02.2022	221	17	4	13:45:14	13:46:34	12	36
11.02.2022	221	17	5	14:27:08	14:29:14	3	3
11.02.2022	221	17	6	15:22:59	15:25:41	3	3
11.02.2022	224	18	1	08:16:40	08:18:52	7	16
11.02.2022	224	18	2	09:03:13	09:05:34	8	47
11.02.2022	224	18	3	09:49:46	09:52:01	4	4

Table J.1: Raw data from the video analysis without empty cells. Includes total number of individuals feeding and total number of pellets eaten.

Date	Camera ID	Tank	No	Time from	Time to	Total # feeding	Total # pellets eaten
11.02.2022	224	18	4	13:45:12	13:47:45	12	41
11.02.2022	224	18	5	14:27:05	14:29:13	3	10
11.02.2022	224	18	6	15:22:59	15:25:07	2	2

Table J.2: Raw data from the video analysis without empty cells. Includes number of individuals eating from both water column and tank bottom and number of pellets eaten from both water column and tank bottom.

Date	Camera ID	Tank	No	Time from	Time to	# feeding from water column	# pellets eaten in water column	# feeding from tank bottom	# pellets eaten tank bottom
07.02.2022	229	7	4	13:46:40	13:49:02	5	5	7	25
07.02.2022	229	7	5	14:02:10	14:04:54	4	4	7	37
07.02.2022	229	7	6	14:33:12	14:35:38	4	6	7	19
07.02.2022	223	8	4	13:46:40	13:48:30	7	8	7	27
07.02.2022	223	8	5	14:02:10	14:04:20	6	10	7	33
07.02.2022	223	8	6	14:33:12	14:35:40	6	6	8	26
07.02.2022	232	9	4	13:46:40	13:48:10	8	10	8	17
07.02.2022	232	9	5	14:02:10	14:03:30	7	8	8	28
07.02.2022	232	9	6	14:33:12	14:35:46	6	7	5	17
07.02.2022	167	10	4	13:46:40	13:48:50	6	13	7	24
07.02.2022	167	10	5	14:02:10	14:04:59	7	11	6	17
07.02.2022	167	10	6	14:33:12	14:35:44	4	8	5	13
07.02.2022	227	11	4	13:46:40	13:48:22	7	10	6	23
07.02.2022	227	11	5	14:02:10	14:03:54	3	5	7	28
07.02.2022	227	11	6	14:33:13	14:36:10	4	4	6	35
07.02.2022	222	12	4	13:46:40	13:48:44	5	9	7	30
07.02.2022	222	12	5	14:02:11	14:04:51	7	8	6	29

Table J.2: Raw data from the video analysis without empty cells. Includes number of individuals eating from both water column and tank bottom and number of pellets eaten from both water column and tank bottom.

Date	Camera ID	Tank	No	Time from	Time to	# feeding from water column	# pellets eaten in water column	# feeding from tank bottom	# pellets eaten tank bottom
07.02.2022	222	12	6	14:33:12	14:36:07	6	7	5	31
07.02.2022	228	16	4	13:46:40	13:49:00	6	8	7	27
07.02.2022	228	16	5	14:02:10	14:04:32	8	6	7	18
07.02.2022	228	16	6	14:33:12	14:35:46	8	10	7	29
07.02.2022	221	17	4	13:46:40	13:49:40	6	6	6	24
07.02.2022	221	17	5	14:02:10	14:04:43	6	8	7	26
07.02.2022	221	17	6	14:33:12	14:35:30	7	9	6	29
07.02.2022	224	18	4	13:46:40	13:48:46	5	5	8	30
07.02.2022	224	18	5	14:02:11	14:04:47	5	5	5	18
07.02.2022	224	18	6	14:33:13	14:36:33	5	7	5	19
08.02.2022	229	7	1	08:16:40	08:18:13	6	9	7	26
08.02.2022	229	7	2	09:03:13	09:05:26	6	7	8	37
08.02.2022	229	7	3	09:49:46	09:51:48	3	4	4	13
08.02.2022	229	7	4	13:46:40	13:48:49	1	1	0	0
08.02.2022	229	7	5	14:33:12	14:35:29	1	1	2	10
08.02.2022	229	7	6	15:19:46	15:22:01	1	1	2	2
08.02.2022	223	8	1	08:16:40	08:28:51	7	10	7	25

Table J.2: Raw data from the video analysis without empty cells. Includes number of individuals eating from both water column and tank bottom and number of pellets eaten from both water column and tank bottom.

Date	Camera ID	Tank	No	Time from	Time to	# feeding from water column	# pellets eaten in water column	# feeding from tank bottom	# pellets eaten tank bottom
08.02.2022	223	8	2	09:03:13	09:05:07	6	6	6	19
08.02.2022	223	8	3	09:49:46	09:53:23	5	7	6	19
08.02.2022	223	8	4	13:46:40	13:49:15	3	4	4	12
08.02.2022	223	8	5	14:33:12	14:35:25	2	2	0	0
08.02.2022	223	8	6	15:19:46	15:22:06	2	3	3	10
08.02.2022	232	9	1	08:16:40	08:17:37	6	14	7	20
08.02.2022	232	9	2	09:03:13	09:05:16	4	7	4	12
08.02.2022	232	9	3	09:49:46	09:51:57	4	10	3	13
08.02.2022	232	9	4	13:46:40	13:48:48	6	10	8	36
08.02.2022	232	9	5	14:33:12	14:35:18	5	7	6	24
08.02.2022	232	9	6	15:19:46	15:21:45	4	4	5	16
08.02.2022	167	10	1	08:16:40	08:27:58	7	12	6	17
08.02.2022	167	10	2	09:03:13	09:05:06	5	6	8	22
08.02.2022	167	10	3	09:49:46	09:52:05	7	14	3	7
08.02.2022	167	10	4	13:46:40	13:49:07	4	6	6	23
08.02.2022	167	10	5	14:33:12	14:35:28	2	2	2	2
08.02.2022	167	10	6	15:19:46	15:21:46	3	3	1	1

Table J.2: Raw data from the video analysis without empty cells. Includes number of individuals eating from both water column and tank bottom and number of pellets eaten from both water column and tank bottom.

Date	Camera ID	Tank	No	Time from	Time to	# feeding from water column	# pellets eaten in water column	# feeding from tank bottom	# pellets eaten tank bottom
08.02.2022	227	11	1	08:16:40	08:18:45	2	3	5	18
08.02.2022	227	11	2	09:03:13	09:05:43	1	3	4	14
08.02.2022	227	11	3	09:49:46	09:51:38	2	2	3	7
08.02.2022	227	11	4	13:46:40	13:48:54	3	4	6	28
08.02.2022	227	11	5	14:33:12	14:35:30	3	6	6	18
08.02.2022	227	11	6	15:19:46	15:22:07	0	0	1	11
08.02.2022	222	12	1	08:16:40	08:17:52	6	9	8	24
08.02.2022	222	12	2	09:03:13	09:05:28	6	7	7	19
08.02.2022	222	12	3	09:49:46	09:52:55	5	6	4	19
08.02.2022	222	12	4	13:46:40	13:48:56	2	1	4	15
08.02.2022	222	12	5	14:33:12	14:35:30	3	3	4	11
08.02.2022	222	12	6	15:19:46	15:21:52	3	3	3	4
08.02.2022	228	16	1	08:16:40	08:18:33	7	12	7	29
08.02.2022	228	16	2	09:03:13	09:05:30	5	6	7	26
08.02.2022	228	16	3	09:49:46	09:52:21	6	9	3	15
08.02.2022	228	16	4	13:46:40	13:49:02	5	5	5	26
08.02.2022	228	16	5	14:33:12	14:35:39	4	6	4	13

Table J.2: Raw data from the video analysis without empty cells. Includes number of individuals eating from both water column and tank bottom and number of pellets eaten from both water column and tank bottom.

Date	Camera ID	Tank	No	Time from	Time to	# feeding from water column	# pellets eaten in water column	# feeding from tank bottom	# pellets eaten tank bottom
08.02.2022	228	16	6	15:19:46	15:21:55	3	4	0	0
08.02.2022	221	17	1	08:16:40	08:18:35	7	9	8	37
08.02.2022	221	17	2	09:03:13	09:05:28	7	10	6	18
08.02.2022	221	17	3	09:49:46	09:52:07	7	9	6	35
08.02.2022	221	17	4	13:46:40	13:48:45	3	5	4	18
08.02.2022	221	17	5	14:33:12	14:35:33	3	3	5	13
08.02.2022	221	17	6	15:19:46	15:22:10	2	4	2	5
08.02.2022	224	18	1	08:16:40	08:18:04	7	7	7	26
08.02.2022	224	18	2	09:03:13	09:05:30	5	5	6	23
08.02.2022	224	18	3	09:49:46	09:52:03	4	4	5	17
08.02.2022	224	18	4	13:46:40	13:48:46	2	1	6	15
08.02.2022	224	18	5	14:33:12	14:35:15	2	2	0	0
08.02.2022	224	18	6	15:19:46	15:21:51	3	2	1	1
09.02.2022	229	7	1	08:16:40	08:18:45	1	4	3	14
09.02.2022	229	7	2	09:03:13	09:05:17	2	3	1	3
09.02.2022	229	7	4	13:46:40	13:48:43	2	3	4	14
09.02.2022	229	7	5	14:33:12	14:35:40	4	5	5	28

Table J.2: Raw data from the video analysis without empty cells. Includes number of individuals eating from both water column and tank bottom and number of pellets eaten from both water column and tank bottom.

Date	Camera ID	Tank	No	Time from	Time to	# feeding from water column	# pellets eaten in water column	# feeding from tank bottom	# pellets eaten tank bottom
09.02.2022	223	8	1	08:16:40	08:19:23	2	2	5	13
09.02.2022	223	8	2	09:03:13	09:06:05	1	2	6	25
09.02.2022	223	8	4	13:46:40	13:48:42	2	2	7	20
09.02.2022	223	8	5	14:33:12	14:34:46	3	3	7	22
09.02.2022	223	8	6	15:19:46	15:21:47	3	3	5	11
09.02.2022	232	9	1	08:16:40	08:19:00	5	10	7	21
09.02.2022	232	9	2	09:03:13	09:05:28	4	6	5	10
09.02.2022	232	9	4	13:46:40	13:48:50	4	5	8	30
09.02.2022	232	9	5	14:33:12	14:35:36	4	7	8	31
09.02.2022	232	9	6	15:19:46	15:21:49	3	4	5	12
09.02.2022	167	10	1	08:16:40	08:19:00	6	8	7	32
09.02.2022	167	10	2	09:03:13	09:05:21	5	7	3	5
09.02.2022	167	10	4	13:46:40	13:48:51	5	10	3	17
09.02.2022	167	10	5	14:33:12	14:35:43	4	6	0	0
09.02.2022	167	10	6	15:19:46	15:21:54	5	11	2	2
09.02.2022	227	11	1	08:16:40	08:19:10	5	7	7	23
09.02.2022	227	11	2	09:03:13	09:05:30	2	4	2	8

Table J.2: Raw data from the video analysis without empty cells. Includes number of individuals eating from both water column and tank bottom and number of pellets eaten from both water column and tank bottom.

Date	Camera ID	Tank	No	Time from	Time to	# feeding from water column	# pellets eaten in water column	# feeding from tank bottom	# pellets eaten tank bottom
09.02.2022	227	11	4	13:46:40	13:48:50	4	5	3	6
09.02.2022	227	11	5	14:33:12	14:35:24	2	2	4	25
09.02.2022	227	11	6	15:19:46	15:21:47	2	2	2	2
09.02.2022	222	12	1	08:16:40	08:18:52	4	7	5	26
09.02.2022	222	12	2	09:03:13	09:06:43	2	3	5	28
09.02.2022	222	12	4	13:46:40	13:49:54	2	2	6	25
09.02.2022	222	12	5	14:33:12	14:35:49	2	2	6	16
09.02.2022	222	12	6	15:19:46	15:21:54	2	2	3	7
09.02.2022	228	16	1	08:16:40	08:19:30	6	8	8	24
09.02.2022	228	16	2	09:03:13	09:06:05	4	4	4	21
09.02.2022	228	16	4	13:46:40	13:49:18	5	7	7	21
09.02.2022	228	16	5	14:33:12	14:35:34	4	5	4	12
09.02.2022	228	16	6	15:19:46	15:21:56	3	3	0	0
09.02.2022	221	17	1	08:16:40	08:18:53	3	4	7	29
09.02.2022	221	17	2	09:03:13	09:05:26	3	5	6	12
09.02.2022	221	17	4	13:46:40	13:48:48	3	3	7	30
09.02.2022	221	17	5	14:33:12	14:36:02	2	2	6	31

Table J.2: Raw data from the video analysis without empty cells. Includes number of individuals eating from both water column and tank bottom and number of pellets eaten from both water column and tank bottom.

Date	Camera ID	Tank	No	Time from	Time to	# feeding from water column	# pellets eaten in water column	# feeding from tank bottom	# pellets eaten tank bottom
09.02.2022	221	17	6	15:19:46	15:21:56	5	8	1	2
09.02.2022	224	18	1	08:16:40	08:19:10	5	9	9	38
09.02.2022	224	18	2	09:03:13	09:06:07	3	3	7	24
09.02.2022	224	18	4	13:46:40	13:48:30	4	7	8	23
09.02.2022	224	18	5	14:33:12	14:35:28	2	2	3	7
09.02.2022	224	18	6	15:19:46	15:21:52	2	2	3	15
10.02.2022	223	8	1	08:16:40	08:18:39	6	12	9	29
10.02.2022	223	8	2	09:03:13	09:05:31	7	8	7	22
10.02.2022	223	8	4	13:46:40	13:48:38	5	12	6	19
10.02.2022	223	8	5	14:33:12	14:35:26	5	7	7	20
10.02.2022	223	8	6	15:19:46	15:21:56	3	4	6	19
10.02.2022	232	9	1	08:16:40	08:18:50	6	11	7	28
10.02.2022	232	9	2	09:03:13	09:05:49	3	6	6	13
10.02.2022	232	9	4	13:46:40	13:48:55	4	6	5	21
10.02.2022	232	9	5	14:33:12	14:35:28	3	4	4	11
10.02.2022	232	9	6	15:19:46	15:22:07	2	3	2	9
10.02.2022	167	10	1	08:16:40	08:18:27	8	7	7	31

Table J.2: Raw data from the video analysis without empty cells. Includes number of individuals eating from both water column and tank bottom and number of pellets eaten from both water column and tank bottom.

Date	Camera ID	Tank	No	Time from	Time to	# feeding from water column	# pellets eaten in water column	# feeding from tank bottom	# pellets eaten tank bottom
10.02.2022	167	10	2	09:03:13	09:05:30	4	5	4	16
10.02.2022	167	10	4	13:46:40	13:48:48	4	9	7	25
10.02.2022	167	10	5	14:33:12	14:35:53	3	8	5	24
10.02.2022	167	10	6	15:19:46	15:21:52	2	6	0	0
10.02.2022	227	11	1	08:16:40	08:19:11	4	9	6	31
10.02.2022	227	11	2	09:03:13	09:05:30	3	3	3	5
10.02.2022	227	11	4	13:46:40	13:48:25	4	5	6	23
10.02.2022	227	11	5	14:33:12	14:35:57	3	7	5	16
10.02.2022	227	11	6	15:19:46	15:22:01	2	4	3	13
10.02.2022	222	12	1	08:16:40	08:18:44	5	5	6	35
10.02.2022	222	12	2	09:03:13	09:05:41	1	2	5	11
10.02.2022	222	12	4	13:46:40	13:48:48	5	10	7	23
10.02.2022	222	12	5	14:33:12	14:36:05	3	5	6	29
10.02.2022	228	16	1	08:16:40	08:18:00	7	10	6	25
10.02.2022	228	16	2	09:03:13	09:05:31	5	7	5	22
10.02.2022	228	16	4	13:46:40	13:48:53	5	7	7	35
10.02.2022	228	16	5	14:33:12	14:35:30	5	6	2	6

Table J.2: Raw data from the video analysis without empty cells. Includes number of individuals eating from both water column and tank bottom and number of pellets eaten from both water column and tank bottom.

Date	Camera ID	Tank	No	Time from	Time to	# feeding from water column	# pellets eaten in water column	# feeding from tank bottom	# pellets eaten tank bottom
10.02.2022	228	16	6	15:19:46	15:21:51	4	6	3	6
10.02.2022	221	17	1	08:16:40	08:18:35	7	9	7	25
10.02.2022	221	17	2	09:03:13	09:05:36	5	11	6	24
10.02.2022	221	17	4	13:46:40	13:48:39	4	5	6	24
10.02.2022	221	17	5	14:33:12	14:36:25	4	8	7	38
10.02.2022	221	17	6	15:19:46	15:21:27	2	2	3	5
10.02.2022	224	18	1	08:16:40	08:18:50	7	9	10	45
10.02.2022	224	18	2	09:03:13	09:06:08	4	7	5	26
10.02.2022	224	18	4	13:46:40	13:48:58	4	5	6	29
10.02.2022	224	18	5	14:33:12	14:35:41	4	5	8	29
10.02.2022	224	18	6	15:19:46	15:22:06	3	3	2	6
11.02.2022	223	8	1	08:16:40	08:18:00	5	5	7	23
11.02.2022	223	8	2	09:03:13	09:05:16	2	2	7	17
11.02.2022	223	8	3	09:49:46	09:51:50	2	5	3	17
11.02.2022	223	8	4	13:45:14	13:47:22	3	5	6	35
11.02.2022	223	8	5	14:27:08	14:29:17	4	7	6	23
11.02.2022	223	8	6	15:22:59	15:25:01	0	0	1	1

Table J.2: Raw data from the video analysis without empty cells. Includes number of individuals eating from both water column and tank bottom and number of pellets eaten from both water column and tank bottom.

Date	Camera ID	Tank	No	Time from	Time to	# feeding from water column	# pellets eaten in water column	# feeding from tank bottom	# pellets eaten tank bottom
11.02.2022	232	9	1	08:16:40	08:19:12	7	12	6	21
11.02.2022	232	9	2	09:03:13	09:05:27	4	6	3	7
11.02.2022	232	9	3	09:49:46	09:52:02	3	5	1	1
11.02.2022	232	9	4	13:45:10	13:47:21	4	7	7	32
11.02.2022	232	9	5	14:27:04	14:29:40	4	7	5	16
11.02.2022	232	9	6	15:22:59	15:25:28	4	6	3	8
11.02.2022	167	10	1	08:16:40	08:29:02	3	3	5	17
11.02.2022	167	10	2	09:03:13	09:05:26	4	6	1	1
11.02.2022	167	10	3	09:49:46	09:52:11	2	4	1	1
11.02.2022	167	10	4	13:45:10	13:47:19	1	2	1	1
11.02.2022	167	10	5	14:27:04	14:29:09	3	4	0	0
11.02.2022	167	10	6	15:22:59	15:25:11	2	2	0	0
11.02.2022	227	11	1	08:16:40	08:19:26	4	7	4	21
11.02.2022	227	11	2	09:03:13	09:05:21	3	8	4	8
11.02.2022	227	11	3	09:49:46	09:51:48	1	3	3	3
11.02.2022	227	11	4	13:45:10	13:47:53	4	5	5	24
11.02.2022	227	11	5	14:27:04	14:29:06	3	6	7	23

Table J.2: Raw data from the video analysis without empty cells. Includes number of individuals eating from both water column and tank bottom and number of pellets eaten from both water column and tank bottom.

Date	Camera ID	Tank	No	Time from	Time to	# feeding from water column	# pellets eaten in water column	# feeding from tank bottom	# pellets eaten tank bottom
11.02.2022	227	11	6	15:22:59	15:25:23	2	2	2	4
11.02.2022	222	12	1	08:16:40	08:19:01	6	10	8	32
11.02.2022	222	12	2	09:03:13	09:05:34	5	7	5	21
11.02.2022	222	12	3	09:49:46	09:51:44	1	2	0	0
11.02.2022	222	12	4	13:45:14	13:46:55	2	2	7	30
11.02.2022	222	12	5	14:27:08	14:29:28	3	4	4	16
11.02.2022	222	12	6	15:22:59	15:25:58	2	2	5	13
11.02.2022	228	16	1	08:16:40	08:28:59	6	7	7	24
11.02.2022	228	16	2	09:03:13	09:05:21	3	3	3	5
11.02.2022	228	16	3	09:49:46	09:52:18	2	2	3	22
11.02.2022	228	16	4	13:45:10	13:47:27	6	12	8	26
11.02.2022	228	16	5	14:27:04	14:29:07	6	7	8	21
11.02.2022	228	16	6	15:22:59	15:25:01	3	5	1	10
11.02.2022	221	17	1	08:16:40	08:19:37	6	8	7	37
11.02.2022	221	17	2	09:03:13	09:06:06	3	4	6	17
11.02.2022	221	17	3	09:49:46	09:51:58	3	3	5	12
11.02.2022	221	17	4	13:45:14	13:46:34	5	6	7	30

Table J.2: Raw data from the video analysis without empty cells. Includes number of individuals eating from both water column and tank bottom and number of pellets eaten from both water column and tank bottom.

Date	Camera ID	Tank	No	Time from	Time to	# feeding from water column	# pellets eaten in water column	# feeding from tank bottom	# pellets eaten tank bottom
11.02.2022	221	17	5	14:27:08	14:29:14	1	1	2	2
11.02.2022	221	17	6	15:22:59	15:25:41	1	1	2	2
11.02.2022	224	18	1	08:16:40	08:18:52	3	5	4	11
11.02.2022	224	18	2	09:03:13	09:05:34	2	2	6	45
11.02.2022	224	18	3	09:49:46	09:52:01	3	3	1	1
11.02.2022	224	18	4	13:45:12	13:47:45	5	8	7	33
11.02.2022	224	18	5	14:27:05	14:29:13	2	6	1	4
11.02.2022	224	18	6	15:22:59	15:25:07	2	2	0	0

Table J.3: Raw data from the video analysis without empty cells. Includes number of fish in camera view before feed drop and maximum number of fish in camera view at the same time.

Date	Camera ID	Tank	No	Time from	Time to	# fish in camera before feeding	max # fish in camera
07.02.2022	229	7	4	13:46:40	13:49:02	10	10
07.02.2022	229	7	5	14:02:10	14:04:54	8	9
07.02.2022	229	7	6	14:33:12	14:35:38	9	10
07.02.2022	223	8	4	13:46:40	13:48:30	7	9
07.02.2022	223	8	5	14:02:10	14:04:20	7	9
07.02.2022	223	8	6	14:33:12	14:35:40	9	9
07.02.2022	232	9	4	13:46:40	13:48:10	5	9
07.02.2022	232	9	5	14:02:10	14:03:30	4	9
07.02.2022	232	9	6	14:33:12	14:35:46	6	9
07.02.2022	167	10	4	13:46:40	13:48:50	7	10
07.02.2022	167	10	5	14:02:10	14:04:59	7	9
07.02.2022	167	10	6	14:33:12	14:35:44	7	9
07.02.2022	227	11	4	13:46:40	13:48:22	3	9
07.02.2022	227	11	5	14:02:10	14:03:54	4	8
07.02.2022	227	11	6	14:33:13	14:36:10	4	7
07.02.2022	222	12	4	13:46:40	13:48:44	6	8
07.02.2022	222	12	5	14:02:11	14:04:51	8	9
07.02.2022	222	12	6	14:33:12	14:36:07	7	9
07.02.2022	228	16	4	13:46:40	13:49:00	7	9
07.02.2022	228	16	5	14:02:10	14:04:32	6	10
07.02.2022	228	16	6	14:33:12	14:35:46	8	10
07.02.2022	221	17	4	13:46:40	13:49:40	5	9
07.02.2022	221	17	5	14:02:10	14:04:43	5	9
07.02.2022	221	17	6	14:33:12	14:35:30	7	9
07.02.2022	224	18	4	13:46:40	13:48:46	7	9
07.02.2022	224	18	5	14:02:11	14:04:47	7	8
07.02.2022	224	18	6	14:33:13	14:36:33	6	7
08.02.2022	229	7	1	08:16:40	08:18:13	9	9
08.02.2022	229	7	2	09:03:13	09:05:26	8	9

Table J.3: Raw data from the video analysis without empty cells. Includes number of fish in camera view before feed drop and maximum number of fish in camera view at the same time.

Date	Camera ID	Tank	No	Time from	Time to	# fish in camera before feeding	max # fish in camera
08.02.2022	229	7	3	09:49:46	09:51:48	10	10
08.02.2022	229	7	4	13:46:40	13:48:49	10	10
08.02.2022	229	7	5	14:33:12	14:35:29	9	10
08.02.2022	229	7	6	15:19:46	15:22:01	9	10
08.02.2022	223	8	1	08:16:40	08:28:51	8	10
08.02.2022	223	8	2	09:03:13	09:05:07	8	9
08.02.2022	223	8	3	09:49:46	09:53:23	9	10
08.02.2022	223	8	4	13:46:40	13:49:15	8	9
08.02.2022	223	8	5	14:33:12	14:35:25	8	9
08.02.2022	223	8	6	15:19:46	15:22:06	8	9
08.02.2022	232	9	1	08:16:40	08:17:37	6	9
08.02.2022	232	9	2	09:03:13	09:05:16	5	7
08.02.2022	232	9	3	09:49:46	09:51:57	4	6
08.02.2022	232	9	4	13:46:40	13:48:48	5	9
08.02.2022	232	9	5	14:33:12	14:35:18	6	8
08.02.2022	232	9	6	15:19:46	15:21:45	6	8
08.02.2022	167	10	1	08:16:40	08:27:58	7	9
08.02.2022	167	10	2	09:03:13	09:05:06	6	8
08.02.2022	167	10	3	09:49:46	09:52:05	4	7
08.02.2022	167	10	4	13:46:40	13:49:07	7	9
08.02.2022	167	10	5	14:33:12	14:35:28	8	9
08.02.2022	167	10	6	15:19:46	15:21:46	7	8
08.02.2022	227	11	1	08:16:40	08:18:45	4	7
08.02.2022	227	11	2	09:03:13	09:05:43	6	7
08.02.2022	227	11	3	09:49:46	09:51:38	5	7
08.02.2022	227	11	4	13:46:40	13:48:54	7	8
08.02.2022	227	11	5	14:33:12	14:35:30	7	9
08.02.2022	227	11	6	15:19:46	15:22:07	6	7
08.02.2022	222	12	1	08:16:40	08:17:52	9	10

Table J.3: Raw data from the video analysis without empty cells. Includes number of fish in camera view before feed drop and maximum number of fish in camera view at the same time.

Date	Camera ID	Tank	No	Time from	Time to	# fish in camera before feeding	max # fish in camera
08.02.2022	222	12	2	09:03:13	09:05:28	6	8
08.02.2022	222	12	3	09:49:46	09:52:55	7	9
08.02.2022	222	12	4	13:46:40	13:48:56	7	9
08.02.2022	222	12	5	14:33:12	14:35:30	6	8
08.02.2022	222	12	6	15:19:46	15:21:52	8	8
08.02.2022	228	16	1	08:16:40	08:18:33	8	9
08.02.2022	228	16	2	09:03:13	09:05:30	8	9
08.02.2022	228	16	3	09:49:46	09:52:21	7	8
08.02.2022	228	16	4	13:46:40	13:49:02	7	10
08.02.2022	228	16	5	14:33:12	14:35:39	7	9
08.02.2022	228	16	6	15:19:46	15:21:55	8	9
08.02.2022	221	17	1	08:16:40	08:18:35	9	9
08.02.2022	221	17	2	09:03:13	09:05:28	6	9
08.02.2022	221	17	3	09:49:46	09:52:07	6	9
08.02.2022	221	17	4	13:46:40	13:48:45	9	10
08.02.2022	221	17	5	14:33:12	14:35:33	8	9
08.02.2022	221	17	6	15:19:46	15:22:10	7	8
08.02.2022	224	18	1	08:16:40	08:18:04	5	8
08.02.2022	224	18	2	09:03:13	09:05:30	6	9
08.02.2022	224	18	3	09:49:46	09:52:03	6	8
08.02.2022	224	18	4	13:46:40	13:48:46	6	8
08.02.2022	224	18	5	14:33:12	14:35:15	7	8
08.02.2022	224	18	6	15:19:46	15:21:51	6	7
09.02.2022	229	7	1	08:16:40	08:18:45	9	10
09.02.2022	229	7	2	09:03:13	09:05:17	10	10
09.02.2022	229	7	4	13:46:40	13:48:43	10	10
09.02.2022	229	7	5	14:33:12	14:35:40	10	10
09.02.2022	223	8	1	08:16:40	08:19:23	9	10
09.02.2022	223	8	2	09:03:13	09:06:05	9	10

Table J.3: Raw data from the video analysis without empty cells. Includes number of fish in camera view before feed drop and maximum number of fish in camera view at the same time.

Date	Camera ID	Tank	No	Time from	Time to	# fish in camera before feeding	max # fish in camera
09.02.2022	223	8	4	13:46:40	13:48:42	9	10
09.02.2022	223	8	5	14:33:12	14:34:46	9	10
09.02.2022	223	8	6	15:19:46	15:21:47	8	10
09.02.2022	232	9	1	08:16:40	08:19:00	5	9
09.02.2022	232	9	2	09:03:13	09:05:28	5	7
09.02.2022	232	9	4	13:46:40	13:48:50	6	9
09.02.2022	232	9	5	14:33:12	14:35:36	7	8
09.02.2022	232	9	6	15:19:46	15:21:49	7	8
09.02.2022	167	10	1	08:16:40	08:19:00	9	10
09.02.2022	167	10	2	09:03:13	09:05:21	9	10
09.02.2022	167	10	4	13:46:40	13:48:51	7	9
09.02.2022	167	10	5	14:33:12	14:35:43	8	8
09.02.2022	167	10	6	15:19:46	15:21:54	7	7
09.02.2022	227	11	1	08:16:40	08:19:10	7	8
09.02.2022	227	11	2	09:03:13	09:05:30	5	6
09.02.2022	227	11	4	13:46:40	13:48:50	5	6
09.02.2022	227	11	5	14:33:12	14:35:24	5	7
09.02.2022	227	11	6	15:19:46	15:21:47	4	6
09.02.2022	222	12	1	08:16:40	08:18:52	5	8
09.02.2022	222	12	2	09:03:13	09:06:43	6	8
09.02.2022	222	12	4	13:46:40	13:49:54	7	10
09.02.2022	222	12	5	14:33:12	14:35:49	4	8
09.02.2022	222	12	6	15:19:46	15:21:54	6	7
09.02.2022	228	16	1	08:16:40	08:19:30	7	10
09.02.2022	228	16	2	09:03:13	09:06:05	9	9
09.02.2022	228	16	4	13:46:40	13:49:18	7	9
09.02.2022	228	16	5	14:33:12	14:35:34	6	8
09.02.2022	228	16	6	15:19:46	15:21:56	7	8
09.02.2022	221	17	1	08:16:40	08:18:53	5	10

Table J.3: Raw data from the video analysis without empty cells. Includes number of fish in camera view before feed drop and maximum number of fish in camera view at the same time.

Date	Camera ID	Tank	No	Time from	Time to	# fish in camera before feeding	max # fish in camera
09.02.2022	221	17	2	09:03:13	09:05:26	6	8
09.02.2022	221	17	4	13:46:40	13:48:48	5	9
09.02.2022	221	17	5	14:33:12	14:36:02	6	8
09.02.2022	221	17	6	15:19:46	15:21:56	7	7
09.02.2022	224	18	1	08:16:40	08:19:10	7	10
09.02.2022	224	18	2	09:03:13	09:06:07	7	9
09.02.2022	224	18	4	13:46:40	13:48:30	7	8
09.02.2022	224	18	5	14:33:12	14:35:28	6	9
09.02.2022	224	18	6	15:19:46	15:21:52	7	9
10.02.2022	223	8	1	08:16:40	08:18:39	7	10
10.02.2022	223	8	2	09:03:13	09:05:31	7	9
10.02.2022	223	8	4	13:46:40	13:48:38	8	9
10.02.2022	223	8	5	14:33:12	14:35:26	8	10
10.02.2022	223	8	6	15:19:46	15:21:56	7	9
10.02.2022	232	9	1	08:16:40	08:18:50	5	9
10.02.2022	232	9	2	09:03:13	09:05:49	6	8
10.02.2022	232	9	4	13:46:40	13:48:55	5	8
10.02.2022	232	9	5	14:33:12	14:35:28	5	6
10.02.2022	232	9	6	15:19:46	15:22:07	7	9
10.02.2022	167	10	1	08:16:40	08:18:27	9	10
10.02.2022	167	10	2	09:03:13	09:05:30	8	9
10.02.2022	167	10	4	13:46:40	13:48:48	6	9
10.02.2022	167	10	5	14:33:12	14:35:53	6	8
10.02.2022	167	10	6	15:19:46	15:21:52	7	7
10.02.2022	227	11	1	08:16:40	08:19:11	4	8
10.02.2022	227	11	2	09:03:13	09:05:30	5	7
10.02.2022	227	11	4	13:46:40	13:48:25	4	8
10.02.2022	227	11	5	14:33:12	14:35:57	4	7
10.02.2022	227	11	6	15:19:46	15:22:01	5	7

Table J.3: Raw data from the video analysis without empty cells. Includes number of fish in camera view before feed drop and maximum number of fish in camera view at the same time.

Date	Camera ID	Tank	No	Time from	Time to	# fish in camera before feeding	max # fish in camera
10.02.2022	222	12	1	08:16:40	08:18:44	5	8
10.02.2022	222	12	2	09:03:13	09:05:41	7	9
10.02.2022	222	12	4	13:46:40	13:48:48	7	9
10.02.2022	222	12	5	14:33:12	14:36:05	6	8
10.02.2022	228	16	1	08:16:40	08:18:00	6	9
10.02.2022	228	16	2	09:03:13	09:05:31	6	8
10.02.2022	228	16	4	13:46:40	13:48:53	6	8
10.02.2022	228	16	5	14:33:12	14:35:30	7	8
10.02.2022	228	16	6	15:19:46	15:21:51	6	8
10.02.2022	221	17	1	08:16:40	08:18:35	7	10
10.02.2022	221	17	2	09:03:13	09:05:36	7	10
10.02.2022	221	17	4	13:46:40	13:48:39	6	8
10.02.2022	221	17	5	14:33:12	14:36:25	6	8
10.02.2022	221	17	6	15:19:46	15:21:27	5	7
10.02.2022	224	18	1	08:16:40	08:18:50	7	10
10.02.2022	224	18	2	09:03:13	09:06:08	6	8
10.02.2022	224	18	4	13:46:40	13:48:58	6	8
10.02.2022	224	18	5	14:33:12	14:35:41	7	9
10.02.2022	224	18	6	15:19:46	15:22:06	7	9
11.02.2022	223	8	1	08:16:40	08:18:00	8	10
11.02.2022	223	8	2	09:03:13	09:05:16	8	9
11.02.2022	223	8	3	09:49:46	09:51:50	10	10
11.02.2022	223	8	4	13:45:14	13:47:22	7	9
11.02.2022	223	8	5	14:27:08	14:29:17	9	10
11.02.2022	223	8	6	15:22:59	15:25:01	8	9
11.02.2022	232	9	1	08:16:40	08:19:12	6	9
11.02.2022	232	9	2	09:03:13	09:05:27	4	7
11.02.2022	232	9	3	09:49:46	09:52:02	5	7
11.02.2022	232	9	4	13:45:10	13:47:21	4	8

Table J.3: Raw data from the video analysis without empty cells. Includes number of fish in camera view before feed drop and maximum number of fish in camera view at the same time.

Date	Camera ID	Tank	No	Time from	Time to	# fish in camera before feeding	max # fish in camera
11.02.2022	232	9	5	14:27:04	14:29:40	5	7
11.02.2022	232	9	6	15:22:59	15:25:28	4	7
11.02.2022	167	10	1	08:16:40	08:29:02	6	10
11.02.2022	167	10	2	09:03:13	09:05:26	7	8
11.02.2022	167	10	3	09:49:46	09:52:11	8	10
11.02.2022	167	10	4	13:45:10	13:47:19	8	10
11.02.2022	167	10	5	14:27:04	14:29:09	7	8
11.02.2022	167	10	6	15:22:59	15:25:11	7	9
11.02.2022	227	11	1	08:16:40	08:19:26	4	7
11.02.2022	227	11	2	09:03:13	09:05:21	4	6
11.02.2022	227	11	3	09:49:46	09:51:48	3	4
11.02.2022	227	11	4	13:45:10	13:47:53	5	8
11.02.2022	227	11	5	14:27:04	14:29:06	5	8
11.02.2022	227	11	6	15:22:59	15:25:23	4	6
11.02.2022	222	12	1	08:16:40	08:19:01	7	9
11.02.2022	222	12	2	09:03:13	09:05:34	6	7
11.02.2022	222	12	3	09:49:46	09:51:44	5	6
11.02.2022	222	12	4	13:45:14	13:46:55	7	9
11.02.2022	222	12	5	14:27:08	14:29:28	6	10
11.02.2022	222	12	6	15:22:59	15:25:58	7	9
11.02.2022	228	16	1	08:16:40	08:28:59	7	9
11.02.2022	228	16	2	09:03:13	09:05:21	8	8
11.02.2022	228	16	3	09:49:46	09:52:18	6	7
11.02.2022	228	16	4	13:45:10	13:47:27	7	9
11.02.2022	228	16	5	14:27:04	14:29:07	8	9
11.02.2022	228	16	6	15:22:59	15:25:01	8	8
11.02.2022	221	17	1	08:16:40	08:19:37	7	9
11.02.2022	221	17	2	09:03:13	09:06:06	7	8
11.02.2022	221	17	3	09:49:46	09:51:58	7	8

Table J.3: Raw data from the video analysis without empty cells. Includes number of fish in camera view before feed drop and maximum number of fish in camera view at the same time.

Date	Camera ID	Tank	No	Time from	Time to	# fish in camera before feeding	max # fish in camera
11.02.2022	221	17	4	13:45:14	13:46:34	6	9
11.02.2022	221	17	5	14:27:08	14:29:14	7	8
11.02.2022	221	17	6	15:22:59	15:25:41	7	7
11.02.2022	224	18	1	08:16:40	08:18:52	4	6
11.02.2022	224	18	2	09:03:13	09:05:34	5	7
11.02.2022	224	18	3	09:49:46	09:52:01	5	6
11.02.2022	224	18	4	13:45:12	13:47:45	7	10
11.02.2022	224	18	5	14:27:05	14:29:13	6	8
11.02.2022	224	18	6	15:22:59	15:25:07	6	6

Table J.4: Raw data from the video analysis without empty cells. Includes number of fish showing no interest in feed.

Date	Camera ID	Tank	No	Time from	Time to	# fish no interest in feed
07.02.2022	229	7	4	13:46:40	13:49:02	1
07.02.2022	229	7	5	14:02:10	14:04:54	0
07.02.2022	229	7	6	14:33:12	14:35:38	0
07.02.2022	223	8	4	13:46:40	13:48:30	0
07.02.2022	223	8	5	14:02:10	14:04:20	0
07.02.2022	223	8	6	14:33:12	14:35:40	0
07.02.2022	232	9	4	13:46:40	13:48:10	0
07.02.2022	232	9	5	14:02:10	14:03:30	0
07.02.2022	232	9	6	14:33:12	14:35:46	0
07.02.2022	167	10	4	13:46:40	13:48:50	0
07.02.2022	167	10	5	14:02:10	14:04:59	0
07.02.2022	167	10	6	14:33:12	14:35:44	1
07.02.2022	227	11	4	13:46:40	13:48:22	0
07.02.2022	227	11	5	14:02:10	14:03:54	0
07.02.2022	227	11	6	14:33:13	14:36:10	0
07.02.2022	222	12	4	13:46:40	13:48:44	0
07.02.2022	222	12	5	14:02:11	14:04:51	0
07.02.2022	222	12	6	14:33:12	14:36:07	0
07.02.2022	228	16	4	13:46:40	13:49:00	0
07.02.2022	228	16	5	14:02:10	14:04:32	0
07.02.2022	228	16	6	14:33:12	14:35:46	0
07.02.2022	221	17	4	13:46:40	13:49:40	0
07.02.2022	221	17	5	14:02:10	14:04:43	0
07.02.2022	221	17	6	14:33:12	14:35:30	0
07.02.2022	224	18	4	13:46:40	13:48:46	0
07.02.2022	224	18	5	14:02:11	14:04:47	0
07.02.2022	224	18	6	14:33:13	14:36:33	0
08.02.2022	229	7	1	08:16:40	08:18:13	0
08.02.2022	229	7	2	09:03:13	09:05:26	0

Table J.4: Raw data from the video analysis without empty cells. Includes number of fish showing no interest in feed.

Date	Camera ID	Tank	No	Time from	Time to	# fish no interest in feed
08.02.2022	229	7	3	09:49:46	09:51:48	3
08.02.2022	229	7	4	13:46:40	13:48:49	9
08.02.2022	229	7	5	14:33:12	14:35:29	8
08.02.2022	229	7	6	15:19:46	15:22:01	7
08.02.2022	223	8	1	08:16:40	08:28:51	0
08.02.2022	223	8	2	09:03:13	09:05:07	0
08.02.2022	223	8	3	09:49:46	09:53:23	0
08.02.2022	223	8	4	13:46:40	13:49:15	4
08.02.2022	223	8	5	14:33:12	14:35:25	8
08.02.2022	223	8	6	15:19:46	15:22:06	5
08.02.2022	232	9	1	08:16:40	08:17:37	0
08.02.2022	232	9	2	09:03:13	09:05:16	0
08.02.2022	232	9	3	09:49:46	09:51:57	0
08.02.2022	232	9	4	13:46:40	13:48:48	0
08.02.2022	232	9	5	14:33:12	14:35:18	0
08.02.2022	232	9	6	15:19:46	15:21:45	0
08.02.2022	167	10	1	08:16:40	08:27:58	0
08.02.2022	167	10	2	09:03:13	09:05:06	0
08.02.2022	167	10	3	09:49:46	09:52:05	0
08.02.2022	167	10	4	13:46:40	13:49:07	1
08.02.2022	167	10	5	14:33:12	14:35:28	4
08.02.2022	167	10	6	15:19:46	15:21:46	4
08.02.2022	227	11	1	08:16:40	08:18:45	0
08.02.2022	227	11	2	09:03:13	09:05:43	2
08.02.2022	227	11	3	09:49:46	09:51:38	2
08.02.2022	227	11	4	13:46:40	13:48:54	0
08.02.2022	227	11	5	14:33:12	14:35:30	0
08.02.2022	227	11	6	15:19:46	15:22:07	6
08.02.2022	222	12	1	08:16:40	08:17:52	0

Table J.4: Raw data from the video analysis without empty cells. Includes number of fish showing no interest in feed.

Date	Camera ID	Tank	No	Time from	Time to	# fish no interest in feed
08.02.2022	222	12	2	09:03:13	09:05:28	0
08.02.2022	222	12	3	09:49:46	09:52:55	0
08.02.2022	222	12	4	13:46:40	13:48:56	5
08.02.2022	222	12	5	14:33:12	14:35:30	4
08.02.2022	222	12	6	15:19:46	15:21:52	3
08.02.2022	228	16	1	08:16:40	08:18:33	0
08.02.2022	228	16	2	09:03:13	09:05:30	0
08.02.2022	228	16	3	09:49:46	09:52:21	1
08.02.2022	228	16	4	13:46:40	13:49:02	0
08.02.2022	228	16	5	14:33:12	14:35:39	2
08.02.2022	228	16	6	15:19:46	15:21:55	7
08.02.2022	221	17	1	08:16:40	08:18:35	0
08.02.2022	221	17	2	09:03:13	09:05:28	0
08.02.2022	221	17	3	09:49:46	09:52:07	0
08.02.2022	221	17	4	13:46:40	13:48:45	5
08.02.2022	221	17	5	14:33:12	14:35:33	3
08.02.2022	221	17	6	15:19:46	15:22:10	5
08.02.2022	224	18	1	08:16:40	08:18:04	0
08.02.2022	224	18	2	09:03:13	09:05:30	0
08.02.2022	224	18	3	09:49:46	09:52:03	0
08.02.2022	224	18	4	13:46:40	13:48:46	2
08.02.2022	224	18	5	14:33:12	14:35:15	6
08.02.2022	224	18	6	15:19:46	15:21:51	4
09.02.2022	229	7	1	08:16:40	08:18:45	5
09.02.2022	229	7	2	09:03:13	09:05:17	7
09.02.2022	229	7	4	13:46:40	13:48:43	5
09.02.2022	229	7	5	14:33:12	14:35:40	3
09.02.2022	223	8	1	08:16:40	08:19:23	2
09.02.2022	223	8	2	09:03:13	09:06:05	2

Table J.4: Raw data from the video analysis without empty cells. Includes number of fish showing no interest in feed.

Date	Camera ID	Tank	No	Time from	Time to	# fish no interest in feed
09.02.2022	223	8	4	13:46:40	13:48:42	2
09.02.2022	223	8	5	14:33:12	14:34:46	0
09.02.2022	223	8	6	15:19:46	15:21:47	2
09.02.2022	232	9	1	08:16:40	08:19:00	0
09.02.2022	232	9	2	09:03:13	09:05:28	0
09.02.2022	232	9	4	13:46:40	13:48:50	0
09.02.2022	232	9	5	14:33:12	14:35:36	0
09.02.2022	232	9	6	15:19:46	15:21:49	0
09.02.2022	167	10	1	08:16:40	08:19:00	0
09.02.2022	167	10	2	09:03:13	09:05:21	2
09.02.2022	167	10	4	13:46:40	13:48:51	2
09.02.2022	167	10	5	14:33:12	14:35:43	4
09.02.2022	167	10	6	15:19:46	15:21:54	2
09.02.2022	227	11	1	08:16:40	08:19:10	0
09.02.2022	227	11	2	09:03:13	09:05:30	0
09.02.2022	227	11	4	13:46:40	13:48:50	0
09.02.2022	227	11	5	14:33:12	14:35:24	1
09.02.2022	227	11	6	15:19:46	15:21:47	2
09.02.2022	222	12	1	08:16:40	08:18:52	0
09.02.2022	222	12	2	09:03:13	09:06:43	2
09.02.2022	222	12	4	13:46:40	13:49:54	0
09.02.2022	222	12	5	14:33:12	14:35:49	1
09.02.2022	222	12	6	15:19:46	15:21:54	4
09.02.2022	228	16	1	08:16:40	08:19:30	0
09.02.2022	228	16	2	09:03:13	09:06:05	2
09.02.2022	228	16	4	13:46:40	13:49:18	0
09.02.2022	228	16	5	14:33:12	14:35:34	0
09.02.2022	228	16	6	15:19:46	15:21:56	4
09.02.2022	221	17	1	08:16:40	08:18:53	1

Table J.4: Raw data from the video analysis without empty cells. Includes number of fish showing no interest in feed.

Date	Camera ID	Tank	No	Time from	Time to	# fish no interest in feed
09.02.2022	221	17	2	09:03:13	09:05:26	0
09.02.2022	221	17	4	13:46:40	13:48:48	0
09.02.2022	221	17	5	14:33:12	14:36:02	0
09.02.2022	221	17	6	15:19:46	15:21:56	2
09.02.2022	224	18	1	08:16:40	08:19:10	0
09.02.2022	224	18	2	09:03:13	09:06:07	1
09.02.2022	224	18	4	13:46:40	13:48:30	0
09.02.2022	224	18	5	14:33:12	14:35:28	4
09.02.2022	224	18	6	15:19:46	15:21:52	4
10.02.2022	223	8	1	08:16:40	08:18:39	0
10.02.2022	223	8	2	09:03:13	09:05:31	0
10.02.2022	223	8	4	13:46:40	13:48:38	0
10.02.2022	223	8	5	14:33:12	14:35:26	0
10.02.2022	223	8	6	15:19:46	15:21:56	2
10.02.2022	232	9	1	08:16:40	08:18:50	0
10.02.2022	232	9	2	09:03:13	09:05:49	1
10.02.2022	232	9	4	13:46:40	13:48:55	0
10.02.2022	232	9	5	14:33:12	14:35:28	0
10.02.2022	232	9	6	15:19:46	15:22:07	3
10.02.2022	167	10	1	08:16:40	08:18:27	0
10.02.2022	167	10	2	09:03:13	09:05:30	2
10.02.2022	167	10	4	13:46:40	13:48:48	0
10.02.2022	167	10	5	14:33:12	14:35:53	2
10.02.2022	167	10	6	15:19:46	15:21:52	5
10.02.2022	227	11	1	08:16:40	08:19:11	0
10.02.2022	227	11	2	09:03:13	09:05:30	1
10.02.2022	227	11	4	13:46:40	13:48:25	0
10.02.2022	227	11	5	14:33:12	14:35:57	0
10.02.2022	227	11	6	15:19:46	15:22:01	3

Table J.4: Raw data from the video analysis without empty cells. Includes number of fish showing no interest in feed.

Date	Camera ID	Tank	No	Time from	Time to	# fish no interest in feed
10.02.2022	222	12	1	08:16:40	08:18:44	0
10.02.2022	222	12	2	09:03:13	09:05:41	2
10.02.2022	222	12	4	13:46:40	13:48:48	0
10.02.2022	222	12	5	14:33:12	14:36:05	0
10.02.2022	228	16	1	08:16:40	08:18:00	0
10.02.2022	228	16	2	09:03:13	09:05:31	1
10.02.2022	228	16	4	13:46:40	13:48:53	0
10.02.2022	228	16	5	14:33:12	14:35:30	2
10.02.2022	228	16	6	15:19:46	15:21:51	3
10.02.2022	221	17	1	08:16:40	08:18:35	0
10.02.2022	221	17	2	09:03:13	09:05:36	0
10.02.2022	221	17	4	13:46:40	13:48:39	0
10.02.2022	221	17	5	14:33:12	14:36:25	0
10.02.2022	221	17	6	15:19:46	15:21:27	2
10.02.2022	224	18	1	08:16:40	08:18:50	0
10.02.2022	224	18	2	09:03:13	09:06:08	0
10.02.2022	224	18	4	13:46:40	13:48:58	0
10.02.2022	224	18	5	14:33:12	14:35:41	0
10.02.2022	224	18	6	15:19:46	15:22:06	4
11.02.2022	223	8	1	08:16:40	08:18:00	0
11.02.2022	223	8	2	09:03:13	09:05:16	1
11.02.2022	223	8	3	09:49:46	09:51:50	5
11.02.2022	223	8	4	13:45:14	13:47:22	0
11.02.2022	223	8	5	14:27:08	14:29:17	0
11.02.2022	223	8	6	15:22:59	15:25:01	8
11.02.2022	232	9	1	08:16:40	08:19:12	0
11.02.2022	232	9	2	09:03:13	09:05:27	0
11.02.2022	232	9	3	09:49:46	09:52:02	4
11.02.2022	232	9	4	13:45:10	13:47:21	0

Table J.4: Raw data from the video analysis without empty cells. Includes number of fish showing no interest in feed.

Date	Camera ID	Tank	No	Time from	Time to	# fish no interest in feed
11.02.2022	232	9	5	14:27:04	14:29:40	1
11.02.2022	232	9	6	15:22:59	15:25:28	1
11.02.2022	167	10	1	08:16:40	08:29:02	2
11.02.2022	167	10	2	09:03:13	09:05:26	4
11.02.2022	167	10	3	09:49:46	09:52:11	7
11.02.2022	167	10	4	13:45:10	13:47:19	8
11.02.2022	167	10	5	14:27:04	14:29:09	5
11.02.2022	167	10	6	15:22:59	15:25:11	7
11.02.2022	227	11	1	08:16:40	08:19:26	0
11.02.2022	227	11	2	09:03:13	09:05:21	0
11.02.2022	227	11	3	09:49:46	09:51:48	0
11.02.2022	227	11	4	13:45:10	13:47:53	0
11.02.2022	227	11	5	14:27:04	14:29:06	0
11.02.2022	227	11	6	15:22:59	15:25:23	3
11.02.2022	222	12	1	08:16:40	08:19:01	0
11.02.2022	222	12	2	09:03:13	09:05:34	0
11.02.2022	222	12	3	09:49:46	09:51:44	5
11.02.2022	222	12	4	13:45:14	13:46:55	1
11.02.2022	222	12	5	14:27:08	14:29:28	2
11.02.2022	222	12	6	15:22:59	15:25:58	3
11.02.2022	228	16	1	08:16:40	08:28:59	0
11.02.2022	228	16	2	09:03:13	09:05:21	3
11.02.2022	228	16	3	09:49:46	09:52:18	3
11.02.2022	228	16	4	13:45:10	13:47:27	0
11.02.2022	228	16	5	14:27:04	14:29:07	0
11.02.2022	228	16	6	15:22:59	15:25:01	4
11.02.2022	221	17	1	08:16:40	08:19:37	0
11.02.2022	221	17	2	09:03:13	09:06:06	0
11.02.2022	221	17	3	09:49:46	09:51:58	2

Table J.4: Raw data from the video analysis without empty cells. Includes number of fish showing no interest in feed.

Date	Camera ID	Tank	No	Time from	Time to	# fish no interest in feed
11.02.2022	221	17	4	13:45:14	13:46:34	0
11.02.2022	221	17	5	14:27:08	14:29:14	4
11.02.2022	221	17	6	15:22:59	15:25:41	6
11.02.2022	224	18	1	08:16:40	08:18:52	0
11.02.2022	224	18	2	09:03:13	09:05:34	0
11.02.2022	224	18	3	09:49:46	09:52:01	2
11.02.2022	224	18	4	13:45:12	13:47:45	0
11.02.2022	224	18	5	14:27:05	14:29:13	4
11.02.2022	224	18	6	15:22:59	15:25:07	4

Appendix K

Initial analysis

K.0.1 Graphical representation based on all video clips

The data from the video analysis was sorted based on time of feeding. Figure K.1 shows that the fish ate more pellets early in the feeding period than in the end of the feeding period. Figure K.2 shows that there were also more individuals who ate early in the feeding period than in the end of the feeding period. This was applicable both for the morning feeding (08:00-10:00) and the afternoon feeding (13:30-15:30). The raw data of the analysis is in appendix J.

Note that some individuals are counted twice, because they ate both from the water column and the bottom of the tank. This is the reason that the axis showing number of individuals in figure K.2 goes further than the total number of fish in the tank. The intersection is illustrated in figure 2.10 in section 2.5.

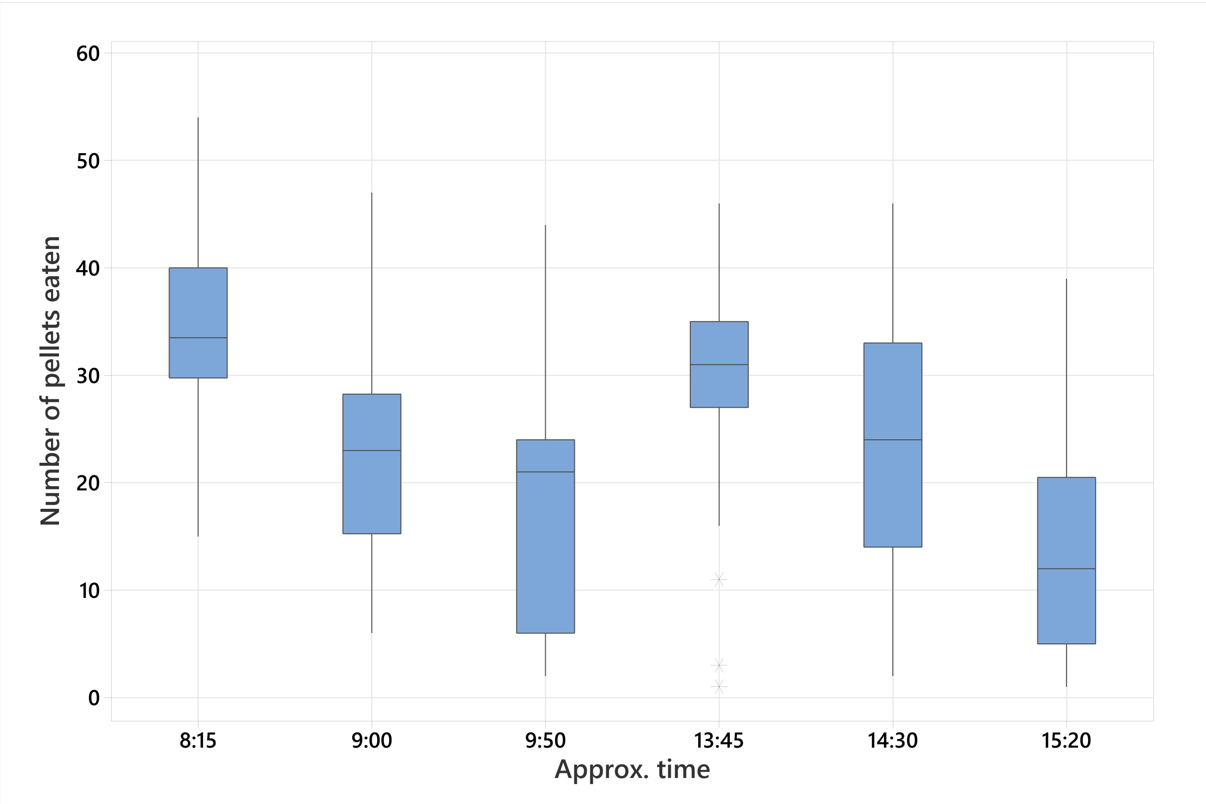


Figure K.1: Boxplot showing number of pellets eaten for all tanks between 7th and 11th February, sorted based on feeding time, here indicated by approximate time of feeding.

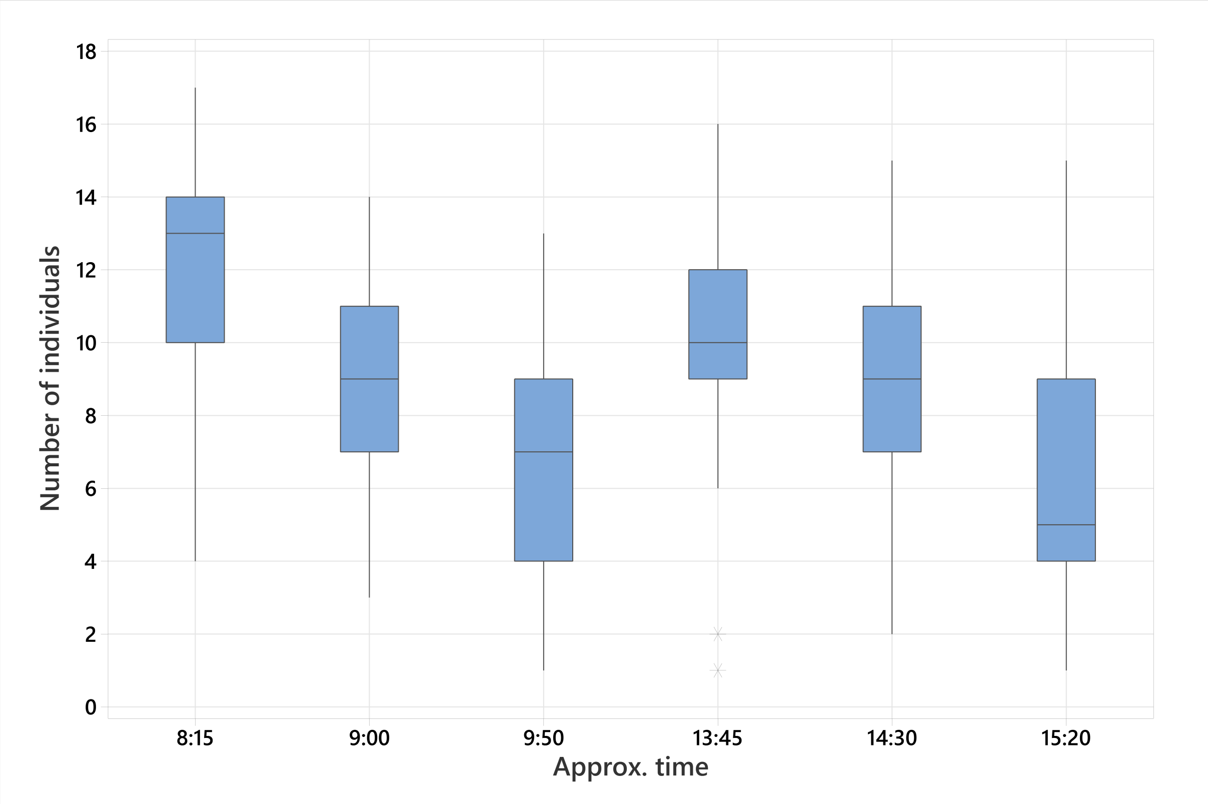


Figure K.2: Boxplot showing number of individuals eating for all tanks between 7th and 11th February, sorted based on feeding time, here indicated by approximate time of feeding.

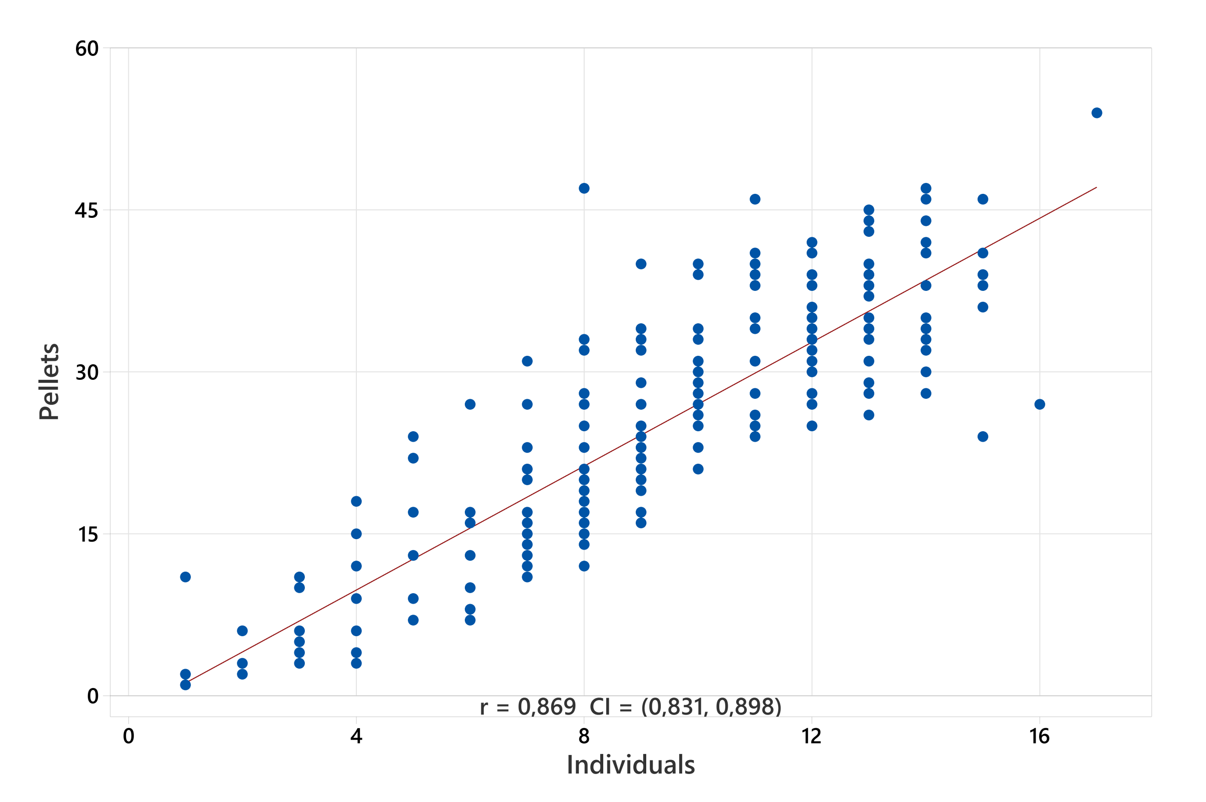


Figure K.3: Matrix plot showing the correlation between number of individuals eating and number of pellets eaten for all tanks between 7th and 11th February.

The strength and direction of the linear relationship between number of individuals eating and number of pellets eaten was calculated by conducting a Pearson Correlation. The Pearson Correlation between the two variables was 0.869, indicating a moderate positive relationship between the two factors. Figure K.3 show the matrix plot for the correlation between the two variables. The regression fit in the matrix plot was $y = -1.691 + 2.870x$ and the R^2 was 75.4%.

K.0.2 Graphical representation of feed collection

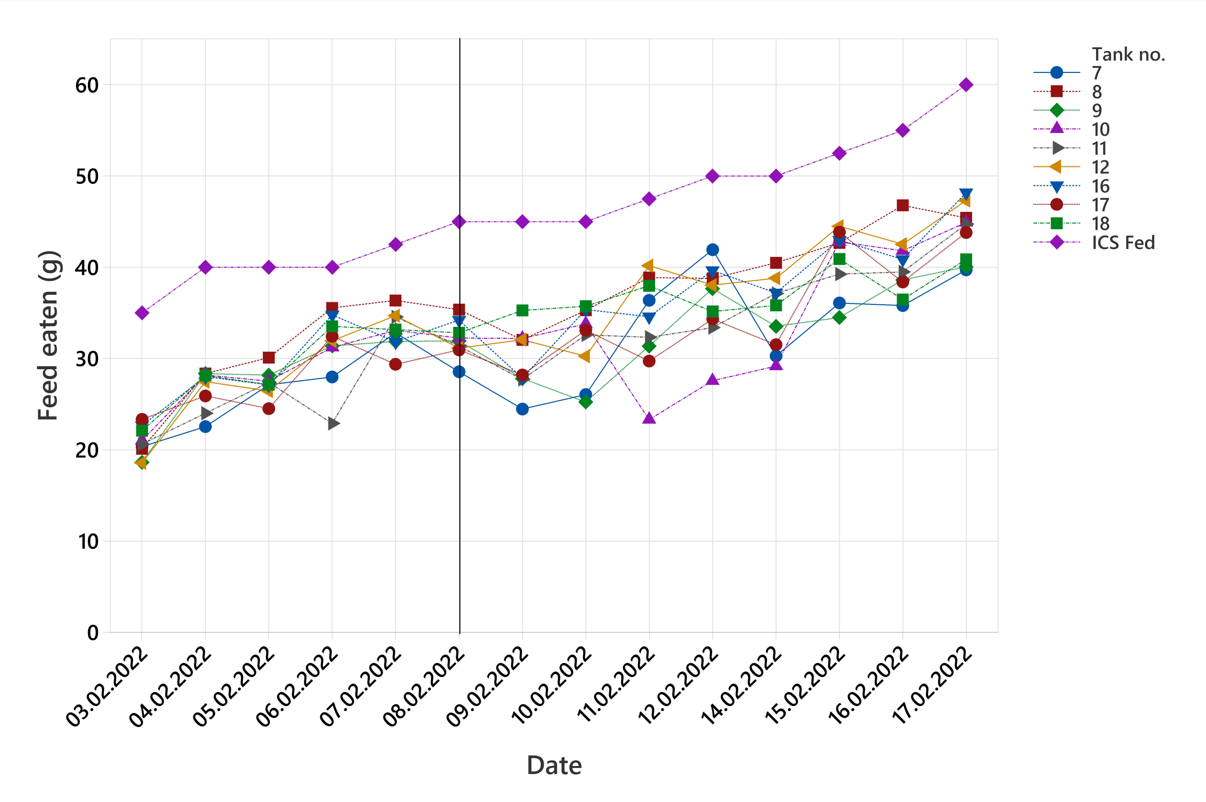


Figure K.4: Line plot showing the calculated amount of feed eaten in grams based on data from ICS and DW of collected feed between 3rd and 17th February, sorted by tank. The vertical line on 8th February indicates the feed change.

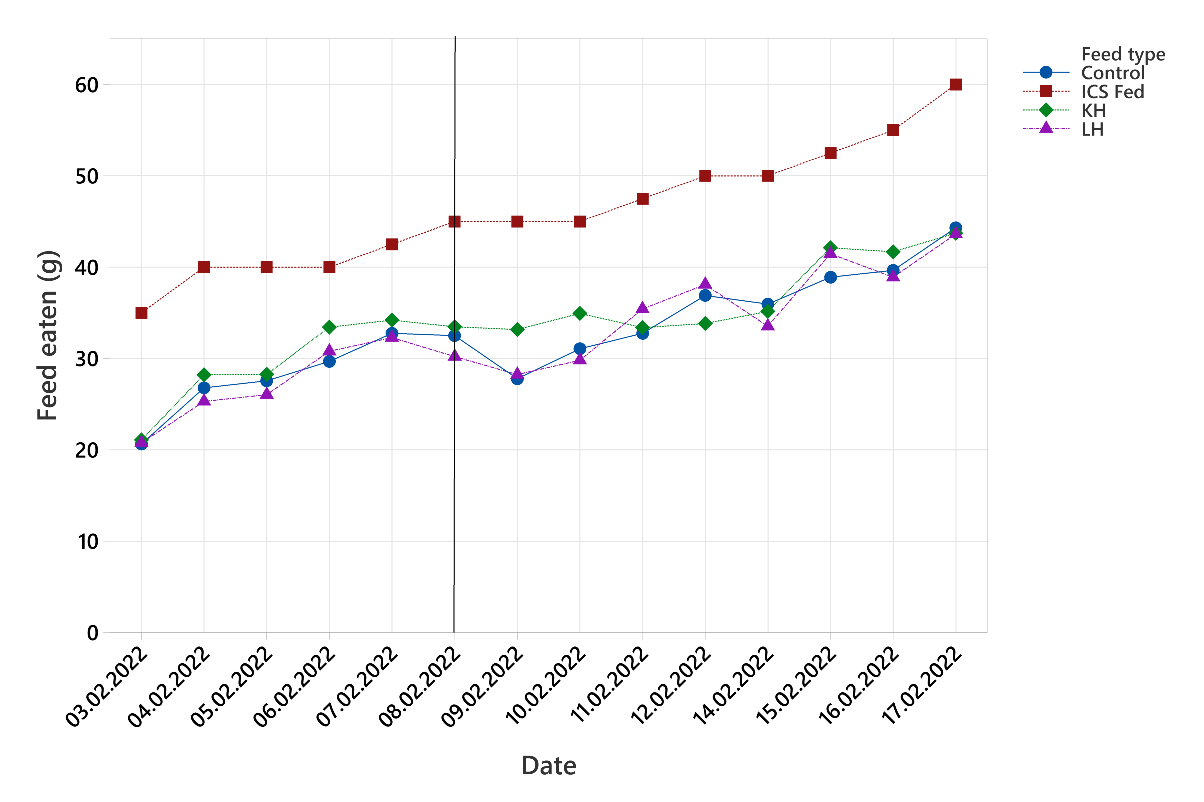


Figure K.5: Line plot showing the calculated amount of feed eaten in grams based on data from ISC and DW of collected feed between 3rd and 17th February, sorted by type of feed. The vertical line on 8th February indicates the feed change.

The line plot in figure K.6 shows the development over time in the number of pellets eaten during analysis of the first and fourth video clip of the day during the period 7th to 11th February, sorted by tank. The line plot shows that the number of pellets eaten in tanks 7, 8, 12, 16 and 17 drops right after change in feed, while tanks 9, 10 and 11 have an increase in number of pellets eaten.

K.0.3 Graphical representation of the video analysis

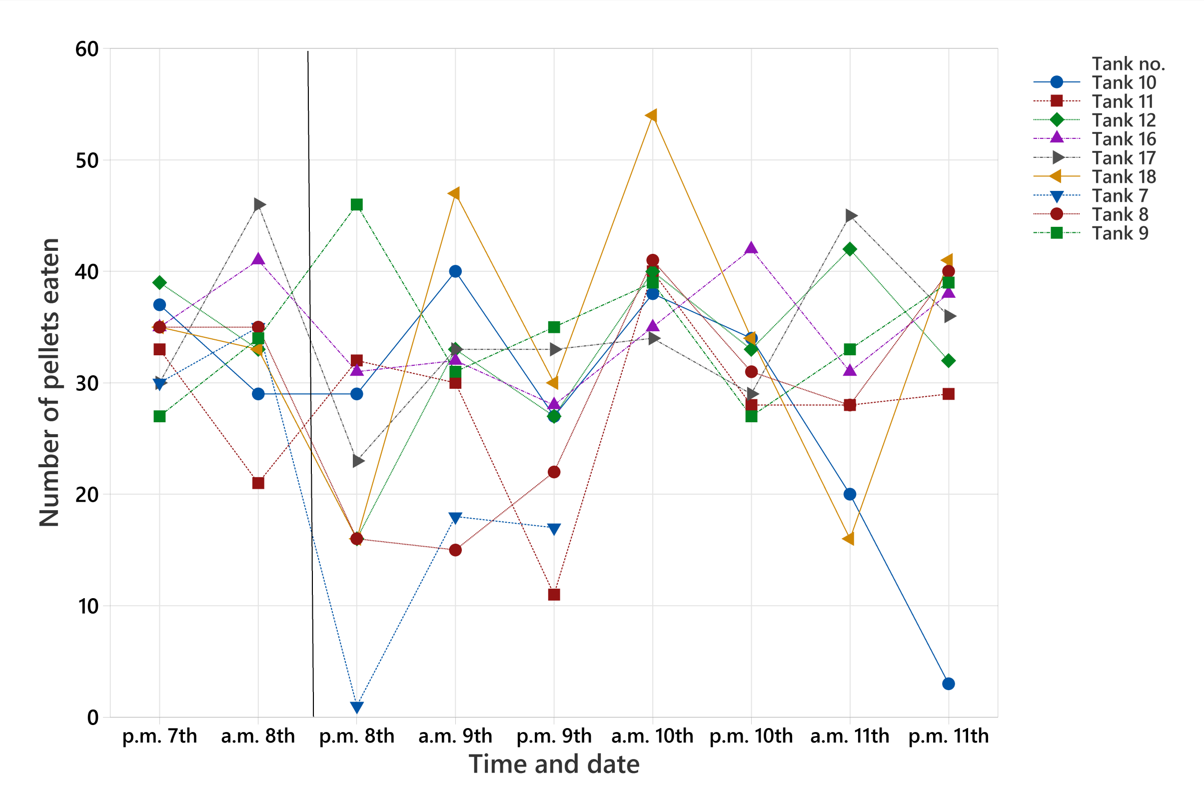


Figure K.6: Line plot showing development over time in the number of pellets eaten during analysis of the first and fourth video clip of the day in the period 7th to 11th February sorted by tank. The vertical line between the morning feed (a.m. 8th) and afternoon feed (p.m. 8th) 8th February indicates the feed change.

The line plot in figure K.7 shows the development over time in the number of individuals eating during analysis of the first video clip of the day from 7th to 11th February, sorted by tank. The line plot shows that the number of individuals eating in tanks 7, 8, 12, 16, 17 and 18 drops right after change in feed, while tank 11 has an increase in the number of individuals eating. Tank 9 and 10 have little change in the number of individuals eating right after feed change.

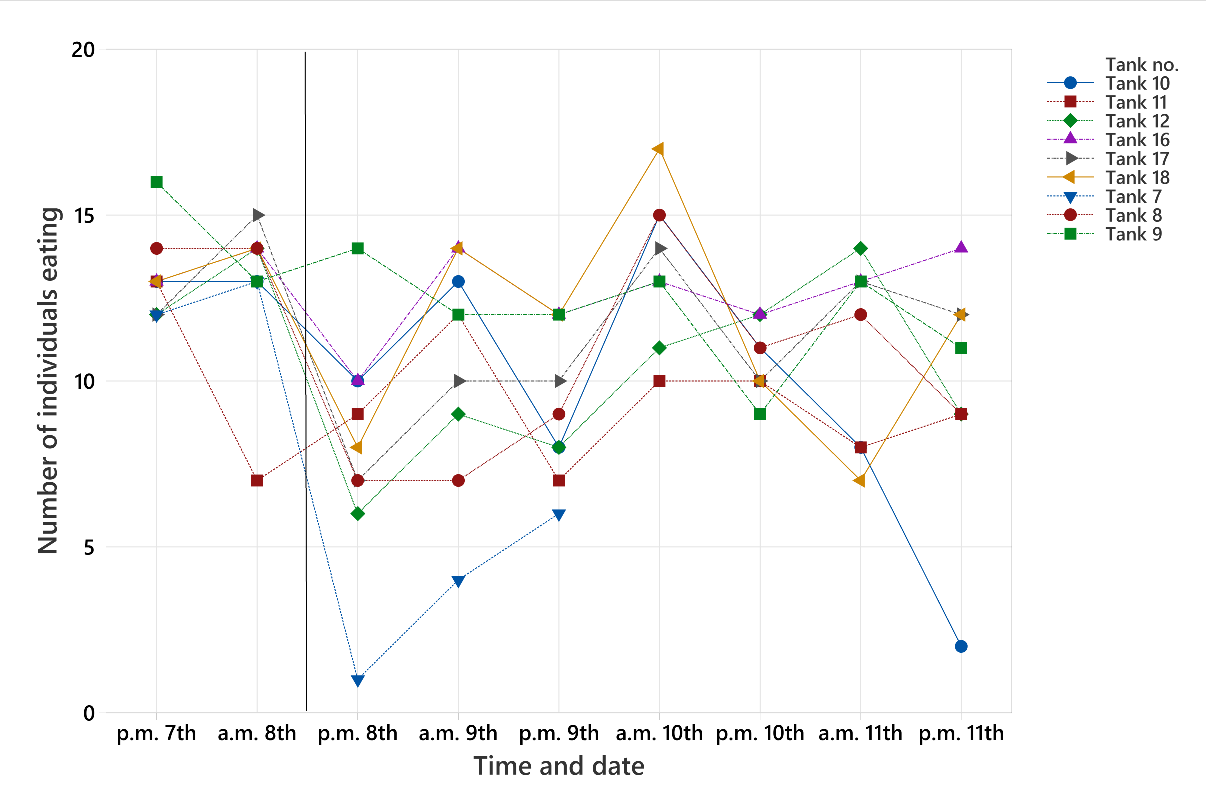


Figure K.7: Line plot showing development over time in the number of individuals eating during the analysis of the first and fourth video clip of the day in the period 7th to 11th February sorted by tank. The vertical line between morning feed (a.m. 8th) and afternoon feed (p.m. 8th) 8th February indicates the feed change.

The line plot in figure K.8 shows the development over time in the number of pellets eaten during the analysis of the first and fourth video clips of the day from 7th to 11th February, sorted by feed type. The line plot shows that the number of pellets eaten in the tanks feed with LH and KH drops right after change in feed, while the control has little change.

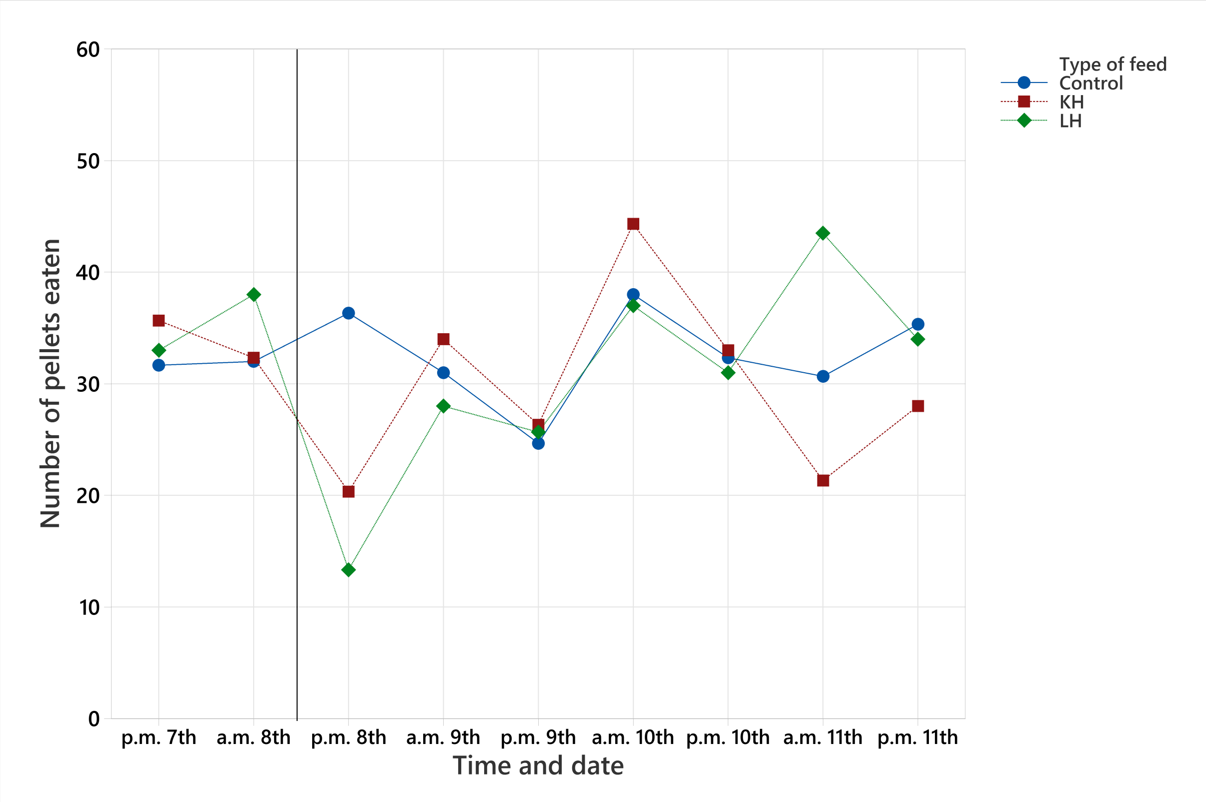
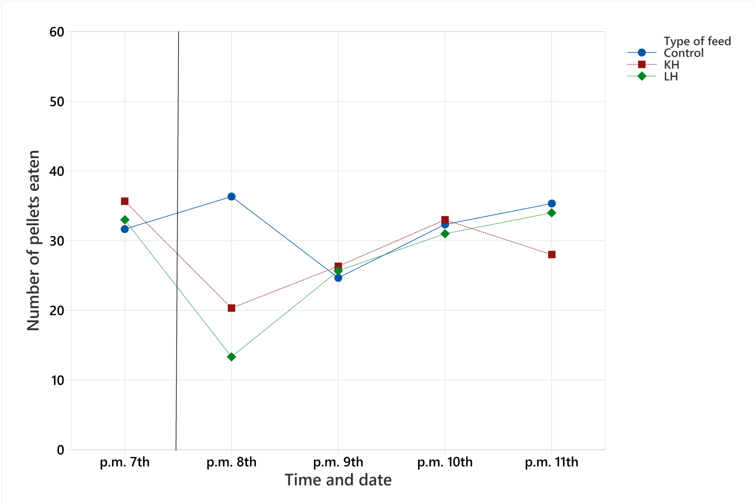
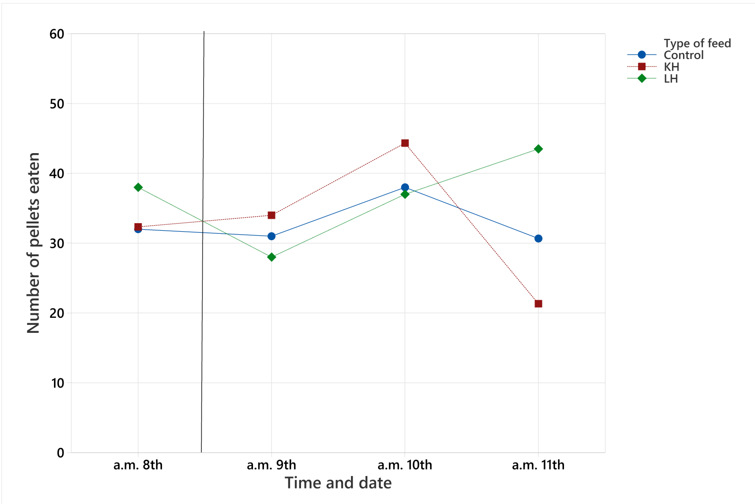


Figure K.8: Line plot showing development over time in number of pellets eaten during analysis of the first and fourth video clip of the day in the period 7th to 11th February sorted by type of feed. The vertical line between morning feed (a.m. 8th) and afternoon feed (p.m. 8th) 8th February indicates the feed change.



(a) Afternoon feedings



(b) Morning feedings

Figure K.9: Line plots showing development over time in number of pellets eaten during analysis of the first and fourth video clip of the day in the period 7th to 11th February sorted by type of feed. The vertical lines indicates the feed change.

The line plot in figure K.10 shows the development over time in the number of individuals eating during analysis of the first and fourth video clip of the day from 7th to 11th February, sorted by feed type. The line plot shows that the number of individuals eating in the tanks feed with LH and KH drops right after change in feed, while the control has little change.

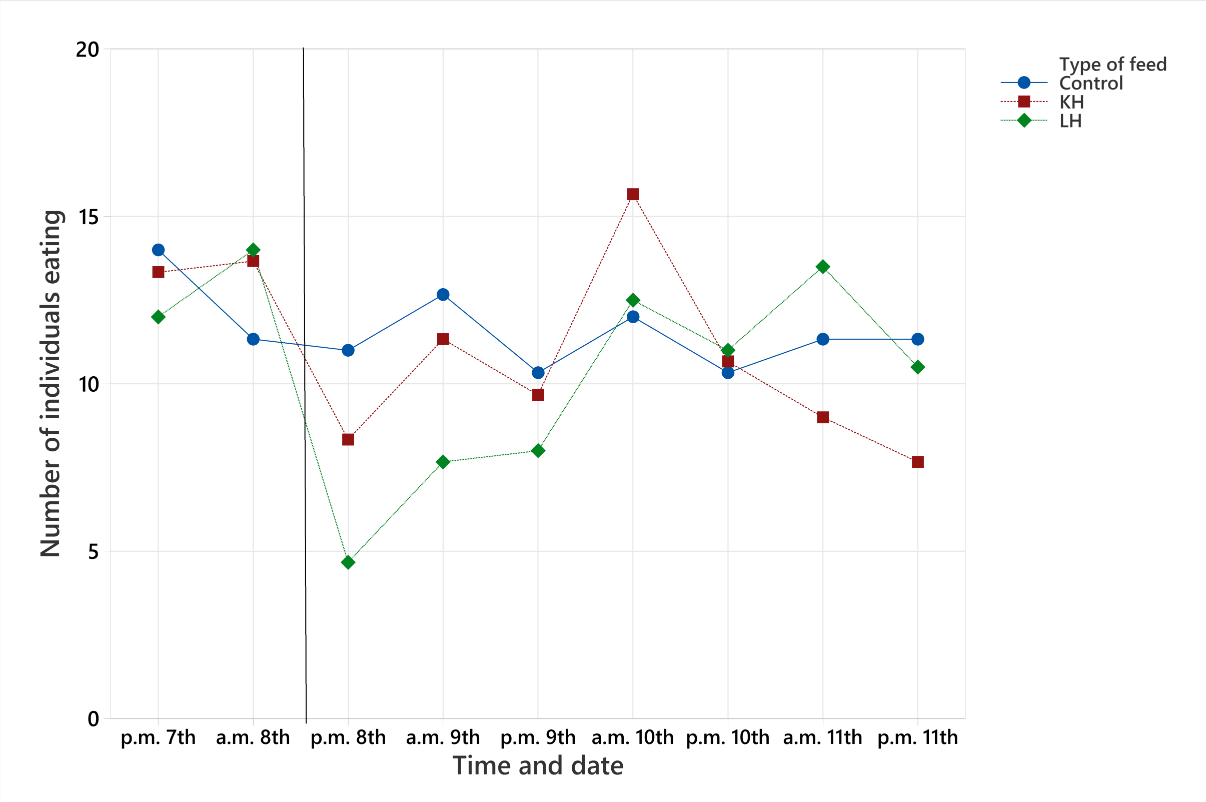
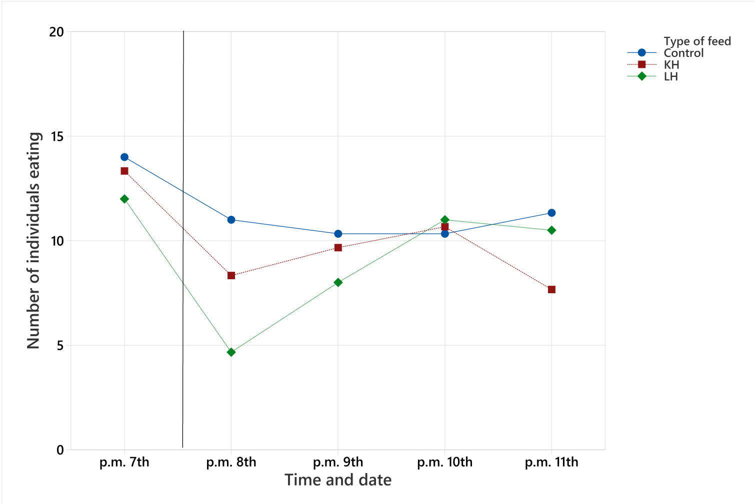
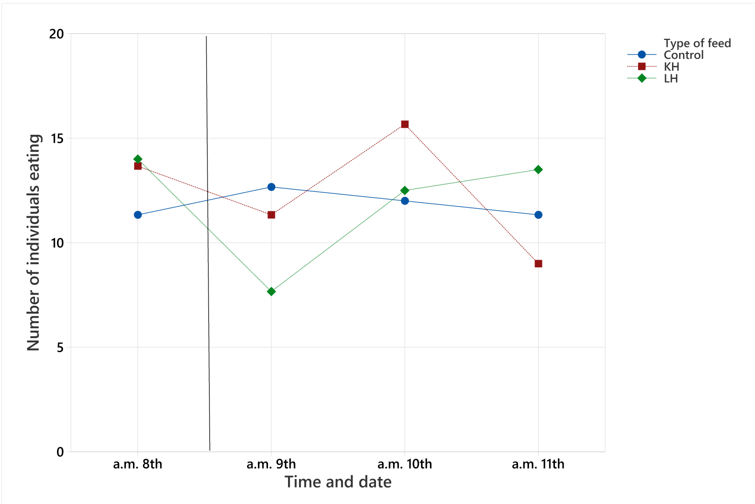


Figure K.10: Line plot showing development over time in number of individuals eating during analysis of the first and fourth video clip of the day in the period 7th to 11th February sorted by type of feed. The vertical line between morning feed (a.m. 8th) and afternoon feed (p.m. 8th) 8th February indicates the feed change.



(a) Afternoon feedings



(b) Morning feedings

Figure K.11: Line plot showing development over time in number of individuals eating during analysis of the first and fourth video clip of the day in the period 7th to 11th February sorted by type of feed. The vertical lines indicates the feed change.

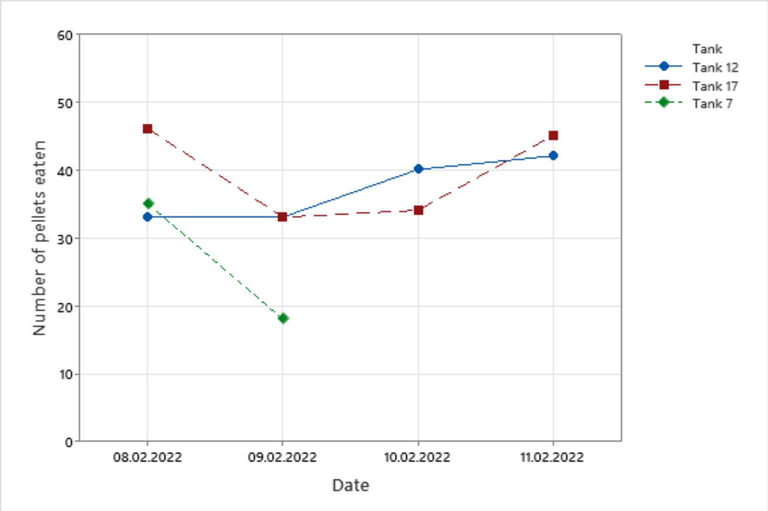


Figure K.12: Line plot showing the development over time in number of pellets eaten for the tanks fed LH

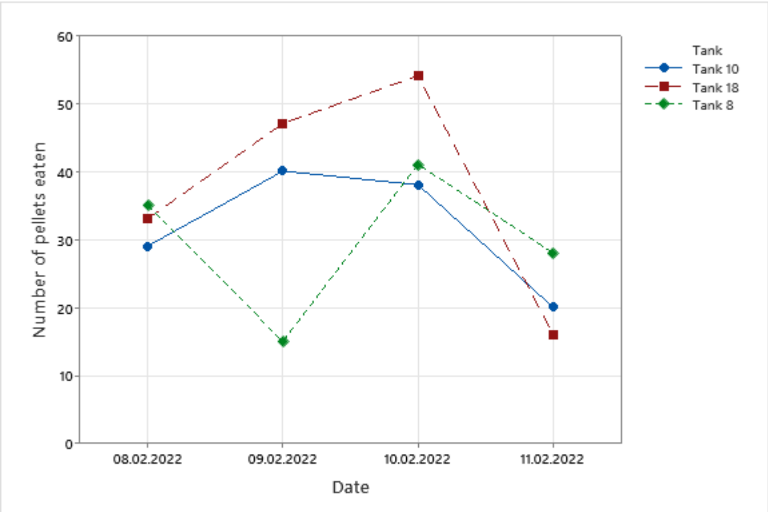


Figure K.13: Line plot showing the development over time in number of pellets eaten for the tanks fed KH

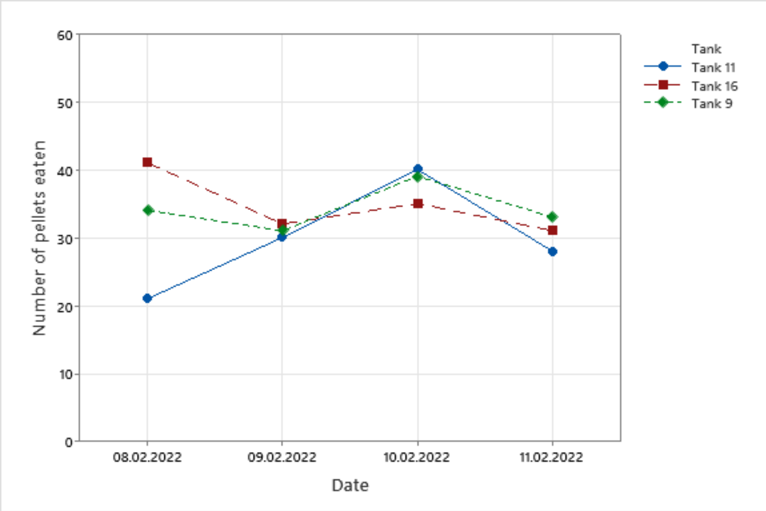


Figure K.14: Line plot showing the development over time in number of pellets eaten for the tanks fed control feed

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