# Growth patterns and condition factors of fish in the Celike River, leuser ecosystem area, East Aceh, Indonesia

*Adli* Waliul Perdana[1*], *Furqan* Maghfiriadi[2] , *Siti* Maulizar[3], *Al* julismi[1], *Muhammad* Dawami[1], *and Firman* M. Nur[3]

[1]Department of Aquaculture, Faculty of Marine and Fisheries, Syiah Kuala University, Banda Aceh 23111, Indonesia
[2]Center for Aquatic Studies and Conservation, Universitas Islam Negeri Ar-Raniry, Banda Aceh, Indonesia
[3]Faculty of Biology, Gadjah Mada University, Indonesia
[4]Research Center for Biosystematics and Evolution, Badan Riset dan Inovasi Nasional (BRIN), Cibinong, Indonesia

**ABSTRACT.** Fish growth patterns are the process of increasing the size and weight of a fish's body that occurs during its lifetime. This growth pattern is influenced by genetic factors, the environment, food availability and the physiological condition of the fish. Research on Growth Patterns and Condition Factors of Fish in the Celike River in the Leuser Ecosystem Area of East Aceh aims to determine the size of fish and provide an overview of fish growth patterns by analyzing the relationship between length and weight and fish condition factors. The method used is a purposive sampling method, namely determining the location of research station based on consideration of habitat characteristics in locations that are thought to have a high presence of fish, are easy to reach and represent the Celike River area in the Leuser Ecosystem Area. This research was carried out in July 2024. The total number of fish obtained was 122 individuals from 10 species belonging to seven families, namely Cyprinidae, Sisoridae, Clariidae, Channidae, Cichlidae, Balitoridae, Aplocheilus. There are two dominant species caught at this location, namely *Tor soro* and *Tor tambra*. *Tor tambra* obtained during the study amounted to 40 individuals with a total length of 70.09 - 434.4 mm and a weight of 3.96 - 811.05 g. *Tor soro*) obtained during the study amounted to 34 individuals with a total length of 61.79 - 144.33 mm and a weight of 2.89 - 32.5 g. The growth pattern of fish in the Celike River with eight fish species is negative allometric, two fish species are isometric and positive allometric, with condition factor values ranging from 0.07 to 8.88.

## 1 Introduction

The Leuser Ecosystem (KEL) in Aceh and North Sumatra Provinces, Indonesia, is one of the largest conservation areas in Southeast Asia, covering 2.6 million hectares with high

* Corresponding author: adliwaliul@usk.ac.id

biodiversity, including 4,000 species of flora and 739 species of fauna [1, 2]. KEL plays an important role as a natural forest through which various rivers pass, including the Celike River, which has swift currents and rocky substrates. The river supports the lives of local communities by providing electricity and livelihoods from fishing. Fish serve as indicators of water quality and have an important role in the ecosystem [3].

Fish is an important biota that is often caught as a source of consumption and livelihood by the community. However, fishing is often done in an environmentally unfriendly manner, such as with the use of poisons and inappropriate fishing gear. The high demand for fish can lead to overfishing, which has the potential to reduce populations and threaten species extinction if not managed properly. Effective management is necessary to maintain the sustainability of fisheries resources. This management requires data on aspects of fish biology, including growth patterns and condition factors, which are important for determining the selectivity of fishing gear so that fish caught are of a viable size [4, 5]. [6] and [7] stated that measurements of fish length and weight are needed to determine variations in weight and length as indicators of fatness, health, productivity, and physiological conditions of fish.

There have been many studies on the length-weight relationship of fish in Aceh River. Some studies conducted in Aceh include length-weight relationships and condition factors of tilapia (*Oreochromis Niloticus*) and mullet (*Mugil cephalus*) caught in the Matang Guru River, Madat District, East Aceh Regency [8], length-weight relationships and condition factors of betutu fish (*Oxyeleotris marmorata*) in the Ulim River, Pidie Jaya Regency, Aceh Province [9], length-weight relationship of fish caught in Krueng Simpoe, Bireun District, Aceh [10]. Meanwhile, fish research in KEL is still relatively low, but it has been done in the Merbau River [11].

Research on growth patterns and condition factors of fish in the Celike River in KEL has never been conducted. Therefore, research on growth patterns and fish condition factors needs to be carried out, because growth patterns are an important step in the management of fisheries resources in waters and provide information on length-weight relationships and fish condition factors. It also serves as basic information for sustainable management of fisheries resources [12].

## 2 Materials and methods

### 2.1 Time and place

This research was conducted in the Celike River in East Aceh District. The research time was in July 2024. Data identification and analysis were carried out at the Multi Function Laboratory, Ar-Raniry State Islamic University.

### 2.2 Tools and materials

There is The tools and materials used in this research are as follows Fishing Rod, Drain, Net, GPS (Global Position System), Fabric Meter, Styrofoam, Vernier calipers, Digital scales, Formalin.

### 2.3 Research methods

This study used a purposive sampling method, namely the determination of the location of the research station was carried out based on considerations of habitat characteristics at

locations that were suspected of having high fish presence, were easily accessible and represented the Celike River area in the Leuser Ecosystem Area [13]. The research location was divided into 6 stations based on the characteristics of different river habitats in the upstream area. Each research station was divided into three substations representing the basin, riverbank and middle of the river. Some characteristics of the river that will be the sampling locations include river pools, tributaries, rapids, and rapids. Fish sampling was carried out using a 10 x 10 m2 plot at each station. The number of plots at each station was 3 plots with a total of 18 plots [14].

## 2.4 Research procedures

Fish sampling, using several fishing gear including nets, fishing rods, nets and scoops. At each station, fish sampling was done using a 6 cubit net with a mesh size of 0.5 inches, each sampling using the net was done 15 times in one day, while the net was installed from 09.00 - 16.00 WIB and checked every three hours. The types of nets used have sizes of 1 inch, 0.5 inches and 1.5 inches which are installed at each observation station with a distance between nets of about 50 m. In rocky river areas that are difficult to use nets and nets, fishing is done using scoops, because small fish are very difficult to catch using nets [15].

## 2.5 Data analysis

The data analysis in this study was analyzed descriptively in the form of tables and figures.The parameters calculated are the length-weight relationship, and the fish condition factor can be calculated using Microsoft Excel using the following formula:

Length Weight Relationship

The relationship between length and weight of fish is analyzed to determine the growth pattern using the formula:

$$W = aLb$$

Information:

W = Fish Weight (g)
L = Fish Length (mm)
a = Constant
b = Exponent

The values a and b are obtained from the results of the regression analysis. The criteria for the value of b are as follows:

b = 3 = Isometric fish growth pattern (balanced increase in weight and length of fish).
b < 3 = Negative allometric fish growth pattern (length increase is more dominant).
b > 3 = Positive allometric fish growth pattern (weight gain is more dominant) [16].

Condition Factors

Condition factors can be analyzed using the following formula:

$$K = \frac{W}{aLb}$$

Information:

K = Condition factor

W = Fish Weight (g)
L = Fish Length (mm)
a : constant b : exponent [17]

# 3 Results and discussion

## 3.1 Results

The results of the analysis of fish growth patterns in the Celike River, showed that eight species showed negative allometric growth patterns, one species showed positive allometric growth, and one was isometric. The results of the length-weight relationship analysis obtained only two dominant fish species found in the Celike River, namely jurung fish (*Tor tambra*) and Gemoh fish (*Tor soro*), both fish species belong to the Cyprinidae family. These fish species have the same growth pattern, namely jurung fish and Gemoh fish have a negative allometric growth pattern. The condition factor values range from 0.04 to 8.88. The length-weight relationship can be used to estimate fish condition factors so that fish health will be seen from variations in the value of this parameter [18]. [19] explains that fish with a condition factor value of 1 - 3 illustrates the physiological function of the body is in good condition. Growth patterns and condition factors of all fish species found in the Celike River are presented in Table 1.

**Table 1** Results of research on growth patterns and fish condition factors in the Celike River.

| Species | Total Length (mm) | | Total Weight (g) | | | | CI of | | | Pattern |
|---|---|---|---|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | a | b | 95% | $R^2$ | K | Growth |
| *Tor Tambra* | 70.09 | 434.4 | 3.96 | 811.05 | 0.00002 | 2.88 | 2.78 - 2.97 | 0.99 | 0.23 | Negative allometric |
| *Tor soro* | 61.79 | 144.33 | 2.89 | 32.5 | 0.00004 | 2.73 | 2.61 - 2.84 | 0.98 | 0.29 | Negative allometric |
| *Homalopterula riplevi* | 46.72 | 85.05 | 0.99 | 4.81 | 0.00007 | 2.51 | 2.24 - 2.76 | 0.96 | 1.39 | Negative allometric |
| *Glyptothorax platypogon* | 81.89 | 132.32 | 4.78 | 14.88 | 0.0001 | 2.39 | 1.79 - 2.97 | 0.99 | 0.37 | Negative allometric |
| *Clarias teijsmanni* | 140.11 | 176.11 | 20.14 | 31.5 | 0.0013 | 1.95 | 1.17 - 2.72 | 1.00 | 0.08 | Negative allometric |
| *Channa limbata* | 101.75 | 130.02 | 15.01 | 20.92 | 0.0319 | 1.33 | 0.02 - 2.63 | 0.99 | 0.07 | Negative allometric |
| *Oreochromis mossambicus* | 88.46 | 108.2 | 16.07 | 19.06 | 0.7076 | 0.70 | 0.41 - 0.98 | 0.92 | 0.04 | Negative allometric |
| *Short Barbodes* | 91.48 | 117.46 | 6.99 | 10.77 | 0.0037 | 1.67 | 1.79 - 5.12 | 0.97 | 0.19 | Negative allometric |
| *Barbodes binotatus* | 75.18 | 114.52 | 4.84 | 18.1 | 0.00001 | 3.05 | 2.54 - 3.54 | 0.99 | 0.40 | Isometric |
| *Aploceilus pancax* | 3.4 | 4.6 | 0.28 | 0.75 | 0.0037 | 3.51 | 2.52 - 4.48 | 0.98 | 8.88 | Positive allometric |

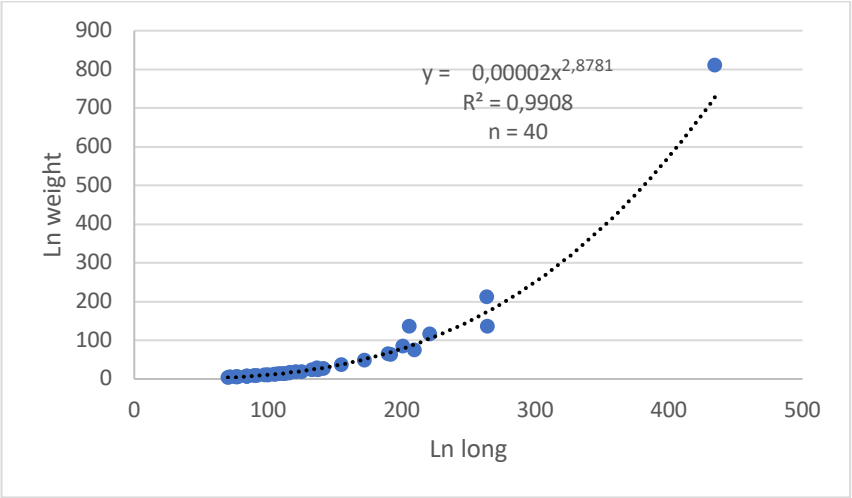


**Fig. 1.** Growth pattern of *Tor tambra* in the Celike River.

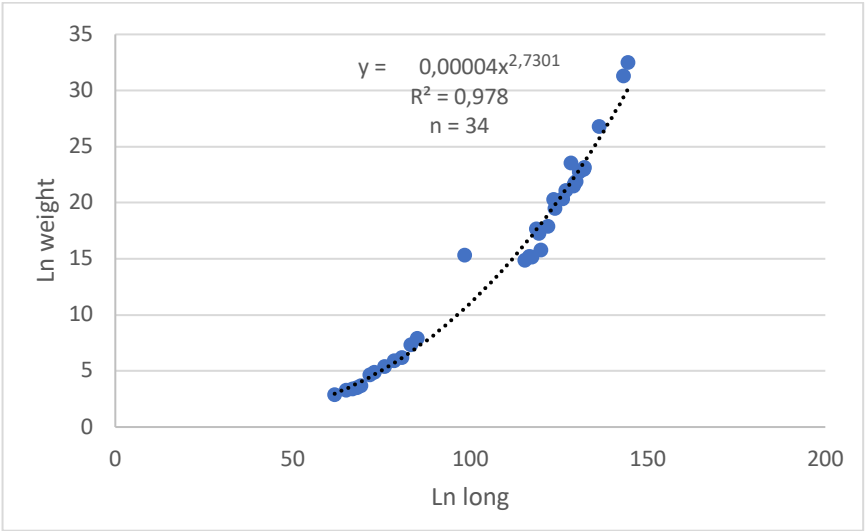


**Fig. 2.** *Tor soro* growth pattern in the Celike River.

## 3.2 Discussion

There are two types of fish length-weight relationships, namely isometric growth (n = 3), and allometric growth (n> 3) or (n <3). n> 3 indicates that the fish is fat/plump, where weight growth is faster than length growth. n <3 indicates that the fish is categorized as thin, where length growth is faster than weight growth [20]. Fish growth is influenced by several biological factors such as gonad growth and gender as well as environmental factors such as feed availability and water conditions [21].

Jurung fish (*Tor tambra*) obtained during the study amounted to 40 individuals with a total length of 70.09 - 434.4 mm and a weight of 3.96 - 811.05 g. The results of the regression analysis of the relationship between length and weight of fish obtained the equation y = 0.00002x - 2.8781. The results of the analysis showed a value of b <3, namely 2.8781. The value of b depends on food availability [22], gonad maturity level [23], and gender. This shows that the growth pattern of Jurung fish is negative allometric, namely the growth pattern

of fish shows that the growth of fish length is faster than the weight of fish. The coefficient of determination ($R^2$) value obtained in Jurung fish is 0.99 or close to 1, indicating that 99% of weight growth is caused by growth in length. This shows that the correlation coefficient relationship between the length and weight variables has a strong relationship or that there is a relationship between the length and weight of the fish [24].

Gemoh fish (*Tor soro*) obtained during the study amounted to 34 individuals with a total length of 61.79 - 144.33 mm and a weight of 2.89 - 32.5 g. The results of the regression analysis of the relationship between fish length and weight obtained the equation y = 0.00004x - 2.7301. The results of the analysis showed a value of b > 3, namely 2.7301. This shows that the growth pattern of Gemoh fish is negative allometric, namely the growth pattern of fish shows that the growth of fish length is faster than the weight of fish. so that the fish look thin. The coefficient of determination ($R^2$) value obtained in Gemoh fish is 0.98, indicating that the weight growth of Gemoh fish is 98% due to growth in length. This shows that the coefficient of determination value is close to 1, indicating that there is a strong relationship between the length and weight of fish [25]. A strong correlation is also suspected due to the availability of sufficient food and environmental conditions that support fish growth [26].

The results of the analysis of Gemoh fish in this study were negative allometric. This result is in line with the research *Tor soro* in the Baturangin, Tangga, Parhitean and Hula-huli areas of the Asahan River, North Sumatra, which obtained a b value <3 [24]. The results of other studies have different growth patterns in the research of *Tor soro* in the Aek Godang River, North Sumatra with a b value = 3.093 which is isometric [27].

The results of the condition factor analysis of two fish species, namely Jurung and Gemoh fish, have different (K) values. *Tor tambra* fish have condition factor values ranging from 0.037 - 0.9495 and *Tor soro* fish range from 0.1121 - 1.5870. The existence of differences in condition factors is in accordance with the statement [28] stated that differences in condition factors are influenced by differences in habitat, season, weight, length, and level of gonad maturity.

Differences in the growth patterns of fish in the Celike River, such as those observed in Jurung (*Tor tambra*) and Gemoh (*Tor soro*), reflect the adaptability of species to specific environmental conditions and their ecological role in the ecosystem. Jurung fish showed negative allometric growth with body length growing faster than body weight, which can be interpreted as an efficient reproductive strategy and ability to utilize available food resources [30]. Gemoh fish showed a similar growth pattern, albeit with a slightly lower coefficient of determination, indicating that the two species are related in their interactions with other species and their position in the food chain suggests that they have different adaptations [31]. Environmental stress due to habitat alteration or pollution can disrupt these growth patterns, causing weight loss and unbalanced growth, as well as affecting gonad maturation and reproductive rates [32][33]. Effective environmental monitoring and management is essential to maintain the health of aquatic ecosystems and support optimal fish growth.

The growth patterns of Jurung fish (*Tor tambra*) and Gemoh fish (*Tor soro*) observed in fish in the Celike River, can provide important insights for ecosystem management practices, especially in the context of fisheries resource sustainability. These growth patterns allow managers to design more sustainable fishing strategies and avoid overfishing, which can worsen the condition of fish populations [34]. Anthropogenic activities, such as overfishing pressure and habitat modification, can disrupt this growth pattern, causing population declines and changes in fish community structure [35]. This study has limitations, such as time constraints and small sample sizes for certain species, which may affect the generalizability of the results. Future research should include longitudinal studies with larger sample sizes and multi-species analyses to understand the complex interactions within ecosystems and the long-term impacts of human activities on fish growth patterns [36].

## 4 Conclusion

Of the 13 species analyzed, there are 8 fish species that have a negative allometric growth pattern, 1 species has a positive allometric growth pattern, and 1 species has an isometric growth pattern. The condition factor value ranges from 0.04 – 1.39. The recommendation for this conservation area is to implement ecosystem-based zones to ensure sustainability. In addition, it is necessary to involve local communities in managing the area and to increase capacity through training and mentoring. Further research can be carried out by analyzing the potential of river areas for cultivation locations.

## Acknowledgment

The study was financed by a Research Grant from the Universitas Syiah Kuala through the "Penelitian Asisten Ahli 2024" scheme [Grant No: 457/UN11.2.1/PG.01.03/SPK/PTNBH/2024].

## References

1. N. Nuribadah, The existence of the Aceh Government in reducing forest damage in Aceh. *Asia-Pac. J. Public Policy* **8(1)**, 25–35 (2022)
2. R. Ardi, A. Yasin, A. Iswandari, F. A. Nugroho, Types of Native Trees of Mount Leuser National Park. North Sumatra: Mount Leuser National Park Center (2021)
3. A. Rahman, L. W. Khairoh, Determination of River Pollution Level of Village Awang Bangkal Based on Nutrition Value Efficient by Using Tilapia (*Oreochromis niloticus* Linn.) as Bioindicator. *J. Ecosci.* **4(1)**, 1–10 (2012)
4. J. J. Mamangkey, S. H. Nasution, Growth and Mortality of Endemic Butini (*Glossigobius matanensis* Weber, 1913) in Lake Towuti, South Sulawesi. *Biol. News* **13(1)**, 31–38 (2014)
5. Nurhayati, Fauziyah, Siti, Relationship between Length-Weight and Fish Growth Patterns in the Musi River Estuary, Banyuasin Regency, South Sumatra. *Maspari J.* **8(2)**, 111–118 (2016)
6. T. J. Richter, Development and evaluation of standard weight equations for bridgelip sucker and largescale sucker. *N. Am. J. Fish. Manage.* **27**, 936–939 (2007)
7. B. G. Blackweel, M. L. Brown, D. W. Willis, Relative weight (Wr) status and current use in fisheries assessment and management. *Rev. Fish. Sci.* **8**, 1–44 (2000)
8. Z. Muttaqin, I. Dewiyanti, D. Aliza, Study of Length Weight Relationship and Condition Factors of Tilapia (*Oreochromis niloticus*) and Mullet (*Mugil cephalus*) Caught in the Matang Guru River, Madat District, East Aceh Regency. *Sci. J. Mar. Fish. Stud. Unsyiah* **1(3)**, 397–403 (2016)
9. M. Nasir, Z. A. Muchlisin, A. A. Muhammadar, Length-weight relationship and condition factor of betutu (*Oxyeleotris marmorata*) in Ulim River, Pidie Jaya District, Aceh Province. *Sci. J. Mar. Fish. Stud. Unsyiah* **1(3)**, 262–267 (2016)
10. Z. Fuadi, I. Dewiyanti, S. Purnawan, Relationship between length and weight of fish caught in Krueng Simpoe, Bireun Regency, Aceh. *Sci. J. Mar. Fish. Stud. Unsyiah* **1(1)**, 169–176 (2016)
11. M. Hidayat, S. Maulizar, A. S. Batubara, N. Kautsari, H. Latuconsina, F. M. Nur, I. Zulfahmi, Ichthyofauna of Merbau River, Leuser Ecosystem Area, Indonesia: species composition, diversity, biometric condition, potency, and conservation status. *Eur. Zool. J.* **90(2)**, 747–761 (2023)

12. S. Aisyah, B. Darma, Desrita, Growth patterns and condition factors of lemeduk fish (*Barbodes schwanenfeldii*) in the Belumai River, Deli Serdang, North Sumatra Province. *Acta Aquatica* **4(1)**, 8–12 (2017)
13. F. M. Nur, A. S. Batubara, M. Abdan, M. Syukran, Z. A. Muchlisin, Ichthyofauna in Coal Mining Area of Mifa Bersaudara Company, West Aceh District, Indonesia. *IOP Conf. Ser.: Earth Environ. Sci.* **348**, 1–7 (2019)
14. T. Sukmono, D. D. Solihin, M. F. Rahardjo, R. Affandi, Ichthyofauna in Lowland Tropical Forest Waters, Harapan Jambi Forest. *Indones. J. Ichthyol.* **13(2)**, 161–174 (2013)
15. F. Maghfiriadi, I. Zulfahmi, E. Paujiah, M. A. Sarong, Ichthyofauna in the Alas River Around the Soraya Research Station, Leuser Ecosystem Area, Subulussalam, Aceh. *Indones. J. Ichthyol.* **19(3)**, 361–374 (2019)
16. D. Kresnasari, Relationship between Length and Weight of Three Types of Introduced Fish Caught in Penjalin Reservoir, Brebes Regency. *J. Akuatiklestari* **4(1)**, 28–34 (2020)
17. I. Zulfahmi, Y. Rahmi, A. Sardi, M. Mahyana, Y. Akmal, R. Rumondang, E. Paujiah, Biometric Condition of Seurukan Fish (*Osteochillus vittatus* Valenciennes, 1842) Exposed to Mercury in Krueng Sabee River Aceh Jaya Indonesia. *Elkawnie* **7(1)**, 67–83 (2021)
18. O. O. Famoofo, W. O. Abdul, Biometry, condition factors and length-weight relationships of sixteen fish species in Iwopin freshwater ecotype of Lekki Lagoon, Ogun State, Southwest Nigeria. *Heliyon* **6(1)**, 1–10 (2020)
19. M. I. Effendie, Fisheries Biology (2nd ed.). Nusatama Library Foundation (2002)
20. M. I. Effendie, Fisheries Biology. Nusatama Library Foundation: Yogyakarta (1997)
21. Nurhayati, Fauziyah, Siti, Relationship between Length-Weight and Fish Growth Patterns in the Musi River Estuary, Banyuasin Regency, South Sumatra. *Maspari J.* **8(2)**, 111–118 (2016)
22. E. D. Le Cren, The weight length relationship and seasonal cycle in gonad weight and the condition in Perch (*Perca fluviatilis*). *J. Anim. Ecol.* **20**, 201–219 (1951)
23. W. E. Frost, The age and growth of eels (*Anguilla anguilla*) from the Windermere catchment area. Part 2. *J. Anim. Ecol.* **4**, 106–124 (1945)
24. Irianto, Length-Weight Relationship and Fish Growth Patterns in the Musi River Estuary, Banyuasin Regency, South Sumatra. *Maspari J.* **8(2)**, 111–118 (2010)
25. Windarti, Basic Skills in Fisheries Biology. Oceanum Press: Pekanbaru, Riau (2020)
26. S. Monice et al., Length-Weight Relationship and Condition Factors of Snakehead Fish (*Channa striata*) in Teluk Petai Lake, Riau Province. *J. Aquat. Resour. Environ.* **2(1)**, 1–6 (2021)
27. B. Siregar, T. A. Barus, S. Ilyas, The relationship between water quality and food habits of Batak fish (*Tor soro*) in the waters of the Asahan River, North Sumatra. *Unimed Biosci. J.* **1(2)**, 1–11 (2013)
28. E. S. Sinaga, C. P. Pulungan, D. Efizon, Length-weight and length-length relationship among the body parts of Batak fish (*Tor soro*) from the upstream of the Aek Godang River, North Sumatera. *Online J. Fac. Fish. Mar. Sci. Univ. Riau* **3(1)**, 1–10 (2016)
29. C. Rodriguez, O. Galli, D. Olsson, J. S. Tellechea, W. Norbis, Length-weight relationships and condition factors of eight fish species inhabiting the Rocha Lagoon, Uruguay. *Braz. J. Oceanogr.* **65(1)**, 97–100 (2017)
30. T. B. Bagenal, F. W. Tesch, Age and Growth. In: T. B. Bagenal (Ed.), Methods for Assessment of Fish Production in Fresh Waters. Blackwell Scientific Publications (1978)
31. R. Froese, D. Pauly, FishBase. Retrieved from http://www.fishbase.org (2021).
32. P. B. Moyle, J. J. Cech, Fishes: An Introduction to Ichthyology. Prentice Hall (2004).

33. J. R. Karr, Biological integrity: A long-neglected aspect of water resource management. *Ecol. Appl.* **1(1)**, 66–84 (1991)
34. R. Hilborn, C. J. Walters (Eds.), Quantitative Fisheries Stock Assessment: Choice, Dynamics and Uncertainty. Springer Science & Business Media (2013)
35. J. B. Jackson, M. X. Kirby, W. H. Berger, K. A. Bjorndal, L. W. Botsford, B. J. Bourque, R. R. Warner, Historical overfishing and the recent collapse of coastal ecosystems. *Science* **293(5530)**, 629–637 (2001)
36. E. K. Pikitch, C. Santora, E. A. Babcock, A. Bakun, R. Bonfil, D. O. Conover, K. J. Sainsbury, Ecosystem-based fishery management. *Science* **305(5682)**, 346–347 (2004)