# LENGTH-WEIGHT RELATIONSHIP, CONDITION FACTOR AND STOMACH CONTENT ANALYSIS OF *EUTROPIICHTHYS MURIUS* (Hamilton, 1822) FROM NARAYANI RIVER, WEST NAWALPARASI, NEPAL

Entry 67
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A thesis submitted

in partial fulfillment of the requirements for the award of the degree of Master of Science in Zoology with special paper Fish Biology and Aquaculture

**Submitted to**

Central Department of Zoology
Institute of Science and Technology
Tribhuvan University

Kirtipur, Kathmandu

Nepal

May 2023

# DECLARATION

I hereby, declare that the work presented in the thesis entitled **"Length-Weight Relationship, Condition Factor and Stomach Content Analysis of *Eutropiichthys murius* (Hamilton, 1822) from Narayani River, West Nawalparasi, Nepal"** has been done by myself and has not submitted elsewhere for the award of any degree. All sources of the information have been specifically acknowledged by the reference to the author(s) or institution(s).

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## RECOMMENDATION

This is to recommend that the thesis entitled "**Length-Weight Relationship, Condition Factor and Stomach Content Analysis of *Eutropiichthys murius* (Hamilton, 1822) from Narayani River, West Nawalparasi, Nepal**" has been carried out by Mr. Sandip Kumar Gupta for the partial fulfillment of Master's degree of Science in Zoology with special paper Fish Biology and Aquaculture. This is his original work and has been carried out under our supervision. To the best of our knowledge this thesis work has not been submitted for any other degree in any institutions.

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## LETTER OF APPROVAL

On the recommendation of supervisor "Prof. Dr. Kumar Sapkota" this thesis submitted by Mr. Sandip Kumar Gupta entitled **"Length-Weight Relationship, Condition Factor and Stomach Content Analysis of *Eutropiichthys murius* (Hamilton, 1822) from Narayani River, West Nawalparasi, Nepal"** is approved for the examination and submitted to the Tribhuvan University in partial fulfillment of requirements for the Master's degree of Science in Zoology with the special paper Fish Biology and Aquaculture.

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## CERTIFICATE OF ACCEPTANCE

This thesis work submitted by Mr. Sandip Kumar Gupta entitled "**Length-Weight Relationship, Condition Factor and Stomach Content Analysis of *Eutropiichthys murius* (Hamilton, 1822) from Narayani River, West Nawalparasi, Nepal**" has been accepted as a partial fulfillment for the requirements of Master's degree of Science in Zoology with special paper Fish Biology and Aquaculture.

### EVALUATION COMMITTEE

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**Sandip Kumar Gupta**

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# LIST OF ABBREVIATIONS

| Abbreviated form | Details of Abbreviations |
|---|---|
| GSI | Gastro Somatic Index |
| LWRs | Length Weight Relationship |
| LFD | Length Frequency Distribution |
| K | Condition Factor |
| TL | Total Length |
| TW | Total Weight |

# ABSTRACT

*Eutropiichthys murius* is the major fish of the riverine ecosystems in Narayani River. The primary goal of this study is to investigate the length-weight relationship, condition factor, and stomach content analysis of *Eutropiichthys murius*. A total of 200 fish samples were collected seasonally from June 2022 to November 2022 with the help of local fishermen by the using cast and hook net. The overall length ranged from 8.5 cm to 39.2 cm, with weights ranging from 7.4g to 395.6g. For the Summer and Autumn seasons, the length-weight relationship was W= 0.218 x $TL^{2.607}$ ($R^2$= 0.879) and W = 0.0096 x $TL^{2.960}$ ($R^2$ = 0.9105), respectively, indicating a negative allometric growth pattern in *E. murius*. In *E. murius*, the values of b for the summer and autumn seasons were 2.607 and 2.960, respectively, indicating a negative allometric growth pattern. The length and weight of this fish did not significantly correlate with one another in two seasons. The condition factor (K) range between 0.33 to 3.06 with mean value 0.77 indicated that the river's fish population was not prospering. From the total number (200) of fishes, 138 (69%) stomach were observed with food and remaining 62 (31%) were empty. Insects, aquatic plants, and detritus constitute the majority of the food items found in the stomach of the fish. *Polyrhachis* spp, *Acridida* spp, *Caribidi* spp, *Leptocorisa* spp, *Stipa tenacissima*, *Hydrilla verticella*, water beetles, zooplanktons, miscellaneous items and non-biotic matters constitute the majority of this fish's basic diet. In conclusion, *E. murius* was omnivorous and displayed negative allometric growth.

# 1.INTRODUTION

## 1.1 Background

The length-weight relationship (LWRs) of fish varies among species and populations. Length-weight relationship is a common method used to study the growth and condition of fish populations. It is based on the assumption that there is a relationship between the length and weight of an individual fish, which can be described by a mathematical equation. The length-weight relationship can provide important information on the growth and condition of the fish populations. For example, changes in the relationship over time can indicate changes in the availability of food or changes in fishing pressure. It can also be used to estimate the weight of fish based on their length, which can be useful for management and conservation purposes. However, it is important to note that the length-weight relationship is not always accurate for individual fish, and should be used as a general guide rather than an absolute measure of condition.

Growth and reproduction, like other critical activities in life, require energy, which is supplied by food. The study of food and nutrition, growth and condition are all crucial parts of life. Understanding fish diet, feeding and nutrition is an important precondition for effective aquaculture production. Many researchers have investigated nutrition and growth in a variety of fishes both in the wild and in captivity. Length-weight relationships differ amongst fish species based on hereditary body form and physiology parameters such as maturity and spawning (Schneider et al. 2000). It is believed that can alter throughout time, demonstrating the wholeness of stomach, general condition of appetite and gonads stages (De Giosa et al. 2014; Flura et al. 2015). Moreover, the development process of the same species living in different environments might change, driven by a variety of biotic and abiotic variables.

The condition factor (K), which was developed from the LWRs, is another essential biometric instrument (Le Cren 1951). K assesses the adequacy of a certain aquatic environment for fish growth by measuring an organism’s divergence from the average weight in a given sample (Yılmaz et al. 2012; Mensah 2015). When K values are equal to or near to one, an overall fitness for fish species is assumed.

### 1.1.1 *Eutropiichthys murius*

It is a long game fish that lacks scales. The overall body tone is a uniform silvery hue of yellow on the belly. Back is blue grey, however. Four pairs of barbels are present. The maxillary barbel extends all the way to the pectoral fin. The nasal barbels protrude somewhat over the orbit's back border. Longer on the upper jaw than the lower. Pointed snout. Deep forking may be seen on the caudal fin. There is an adipose tissue. With an altitude range of 70 to 900 m, it is a significant game fish in the Terai. Lowland parts of the Gandaki, Koshi, and Karnali rivers are habitat to this species. *E. murius* also found in Bangladesh, Pakistan, and India as well, (Shrestha 2019).

Photo 1. Eutropiichthys murius

**Diagnostic Character: D1/7|0; P1/10; V6; A38-43 (3/35-40); C17; TL=28 cm.**

### 1.1.2 Length – weight relationship

All living things exhibit growth, regarded as a fundamental trait. Accepted that both fish population and individual health are represented in growth. The Length-weight relationship is significant in fisheries assessment (Ayoade & Ikulala 2007). It has received the greatest attention in fish biology research (Chandra & Jhan 2010). Length-weight relationships aid in establishing the relative health of the fish population by comparing the fatness and wellbeing of fish. LWRs analyzes fish stocks for a number of reasons, including stock biomass evaluation and comparison of fish population ontogeny (Le Cren 1951). LWRs are used to assess fish weight, biomass, and habitat condition (Raman et al. 2018). The variety of factors impact LWRS, including sample size, location, sex, health, gonadal development, and stomach fullness (Esmaeili et al. 2014). Individuals of the same species living in various environment might have variable growth processes due to a variety of biotic and abiotic factors. If the complete length of a specimen is known, the length-weight relationship allows for easy computation of the weight; these relationships are important quick estimation of biomass is required (Froese 1998). LWRs are significant in fish biology because they show the status of the fish population and allow for evaluation of fish growth rates (Hossain et al. 2006). It makes it easier to convert length data into weight for the purposes of determining biomass. While direct sampling of each fish in the stock is costly and difficult to quantify, LWR can provide stock weight (Hasan et al. 2021). Fish length frequency distributions (LFD) expose ecological and life history details. Individual optimism may be assessed using morphometric connections between length and weight, as well as possible changes between different unit stocks of the same species (Jobling 2008). Measurements of length and weight combined with age data can provide information about the biomass, age, life span, mortality, growth and reproduction of fish stocks (Kumar et al. 2014).

The length-weight relationship is useful in fish biology, physiology, and ecology. It was first used to provide information on fish health. The utilization of length-weight relationship in fisheries biology allows for the conversion of growth in relation to length (Alam et al. 2012). The goal of length-weight relationship analysis is to precisely describe the connections between length and weight so that they are adapted to one another. It also examines the variation from the predicted length of specific fish (Dan-Kishiya 2013). The length-weight relationship of fish is widely acknowledged as being crucial in fisheries science, and stock management (Abdoli & Rasooli 2008).

Length-weight relationship is a common method used to study the growth and condition of fish populations. It is based on the assumption that there is a relationship between the length and weight of an individual fish, which can be described by a mathematical equation.

The length-weight relationship of fish varies among species and populations, and can also be affected by environmental factors such as temperature, food availability, and habitat quality. However, in general, the relationship can be described by power-law equation of the form:

W=aL^b

where, W is the weight of the fish, L is the length of the fish, a and b are constants that depend on the species and population, and the exponent b is typically between 2 and 3.

### 1.1.3 Condition factor

The condition factor of a fish is a measure of its overall health and body condition. The condition factor is used by scientists and fisheries managers to assess the health and productivity of fish populations and to monitor changes in fish condition over time. Factors that can affect the condition factor of fish include environmental conditions, food availability, predation, and fishing pressure. In general, a higher condition factor indicates that a fish is in good health and has sufficient energy reserves to survive and reproduce. Likewise, a low condition factor may indicate that a fish is under stress, malnourished, or otherwise compromised. Understanding the condition factor of fish is important for maintaining healthy fish populations and sustainable fisheries management practices.

The Condition factor (K) of fish reveals the physical and biological changes accumulated by the interplay of food condition, parasite infection, and habitat physiological condition (Datta et al. 2013). Condition factor is used in fisheries science to compare the “condition”, “fatness” and well-being of fish. Fulton’s Condition Index (CI) depicts the connection between fish weight and length, which was used to measure the fish’s health. The Fulton’s condition index serves as an indicator of fish health, with 1 representing a fish in perfect health, < 1 representing a “thin” fish, and > 1 representing a “fat” fish (de Vries et al. 2020). According to the theory, fish that are physiologically healthier are those that are heavier at a particular length. Fish condition factor may be used to monitor fish feeding occurrence, age, and growth rate. The condition factor is an important metric for tracking fish feeding frequency, age, and growth rates. It may be used to assess the state of the aquatic ecosystem, by both biotic and abiotic environmental elements (Pal et al. 2013). The condition factor can assist determine whether or not a location is ideal for fish growth and development. The Fulton’s condition factor in gillnet captures indicates how the model length of fish affects (Kurkilahti et al. 2002). Knowing the life cycle of fish species and properly managing them are both dependent on the condition factor, which assists in maintaining the ecosystem’s equilibrium (Imam et al. 2021; Imam et al. 2021). Condition factor may also be used to track feeding intensity, age, and growth rates in fish (Oni et al. 1983). It is heavily impacted by both biotic and abiotic environmental variables and may be used to measure the health of the aquatic habitat in which fish reside (Anene & Sciences 2005).

### 1.1.4 Stomach content analysis

Food is essential for heterotrophic organisms because it supplies the energy required for somatic growth, reproduction, and survival. Nutrition is required for many metabolic activities. Effective aquaculture management necessitates a thorough understanding of the food and feeding patterns of the diverse species (Bhattacharya et al. 2020). Depending on ontogeny changes, prey abundance, and other factors, various creatures exhibit varying levels of eating preferences and specialization within and between species, which can impact food web dynamics as well as their feeding methods (Landry et al. 2018). Food habit research evaluates the most commonly consumed prey as well as the relative relevance of other meal categories (V et al. 2019). Animal feeding ecology research is essential for understanding trophic interactions, population, and community dynamics within an ecosystem, and making comparisons between systems (Amundsen & Sánchez-Hernández 2019).

The stomach content of fish species can vary depending on their diet and habitat. Generally, fish consume a wide variety of food items such as plankton, algae, insects, crustaceans, mollusks, small fish, and even other vertebrates. Some fish are herbivores and primarily feed on plants, while others are carnivores and primarily feed on other animals. Additionally, some fish are omnivores and consume both plant and animal parts. The stomach contents of fish can provide valuable information to researchers studying the ecology and behavior of fish species, as well as the health and condition of fish populations. By analyzing the stomach contents of fish, researchers can gain insight into the dietary habits of fish, the availability of prey in their environment, and the impact of environmental changes on fish populations.

The examination of varied eating behaviors and feeding habits using both qualitative and quantitative approaches are very important in fish biology. *Puntius sophore* feeds mostly on natural phytoplankton and zooplankton (Ahmad et al. 2010). *Glossogobius giuris*’s intestinal contents contained teleost fish fry, prawns, semi-digested debris, and traces of insects, zooplankton, and algae (Hossain et al. 2016). According to investigations done on Kohar and

Tilayar reservoirs, juveniles of *G. giueis* are planktonic feeders, but adults gradually become carnivorous, living on insect larvae up to a certain stage (51–100 mm) and then becoming predatory by devouring fish (Natarajan et al. 1976). Copepods and other crustaceans were found in greater abundance in the stomach as *P. argenteus* levels rose (Dadzie et al. 1998). Mollusks were identified as the third most significant item in the diet of P. argenteus (Kuthalingam 1963; Rao 1964; Pati 2011). The gastro-somatic index aids in determining fish eating intensity (Sangam et al. 2019). It has become routine procedure to research the eating behaviors of many animals through an investigation of their stomach contents (Hyslop 1980).

## 1.2 OBJECTIVES

### 1.2.1 General objective

- To investigate the length- weight relationship, condition factor and, stomach content of *Eutropiichthus murius* from Narayani River, West Nawalparasi.

### 1.2.2 Specific objectives

- To investigate the length- weight relationship
- To determine gastro-somatic index.

## 1.3 RESEARCH QUESTIONS

- What is the growth pattern of *Eutropiichthus murius*?

## 1.4 RATIONALE OF THE STUDY

Characteristics features such as length-weight with stomach content study of *E. murius* of the Narayani River is yet unexplored. Morphological traits, diets and feeding habits are all key elements in the specie’s management and conservation. The number of tourists have been increasing due to religious and tourist place. This fish is highly demanded by tourist because of its high delicious taste. Hence, the length-weight relationship, condition factor, and stomach content analysis of *E. murius* from the Narayani River should give information for optimal management, fish conservation and tourist development.

# 2. LITERATURE REVIEW

## 2.1 Length-weight relationship

Jonabo et al. (2009) explained that length-weight relationships of fish are crucial in fisheries biology and population dynamics, because several stock assessment models needed the use of LWRs parameters. Study demonstrated that the development patterns of *Tilapia mariar, Oreochromis niloticus, Barbus accidentalis*, and *Barilius loati* were negatively allometric, with ‘b’ values ranging from 1.4 to 2.3 (Dan-Kishiya 2013). The length-weight relationship has been widely used as indicators of fish condition, to compare the life histories of specific species between locations, and to investigate other aspects of fish population dynamics (Andreu-Soler et al. 2006). Longevity and weight statistics can also provide significant insights regarding climatic and environment changes, as well as changes in fishing tactics. Negative allometric values less than 3 were discovered in *Clarius gariepinus* and *Oreochromis niloticus* from all Wudil river locations (Gesto et al. 2017). Similarly, Jisr et al. (2018) discovered that 9 fish species from the North Lebanon sea area had varied b values less than 3 during warm and cold times. Similarly, Dewiyanti et al. (2020) found negative allometric growth in three dominating species in Kaula Gigieng waters, with a strong correlation factor. Among fifty-two species in the south (Sicily Falsone et al. 2020), 45.8% showed negative allometric growth, whereas 33.4% and 20.8% showed positive and isometric growth, respectively. The slope ‘b’ values for *Cirrhinus mrigala* varied from 3.52 to 2.11 and *Labeo gonius* as well (Dubey et al. 2012). Miranda et al. (2006) discovered that the value of ‘b’ in weight-length (W-L) correlations for 28 *Ilerian Peninsula* cyprinid species ranged from 2.78 to 3.47, ‘b’ values for *Echelus myrus* to *Gobius niger* varied from 2.662 to 3.395.

*Magalaspis cordyla* was found in Karachi during the pre-monsoon and post monsoon season with both positive and negative allometric growth, the majority of ‘b’ values (roughly 98%) fell between 2.7 and 3.4 (Ahmed et al. 2013). In contrast, Chakraborty (2003) discovered negative allometric growth in *Mystus vitatus* during the summer and monsoon seasons, with a high correlation in the summer. Most species had negative allometric development in both the northeast and south east monsoons, (Ontomwa et al. 2018). AE et al. (2015) reported allometric growth in the summer and fall, but isomeric growth in the spring.

### 2.2 Condition factor

According to Jones et al. (2018), when condition factor values are equal to or nearly equal to 1, it is presumed that fish species are fit in their environment generally. Jones et al. (1999) demonstrated that fish weight improved the condition factor of two salmon species. According to Falioye and Oluajo (2005), the mean value of 'K' for C*hrysichthys nigrodigitatus, Sarotherodon galilaeus, Pelmatolapis mariae, Heterotis niloticus, Tilapia zillii, Sarotherodon melanotheron, Synodontis nigrita,* and *Hyperopisus bebe occidentalis* is less than 1. While *Hemichromis fasciatus, Uranoscopus scaber, Polypterus senegalus, Papyrocranus afer, Saphyraena barracula,* and *Dagetichrhys lakdoensis* had higher than 1. The results indicate that the condition factor of fish species less than one in Lekki Lagoon's Iwopin freshwater ecotype, but fish with 1 condition factor were in good shape, and the same result was explored by Famoofo and Abdul (2020) who examined the population structure of 139 fishes representing 11 families and 16 species in the Iwopin freshwater ecotype of Lekki Lagoon. The Fulton condition factor values varied from 0.80 to 0.28. The 'K' value for *Chrysichthys nigrodigitatus* was found to be greater than others, i.e. ($0.80 \pm 0.20$), while Pranik, (2016) found the lowest ($1.28 \pm 0.89$) in *Hemichromis fasciatus* which indicated high K value during pre and post spawning period. Furthermore, smaller Kn value is seen during the spawning time, as well as the pre and post spawning periods in *Trichogaster latius* and *Chanda nama* (Sangam et al. 2019).

### 2.3 Stomach contents analysis

The food and feeding ecology of fish species has drawn the interest of ichthyologist worldwide. According to Kaundal (2012), *Sizothorax richardsonii, Garra gotyla gonila,* and *Chrosrocheilus latius latius* are bottom feeders with ventral mouths, whereas *Barilius bendelinsis, Puntius ticto,* and *Masracembelus armatus* have anterior mouths. *P. ticto* and *M. armatus* have adopted column feeding habit while *B. bendeliris* is a surface feeder. To depict and evaluate stomach contents, frequency, weight, and prey number (percentage or absolute) data are commonly utilized (Ibanez et al. 2021). Hynes (1950) investigated fish food using a number of ways. The point technique, occurrence method, number method, dominance method, volume and weight method, fullness of stomach method are among them. The number of stomachs containing each food item is calculated using the frequency of occurrence analysis and expressed as a percentage of all stomachs (Frost 1954). It has long been common practice to study fish and other animal's eating habits by physically analyzing their stomach contents (Sagar et al. 2019). Hossain et al. (2012) used the percentage and point technique to analyze the stomach content of *Puntius sarana* and discovered that it is omnivorous in nature, with Chlorophyceae and Bacillariophyceae dominating the stomach, with the highest point 22.39 for Chlorophyceae. According to Renones et al. (2002), *Epinephelus marginatus* generally ingested crustaceans (Largely *Decapoda Reptantia*), mollusks (mostly Cephalopoda), and fish (Osteichthyes). Cephalopods became an increasingly important source of food for dusky groupers as they evolved, while tiny dusky groupers continued to eat crustaceans, particularly brachyurans.

Gupta and Banerjee (2013) reported eight kinds of *Amblypharymgodon mola*'s stomach content: Rotifer, Plant parts, Eugleniphyceae, Planktonic crustacea, Bacillariophyceae, and Unidentified species. According to the ratio of occurrence methods, an average of 44.46% of Chlorophyceae has been recorded. *Pediastrum, Tetrahedron, Scenedesmus,* and *Colostrum* have been identified as the dominant genera among them. The months of June and January had the highest and lowest percentage of Chlorophyceae occurrence, respectively. Hossain et al. (2012) show that the percentage occurrence and point method were used to do qualitative and quantitative analysis of each stomach of fish and gut contents, and the stomach fullness was measured using the fullness index method. The Chlorophyceae were about equally dominating in terms of occurrence. Haque et al. (2021) reported that crustaceans were the most important food items for *R. rita* fish that are mollusks and arthropods rather than plant stuff and insects.

# 3. MATERIALS AND METHODS

## 3.1 Study area

The study area was Narayani River of West Nawalparasi of Nepal. There are seven tributaries to the snow-fed Narayani River. The Narayani River, which runs west and crosses the border with India to join the Ganges, is the deepest river in Nepal. Except of the rainy season, the Narayani River's water is crystal pure. Although gravel and sand predominate downstream, pebble and cobble constitute the predominant river bed upstream.

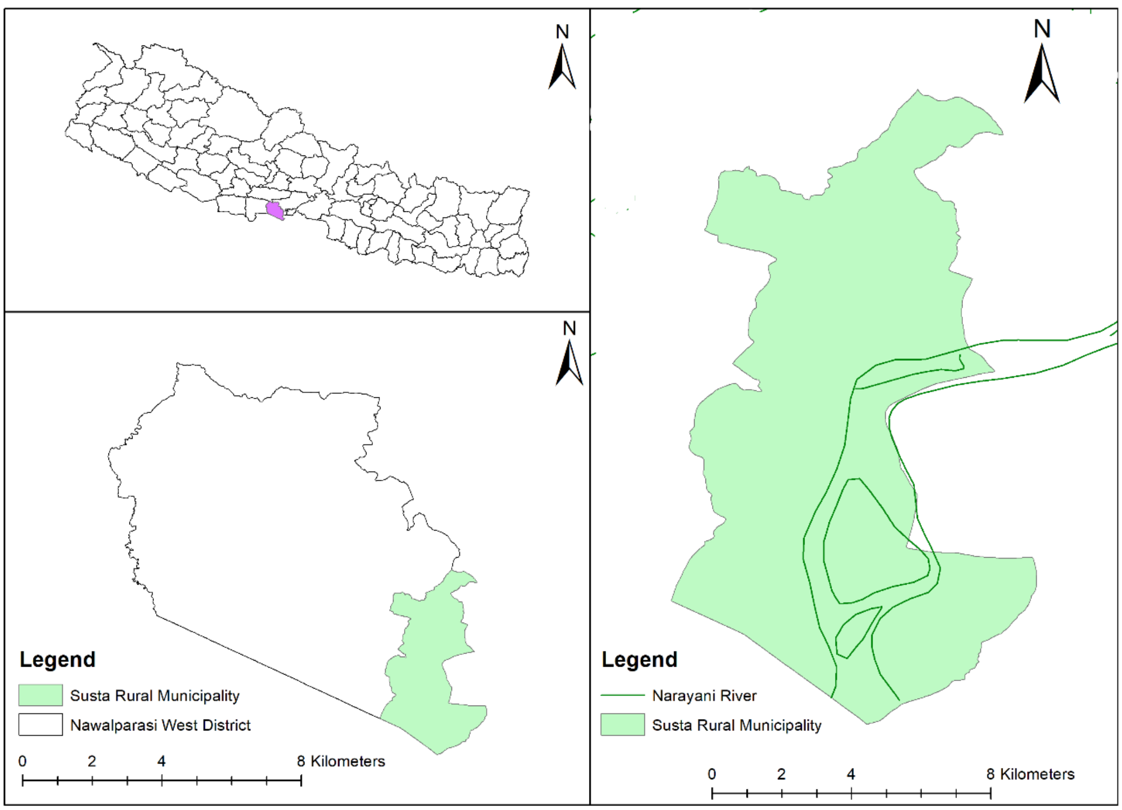


Figure 1. Map showing the study area of Narayani River in West Nawalparasi district

## 3.2 Materials

- Cast net (0.8 mm)
- Hook net
- Weighing balance
- Dissecting equipment
- Dissecting pan
- Stereo-microscope

## 3.3 Methods

Following the local government's approval or decision, fish were collected with the assistance of local fisherman.

Fishes were collected over two seasons (Summer and Autumn) in 2022 from the Narayani River of West Nawalparasi. Fishes were collected by using the cast net (0.8mm) and hook net. Fishes were differentiated into male and female on the basis of their secondary characteristics. After that, fishes were preserved in 8% of formalin and fish samples were transported to fish laboratory of Central Department of Zoology for further work.

### 3.3.1 Length-Weight measurement

An instrument with a ruler that is closest to 0.1 cm was used to measure the total length (TL) and standard length (SL) of the fish. Fish was examined for standard length from the tip of the snout to the base of the of the caudal fin and for total length from the tip of the snout to the tail fin. A digital weighing balance was used to weigh the fish's body weight. The fishes were dried using blotting paper.

### 3.3.2 Fish dissection

The fish was dissected with surgical scissors, and gut was removed and weighed in weighing balance and weight of the gut was noted. The fish gut was dissected and the stomach contents were removed. Then, it was directly observed with the stereo-microscope.

### 3.3.3 Diet analysis

The Gastro-somatic index was calculated by weighing the stomach and using that information to calculate its weight. The stomach was removed from the body vertically, and the contents were weighed and transferred to a petri-dish for microscopic analysis. The stomach contents were analyzed using a volumetric and frequency occurrence approach to determined their composition in accordance with Hyslop's theory (1980).

### 3.3.4 Data analysis

#### 3.3.4.1 Length weight relationship

To investigate the length-weight relationship, the total length (TL) and weight (W) of an individual fish with a certain length was measured in order to determine the pattern of growth and standard welfare of the fish. The length-weight relationship data were evaluated by using the technique (Le Cren 1951).

$$W = a\,TL^{\mathbf{b}}$$

$$\text{Log } W = \log a + b \log TL$$

W is the total weight, TL is the total length, (a) is the coefficient related to body form and (b) is an exponent indicating isometric growth when equal to 3 and allometric growth when different to 3 (the allometry is majorant if $b>3$ and minorant if $b<3$) (Froese, 2000). The degrees of association between variables (TL and W) was assessed by the coefficient of determination ($R^2$).

#### 3.3.4.2 Condition factor

The condition factor (K) were calculated for individual fish species for each season using the conventional formula described by Worthington and Ricardo (1936) as:

$$K = \frac{W*100}{L^3}$$

#### 3.3.4.3 Gastro-Somatic Index (G.S.I)

The standard formula (Bhatnagar & Karamchandani 1970) presented below was used to determine the diversity in feeding intensity of *Eutropiichthys murius* in various seasons;

$$G.S.I = \frac{\text{Weight of stomach (g)}}{\text{Weight of fish (g)}} \times 100$$

#### 3.3.4.4Qualitative and quantitative analysis of gut content

The two main kinds of gut content analysis techniques are qualitative and quantitative. An exhaustive identification of the organisms present in the stomach contents constitutes the qualitative analysis. The identification of insects which were found on the stomach of *E. murius* were identified with the help of bool written by Thapa (2015). The volumetric approach and the numerical method (Wolfert & Miller 1978) were applied in the current work.

#### 3.3.4.5 Index of fullness

The status or intensity of eating is an essential factor measured by a stomach inspection. This was influenced by the level of distension of the stomach or the amount of food contained within it. By sight, the stomach slightly wider was assessed and characterized as "full" or "distended", "moderate", "half" and "empty".

# 4. RESULTS

## 4.1 Length-weight relationship and condition factor of fish

A total of 200 samples of *Eutropiichthys murius* were collected seasonally (summer and autumn). Throughout the summer, 100 individuals of *Eutropiichthys murius* with total lengths ranging from 8.5 to 39.2 cm with a mean of 20.7 cm and body weights ranging from 7.4 to 340.7g with a mean of 83.9g were recorded. During the Autumn, 100 samples with total lengths ranging 14.1 to 38.5 cm with a mean of 22.5 cm and body weights ranging from 14.4 to 365.6g with a mean of 128.4g were recorded (Table 1).

Table 1. Length, weight and condition factor of fish in summer and autumn

| | Summer season | Autumn season |
|---|---|---|
| No. of fish examined | 100 | 100 |
| Total length (cm) (range) | 8.5-39.2 | 14.1-38.5 |
| Standard length (cm) (range) | 6-33.5 | 11-32.5 |
| Weight (g) (range) | 7.4-340.7 | 14.4-395.6 |
| Total length (Mean) | 20.7 | 22.5 |
| Weight (g) (mean) | 83.9 | 128.4 |
| Condition factor (K) (range) | 0.44-3.06 | 0.33-2.69 |
| Condition factor (mean) | 0.77±0.049 | 0.64±0.031 |

The condition factor of summer season was 0.77 which indicated that the fish population was relatively unhealthy. The fish population in the season was likely well-fed and had few health issues due to some factor. During the autumn season, the condition factor was 0.64 obtained which indicated that the fish population might be experiencing some stress or health issues.

## 4.2 Length-weight relationship

A total of 200 *Eutropiichthys murius* individuals with TLs ranging from 8.5 to 39.2cm and body weights ranging from 7.4 to 395.6g were analyzed. The equations below were used to represent the length-weight relationships of *Eutropiichthys murius* based on pulled data: $W = 0.218 \times TL^{2.607}$ ($R^2 = 0.879$) for summer season and $W = 0.0069 \times TL^{2.9608}$ ($R^2 = 0.9105$) for autumn season.

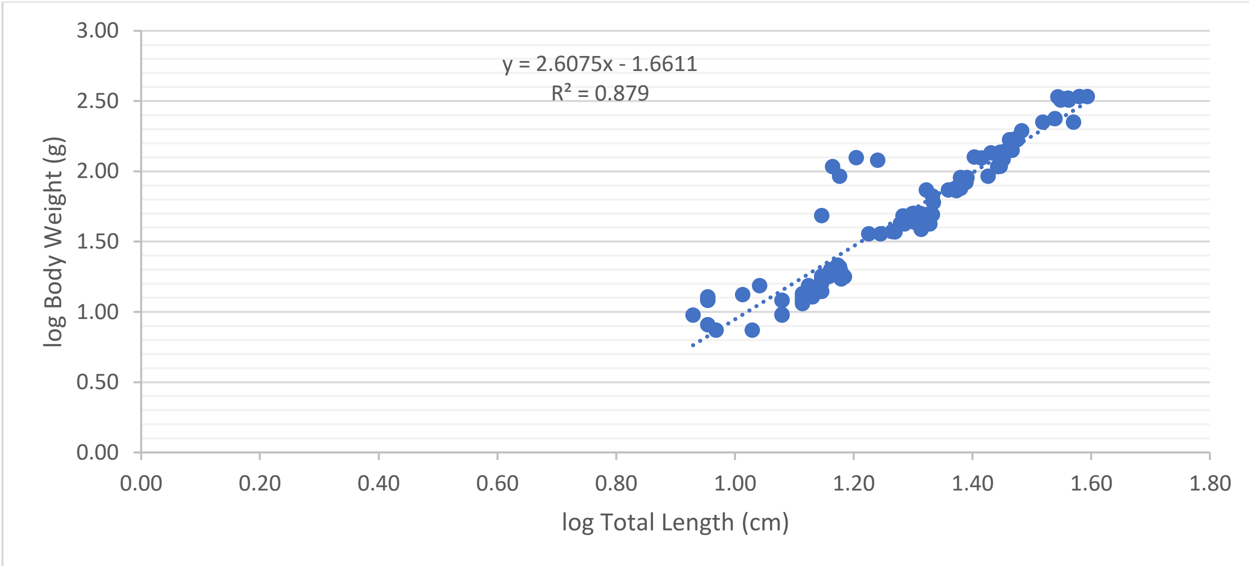


Figure 2. Length and weight with logarithmic relationship of *E. murius* in Summer

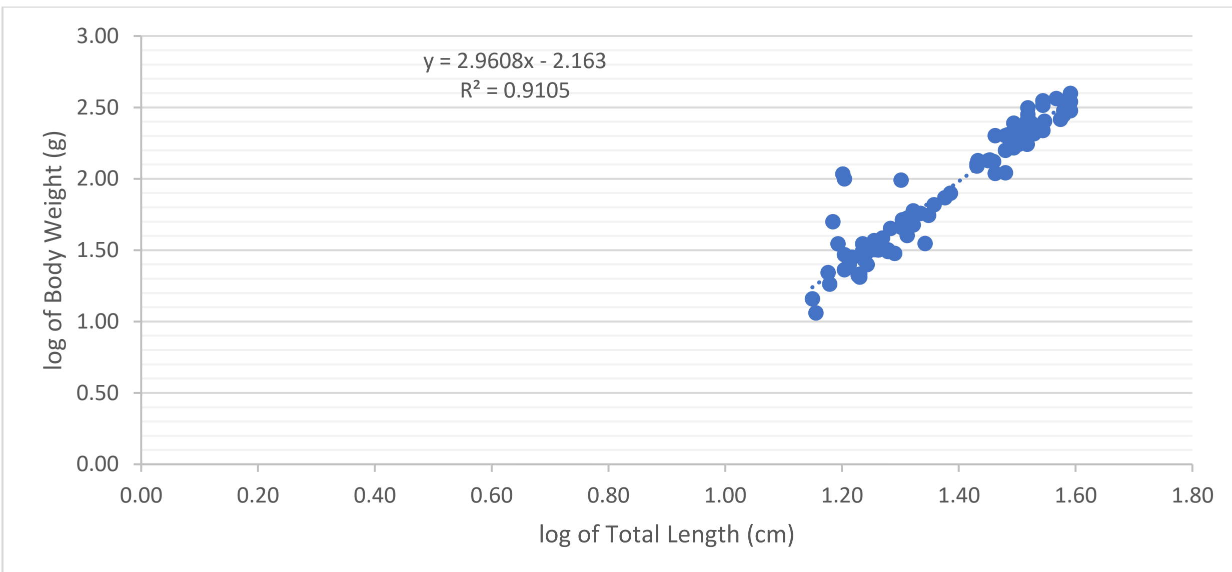


Figure 3. Length and weight with logarithmic relationship of *E. murius* in Autumn

The value of *b* less than 3 in both season showed that the fish possessed negative allometric growth pattern, however, the fish possessed negative allometry in Summer and Autumn season with *b* value 2.607 and 2.960, respectively. Apart from this, the coefficient of determination ($R^2$) was closer to 1 indicating positive correlation between length and weight (Table 2).

Table 2. The length- weight relationship of Eutropiichthus murius for two seasons

| Season | a | b | $R^2$ | $W = aTL^b$ | Growth pattern |
|---|---|---|---|---|---|
| Summer | 0.218 | 2.607 | 0.879 | $W = 0.218 \times TL^{2.607}$ | Negative allometric |
| Autumn | 0.0069 | 2.960 | 0.910 | $W = 0.0069 \times TL^{2.960}$ | Negative allometric |

**4.3 Gastro-Somatic-Index (G.S.I)**

Two hundred stomach samples were obtained, and the Gastro-Somatic-Index (G.S.I) of each sample was calculated separately. The Summer season had the highest mean G.S.I. (9.34), while the Autumn season had the lowest (8.18). The G.S.I. of the obtained samples varied somewhat, showing that fish eat at varying variety. The mean G.S.I. value was calculated and presented in Table 3.

Table 3. G.S.I. of *Eutropiichthus murius* for Summer and Autumn season

| Season | No. of fish examined | Mean Total length | G.S.I. (range) | Mean G.S.I.±SD |
|---|---|---|---|---|
| Summer | 100 | 20.7 | 1.67-25.56 | 9.34±0.44 |
| Autumn | 100 | 22.5 | 2.86-21.88 | 8.18±0.33 |

**4.4 Index of fullness**

The feeding intensity was calculated using the proportion of gut fullness or empty. It was observed that out of 200 stomachs, 138 stomachs contained food whereas 62 were reported to be empty.

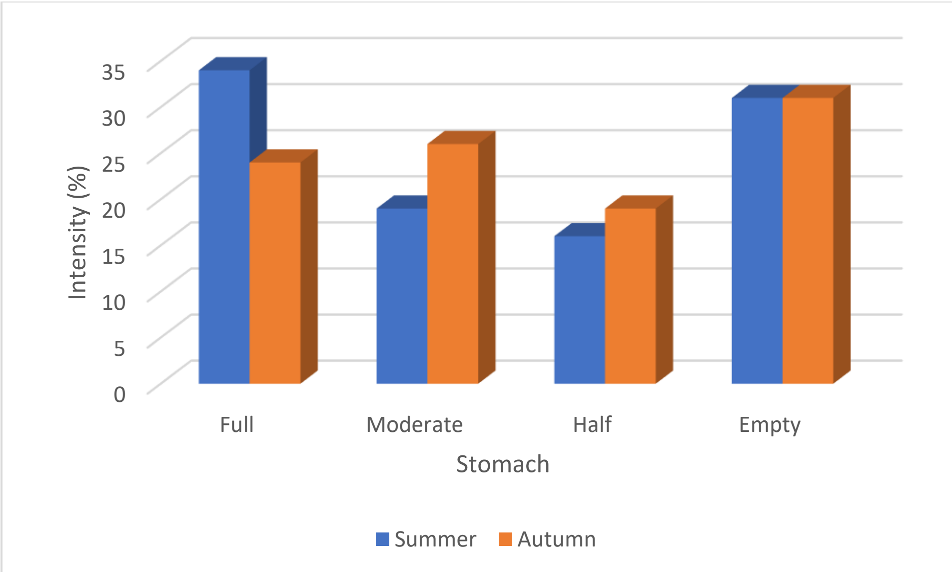


Figure 4. Feeding intensity of E. murius collected from the Narayani River, Nawalparasi west

The fish inferred the percentage of full stomach as 34% and 24% in summer and autumn season, respectively. Similarly, highest percentage (34%) and lowest percentage (16%) of half stomach were observed in summer season. Both, in summer season and autumn season, 31% of fishes were with empty stomach observed.

**4.5 Qualitative and quantitative analysis of stomach content**

To represent the diet and eating habits, the stomachs of 200 specimens ranging in size from 8.5 cm to 39.5 cm were analyzed. *Polyrhachis* spp, *Caribidi* spp, *Acrididae* spp,*Leptocoriza* spp, *Stipa tenacissima*, *Hydrilla verticillate*, water beetles and zooplanktons were found in the most abundance in their stomachs. *Polyrhachis* spp. formed the majority of fish diet and the most prevalent food item. The second significant component of fish diet includes *Leptocoriza* spp. and *Stipa tenacissima*. The majority of the insects and their pieces, as well as some plant parts, were found in the fish’s stomach. The stomach also included some sand particles, mollusks, detritus organic stuff, and undigested element classified as miscellaneous.

Table 4. Food items in the stomach of E. murius

| | Food groups | Food items |
|---|---|---|
| Animals Matter | Insects | *Polyrhachis* spp, *Carbidi* spp, *Acridida* spp, *Leptocorisa* spp, earthworm and water beetle |
| Plant matter | | *Stipa tenacissima*, *Hydrilla vercillate*, Paady, and plant leaf |
| Miscellaneous | | Sand, mud, detritus and chicken's feathers (plastic and rubber) |

**4.6 Non-biotic content in diet**

Out of 200 samples, non-biotic materials such as rubber and plastic were observed from 17 samples. Plastic and rubber containing stomachs were unable to digest the food items and also some of them consisted of only plastic and rubber in their stomach, which indicated that how our natural resources have been polluting due to anthropogenic activities.

Photo 2. Non-biotic content in stomach

# 5. DISCUSSION

## 5.1 Length-weight relationship

There were no previous records of length frequency distribution and stomach content analysis of this species from the Narayani River. When growth is measured in terms of length, it was discovered that the growth of *Eutropiichthys murius* in this experiment was negative allometric, with a mean value of ‘b’ was 2.7 (b= 2.607 & b=2.96, for summer and autumn seasons, respectively). In both, summer and autumn seasons, b values were less than 3 indicating that the fish displayed unfavorable traits. Similar research performed in River Ganga demonstrated result having ‘b’ value 2.977, (Karna et al. 2018), which is almost similar with result obtained from our research. The change in growth pattern across seasons might be attributed to environmental factors, fish size selection, food availability, gonadal maturation period, and water parameters of the Narayani River during different seasons. Our result matches with the growth factor ‘b’ ranged from 1.85 to 2.29 for *P. leonensis* and *M. cyprinoides* with mean value of 2.41$\pm$0.16, and these values were less than 3, indicating that the fish had negative allometric growth, signifying that they got slenderer as they gained weight (Onimisi et al. 2015). Agboola and Anetekhai (2008), who recorded the length-weight correlations of 35 fish species from Badagry Creek, Lagos, obtained values between (2.06-3.25), which are comparable to this results. It matches to the b values (2.79-3.2) reported by (Fafioye and Oluajo 2005) who recorded the relationships between length and weight of five different fish species in Lagos’ Epe Lagoon. The value of ‘b’ ranged from 2.11to 3.52 for *Cirrhinus mrigala, Puntius sophore* and *Labeo gonius,* with which the mean value of ‘b’ was 3, result showed the isometric growth (Dubey et al. 2012) but our investigation results opposite to it due to negative allometric growth was observed.

The LWRs of 200 fish revealed that significant correlation data were, for the summer season, i.e., $R^2$=0.879, and for the autumn season, i.e.,0.91, with a mean value of 0.89, it showed that autumn season had little correlation between length and weight than the summer season, similar correlation value (r=0.99) was obtained by (Karna et al. 2018) of same species from Ganga River, India, contrast to Rahman et al. (2012), who found that LWRs of both *Puntius sophore* sexes combined were strongly associated with r>0.94 value. Alam et al. (2012)

reported the same result as previously, with values ranging from 0.89 to 0.96 for all studied specimens.

### 5.2 Condition factor

The condition factor (K) provides information on a fish's physiological state in relation to its wellbeing. According to Perry et al. (1996) fish with a poor condition index are likely to have had a harsh physical environment or inadequate nutrition. According to the Maguire et al. (1993), a rise in K levels suggests fat storage and occasionally gonadal development from a nutritional standpoint. Angelescu et al. (1958) showed that the maximum K values are attained in species when the fish is completely developed and has a higher reproductive capacity. The K values, which varied from 0.44 to 3.06, show the health of the fish over the summer season and correspond with the finding of Jana and Dasgupta (2008). The K values which varied from 0.33-2.69 also indicate the health of fish in the autumn season but not in the summer season in the present result. The value of K for autumn season to the *C. nigro digitalis* had 2.17 and *S. barracuda* had K value 0.37 (Ekpo & Ibolk 2014). Bahuguna et al.(2021) found *Puntius sophore's* 'K' value was (0.93±0.19), which is greater than our calculated value (0.77). Datta et al. (2013) reported that the 'K' value of *Phycis blennoides* increases from March to August (Summer Season) than the other season of the year and our result also showed the higher 'K' value in summer season. Our investigations also supported by Olopade et al. (2015) who discovered the mean value of 'K' for both male and female *Leuciscue niloticus* as 0.55±0.09 having poor adaptation of fish in their relative habitat in the Epe lagoon. Overall study shows that the condition factor of *E. murius* is higher in the summer season than the autumn season, due to the good environmental condition, feeding condition and gonadal development. The fish in this season might be undernourished or facing environmental stressors such as pollution or habitat degradation.

### 5.3 Gastro-somatic index

For the summer and autumn seasons, the gastro somatic index values varied from 1.67-25.56 and 2.86-21.88, respectively. Summer had the greatest mean gastro somatic index while autumn had the lowest. The GSI value fluctuates due to the changing feeding intensity of fishes in various seasons. The value of GSI reduced in the autumn season as compared to the summer season due to decreasing availability of food items in the environment. Risal et al.

(2019) show that the gastro somatic index ranged from 4.03 to 7.27 within the size range of 4.4-10cm, which contradicts the finding of this investigation. By observing the values of the gastro-somatic index (GSI) of *S. richardsonii* at various size groups, Kaundal (2012) found that the GSI ranged from 5.43 to 10.25, which is somewhat comparable to the current findings because of variations in feeding intensity caused by a reduction in the availability of food.

### 5.4 Qualitative and quantitative analysis of stomach content

The current study discovered that the intensity of feeding varied depending on the season. In the summer and autumn season, empty stomachs were 31% in both, although 34% and 24% of stomachs were found fullness with food items. During the summer season stomach fullness or feeding intensity was high due to the spawning time and seasonal changes in water temperature and food item. Also, during spawning time fish need more energy input in order to meet the reproduction requirements (Froese 2000). The percentage of empty, moderate, half, and full stomachs revealed a seasonal variation in feeding intensity. The most likely cause of this is, not enough or lack of quantity of food items in fish habitat. A range of food items belonging to *Polyrhachis* spp, *Carbidi* spp, *Acrididae* spp, *Leptocoriza* spp, *Stipa tenacissima*, water beetle and zooplankton were identified in the current research. Due to its inclusive preference for insects (*Polyrhachis* spp, *Caribidi* spp, *Acrididae* spp, *Leptocoriza* spp and *Pentatomidi* spp) and pant parts (*Hydrilla* and *Stipa tenacissima*), the fish in Narayani River is classified as omnivore and surface feeder. This fish also ingested a larger proportion of animal-based food (insects). The presence of *Polyrhachis* spp, (62.32%) water beetle (46.38%) and *Stipa tenacissima*'s (42.03%) parts in the stomach of *E. murius* were observed at a high proportion, because of the *Polyrhachis* spp and water beetles were mostly found in the parts of the *S. tinacissima*. This aided *E. murius* is a surface feeder. The total percentage of plant and animal-based diet, on the other hand, proved its omnivorous character. The present study's findings contradicted those of Sharma (1984), Bhatt et al. (1985), and Kaundal (2012), who found *S. richardsonii* to be herbivorous with a low amount of animal matter. The current finding is relevant to the Osman (2013) who revealed that *E. teres*'s stomach contained a large number of animal components and was omnivorous in nature.

### 5.5 Non-biotic content in diet

Animals frequently consume plastic because they are usually unable to distinguish it from food. Lugworms and baleen whales, as well as plankton and other filter-feeding organisms, cannot distinguish between them. Some fish eat floating plastic and rubber items in the water because they mistake it for fish eggs and bite at it (National Oceanography Centre 2020). There have been reports of dying whales with tones of plastic in their stomachs. According to long-term Dutch research, the stomach contents of the northern fulmar often include 25 pieces of plastic. In December 2018, a sperm whale washed ashore at Indonesia's Wakatobi National Park with 115 cups, 25 bags, four bottles, and two slippers in its stomach. The 210 species of fish that are taken commercially have been shown to consume plastic, while the researchers that probably an underestimate. Although the database showed that more than two-thirds of the fish species under study had consumed plastic, there were still 148 species for which there was no evidence of this. Our research results similar as above, out 200 fish samples, 17 fish samples were contained plastic and rubber in their stomach.

# 6. CONCLUSION AND RECOMMENDATIONS

## 6.1 Conclusion

The present study on the length-weight relationship, condition factor, and stomach content analysis of *E. murius* from the Narayani River, West Nawalparasi found that the fish's LWR fluctuated between seasons. *E. murius* displayed negative allometric growth in both the summer and autumn seasons, resulting in a rise in body length rather than weight. It reveals that the Narayani River's environmental conditions might not suitable to the appropriate growth and development of *E. murius*, due to the presence of pollutants in the water of Narayani River and also due to the presence of non-biotic matter in the stomach of *E. murius*.

## 6.2 Recommendations

Following are some crucial recommendations based on this research:

- ✓ Promote the reduction of plastic and rubber waste at the source. Encourage the use of reusable and biodegradable alternatives, and discourage single-use plastic and rubber product.
- ✓ Enhance waste management infrastructure to ensure proper collection, recycling, and disposal of plastic and rubber waste.
- ✓ Support research and innovative: Invest in research and development of innovative solutions to tackle plastic and rubber pollution.

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## Photographs



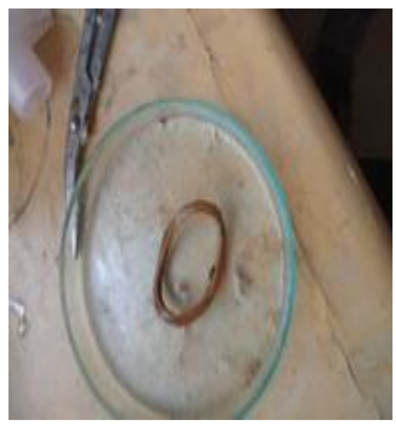
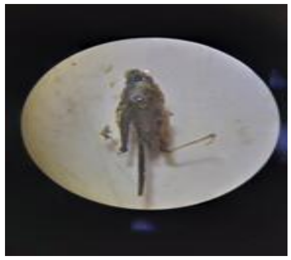



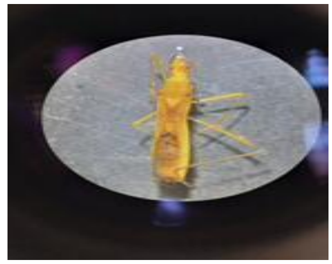
Photo 3. Content of stomach

Photo 4: Laboratory work (Dissection and Analysis of Fish)

*Polyrhachis* spp.

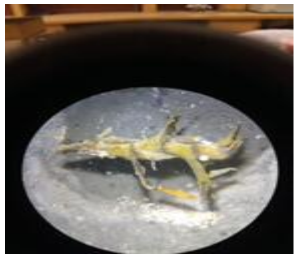


*Acridida* spp.



*Leptocorisa* spp.

*Pentatomidi* spp.



*Hydrilla* spp.

**Photo 5: Identified species**