NASKAH AWAL SAAT DISUBMIT

ILMU KELAUTAN
Indonesian Journal of Marine Sciences
p-ISSN : 0853-7291
e-ISSN : 2406-7598

#44452 Summary

Summary (https://ejournal.undip.ac.id/index.php/ijms/author/submission/44452)
Review (https://ejournal.undip.ac.id/index.php/ijms/author/submissionReview/44452)
Editing (https://ejournal.undip.ac.id/index.php/ijms/author/submissionEditing/44452)

Submission

Authors	Abdul Hafidz Olii, Elena Wonneberger, Nuralim Pasisingi
Title	Growth Performance of Layang (Scad) Fish (Decapterus russelli, Ruppell 1830) Caught from Tomini Bay, Indonesia
Original file	44452-137914-2-SM.doc (https://ejournal.undip.ac.id/index.php/ijms/author/downloadFile/44452/137914/2) 28-01-2022
Supp. files	None
Submitter	Ms. Nuralim Pasisingi (https://ejournal.undip.ac.id/index.php/ijms/user/email?to%5B%5D=Ms.%20Nuralim%20Pasisingi%20%3Cnuralim%40ung.ac.id%3E&redirectUrl=https%3A%2F%2Fejournal.undip.ac.id%2Findex.php%2Fijms%2Fauthor%2Fsubmission%2F44452&subject=Growth%20P
Date submitted	January 28, 2022 - 02:28 AM
Section	Research Articles
Editor	Indonesian Journal of Marine Science (https://ejournal.undip.ac.id/index.php/ijms/user/email?to%5B%5D=Indonesian%20Journal%20of%20Marine%20Science%20%3Cijms.undip%40gmail.com%3E&redirectUrl=https%3A%2F%2Fejournal.undip.ac.id%2Findex.php%2Fijms%2Fauthor%2Fsubmission%2F4
Author comments	I did some revisions to the previous manuscript and also added an overseas author as suggested by the editor
Reviewers suggestion	1. Yunita Magrima Anzani, Biology and Aquatic management; email: yunita.magrima@faperta.untan.ac.id (mailto:yunita.magrima@faperta.untan.ac.id) 2. Perdana Putra Kelana; Aquatic Resources Management; email: perdana.pk@politeknikkpdumai.ac.id 3. Putri Sapira Ibrahim; Research Center for Oceanographic Indonesian Institute of Sciences; email: putri.sapira.ibrahim@lipi.go.id
Abstract Views	0

Status

Status	##mpgundip.submissions.published## Vol 27, No 2 (2022): Ilmu Kelautan
Initiated	23-06-2022
Last modified	23-06-2022

Submission Metadata

Authors

Name	Abdul Hafidz Olii (https://ejournal.undip.ac.id/index.php/ijms/user/email?redirectUrl=https%3A%2F%2Fejournal.undip.ac.id%2Findex.php%2Fijms%2Fauthor%2Fsubmission%2F44452&to%5B%5D=Abdul%20Hafidz%20Olii%20%3Colliihafidz%40gmail.com%3E&subject=Growth%20Pe
Affiliation	Aquatic Resources Management Study Programme, Faculty of Fisheries and Marine Science, Gorontalo State University
Country	Indonesia
Bio Statement	–
Name	Elena Wonneberger (https://ejournal.undip.ac.id/index.php/ijms/user/email?redirectUrl=https%3A%2F%2Fejournal.undip.ac.id%2Findex.php%2Fijms%2Fauthor%2Fsubmission%2F44452&to%5B%5D=Elena%20Wonneberger%20%3CE.Wonneberger%40gmx.de%3E&subject=Growth%20P
Scopus ID	57206730497 (http://www.scopus.com/authid/detail.uri?authorId=57206730497)
Affiliation	Centre of Marine Sciences (CCMAR), Universidade do Algarve
Country	Portugal
Bio Statement	–
Name	Nuralim Pasisingi (https://ejournal.undip.ac.id/index.php/ijms/user/email?redirectUrl=https%3A%2F%2Fejournal.undip.ac.id%2Findex.php%2Fijms%2Fauthor%2Fsubmission%2F44452&to%5B%5D=Nuralim%20Pasisingi%20%3Cnuralim%40ung.ac.id%3E&subject=Growth%20Performa
Publons ID	https://orcid.org/ 0000-0001-9655-8540 (https://orcid.org/ 0000-0001-9655-8540)
Scopus ID	57196043395 (http://www.scopus.com/authid/detail.uri?authorId=57196043395)
Sinta ID	6149087 (http://sinta.ristekbrin.go.id/authors/detail?id=6149087&view=overview)
Affiliation	Aquatic Resources Management Study Programme, Faculty of Fisheries and Marine Science, Gorontalo State University
Country	Indonesia
Bio Statement	–

Principal contact for editorial correspondence.

Title and Abstract

Title	Growth Performance of Layang (Scad) Fish (Decapterus russelli, Ruppell 1830) Caught from Tomini Bay, Indonesia
Abstract	*Regarding exploitation and optimizing fisheries resources management in Tomini Bay, the Layang scad fish (Decapterus russelli, Ruppell 1830) is one of the small pelagic fishes inhabiting the bay that still lacks biological information. The species becomes the main target commodity for local fishers as it is commonly consumed as a protein source for coastal communities. This study aimed to determine the length-weight relationships and the growth pattern of Layang fish caught by fishers from Tomini Bay. The samples were collected once per month at Gorontalo City Fish Landing Spot from April to June 2020. Tomini Bay was confirmed as the fishing ground of all the landed fish. Layang is caught by Mini purse seines with a minimum mesh size of ¾ inch. A total of 896 samples of Layang fish were collected randomly from the fishers' catch during their unloading activity at the landing site. Abdomen dissection was performed on all samples for determining the fish's sex. The fish samples' total length and body weight were measured using a ruler (nearest = 1 mm) and a scale (nearest = 0.01 gram). The result revealed that the length-weight equation of male Layang was $W = 0.000004\ L^{3.1972}$ (R^2 = 97.57%), and that of female was $W = 0.0000007\ L^{3.0613}$ (R^2 = 98.99%). This result implied a positive allometric growth pattern, excluding the females in April 2020.*
Notice	–
Original DOI	–

Indexing

Keywords	allometric growth; Gorontalo; scad; length-weight relationship; population dynamics; Tomini
Language	en

Supporting Agencies / Funders

Agencies/Funders	–
Agencies/Funders Doi	–

Abdul Hafidz Olii <oliihafidz@ung.ac.id>

[IK.IJMS] Submission Acknowledgement

1 message

Ambariyanto <ijms@live.undip.ac.id> Fri, Jan 28, 2022 at 10:28 AM
Reply-To: "Nuralim Pasisingi" <nuralim@ung.ac.id>
To: "Nuralim Pasisingi" <nuralim@ung.ac.id>
Cc: Abdul Hafidz Olii <oliihafidz@ung.ac.id>, Elena Wonneberger <E.Wonneberger@gmx.de>

Dear

Nuralim Pasisingi, Abdul Hafidz Olii, Elena Wonneberger

Thank you for submitting the manuscript, "Growth Performance of Layang (Scad) Fish (Decapterus russelli, Ruppell 1830) Caught from Tomini Bay, Indonesia" to ILMU KELAUTAN: Indonesian Journal of Marine Sciences. With the online journal management system that we are using, you will be able to track its progress through the editorial process by logging in to the journal web site:

Manuscript URL: https://ejournal.undip.ac.id/index.php/ijms/author/submission/44452
Username: nuralim_789

If you have any questions, please contact me. Thank you for considering this journal as a venue for your work.

Ambariyanto
ILMU KELAUTAN: Indonesian Journal of Marine Sciences

INDONESIAN JOURNAL OF MARINE SCIENCE
http://ejournal.undip.ac.id/index.php/ijms

Growth Performance of Layang (Scad) Fish (*Decapterus russelli,* Ruppell 1830) Caught from Tomini Bay, Indonesia

Abdul Hafidz Olii[1], Elena Wonneberger[2], and Nuralim Pasisingi[1*]

[1]Aquatic Resources Management Study Programme, Faculty of Fisheries and Marine Science, Gorontalo State University, Jl. Jenderal Sudirman No. 6, Gorontalo City, Gorontalo Province, 96128, Indonesia
[2]Centre of Marine Sciences (CCMAR), Universidade do Algarve, 8005-139, Faro, Portugal
*Email: nuralim@ung.ac.id

Abstract

Regarding an exploitation optimizing of fisheries resources management in Tomini Bay, Layang fish (*Decapterus ruselli*, Ruppell 1830) is one of the various small pelagic fishes inhabiting the bay that still has lacks biological fisheries information. Whereas the species becomes the main target commodity for local fishers as it is commonly consumed as a protein source in the human diet. The samples were collected once per month at Gorontalo City Fish Landing Spot from April to June 2020. Tomini Bay was confirmed as the fishing ground of all the landed fish. Mini purse seines with a minimum mesh size of ¾ inch are the gears used by the fishers for catching layang fish. Samples were collected randomly from the fishermen's catch during their unloading activity at the landing site. Abdomen dissection was performed to all samples for determining the fish sexuality. Additionally, the fish samples' total length and body weight were quantified using a ruler (nearest = 1 mm) and a scale (nearest = 0.01 gram) separately. The result analysis revealed that the length-weight equation of male was $W = 0.000004\ L^{3.1972}$ ($R^2 = 97.57\%$), and that of female was $W = 0.0000007\ L^{3.0613}$ ($R^2 = 98.99\%$). Male and female layang fish *D. russelli* in Tomini Bay based on the sampling during these three-monthly sampling periods implied a positive allometric growth pattern, excluding the female in April 2020.

Keywords: allometric growth; Gorontalo; scad; length-weight relationship; population dynamics; Tomini

Introduction

Tomini Bay forms as a semi-enclosed water area (Miller *et al*., 2016) which is fertile (Kadim *et al*., 2019) with high marine biodiversity supported by the availability of phytoplanktons (Kadim *et al*., 2018) as primary food sources. The bay is also inhabited by diverse species of marine mammals (Mustika *et al*., 2021), various pelagic fishes (Mardlijah and Patria, 2016; Pasisingi *et al*., 2020; Pasisingi *et al*., 2020; Pasisingi *et al*., 2021; Pasisingi *et al*., 2021), small amphidromous fishes (Olii *et al*., 2017; Pasisingi and Abdullah, 2018; Olii *et al*., 2019; Pasisingi *et al*., 2021; Pasisingi *et al*., 2020; Pasisingi *et al*., 2020), as well as macrozoobenthos (Kadim *et al*., 2022). Moreover, local wisdom supports the sustainable management of coastal and marine resources in Tomini Bay (Obie, 2018).

Scientific data of Tomini Bay pelagic fish population dynamics are still minimal, making the level and utilization of the fish resources uncontrollable. Therefore, efforts to optimize fish resources to maximize the community's welfare around the bay area are still not optimal. Layang fish (*Decapterus russelli,* Ruppell 1830) that has a common name Scad (Sunaryo *et al*., 2019; Suwarso and Zamroni, 2015) or Indian Scad (Poojary *et al*., 2010; Chiesa *et al*., 2019) is one of the pelagic species of the Carangids group which is widely distributed including Tomini Bay as a part of Indo-Pacific region (Panda *et al.*, 2012), western Indian Ocean, and northern Arabian Sea

(Kalhoro *et al*., 2017). Apart from having a substantial economic value (Khasanah *et al*., 2020) and being in demand by the broader community due to its taste, the fish also contains protein (Cahyono and Mardani 2020; Fatma *et al*., 2020) to be consumed as a source of food nutrition. Layang fish diversification and processing (Tondais *et al*., 2020; Kurniawan *et al*., 2020b; Kurniawan *et al*., 2020a; Henra *et al*., 2020; Paparang, 2013) were also being developed in order to meet market demand for the commodity.

Lack of scientific data on layang fish resources in Tomini Bay is a challenge in determining and formulating the proper management direction by considering layang fish *D. russelli* as the target fish caught by fishermen in Indonesian as in Tomini Bay (Lawadjo *et al.*, 2021), Malacca Strait (Alnanda *et al*., 2020), Makassar Strait (Cahyono and Mardani, 2020), and Ternate (Tangke, 2020). Therefore, comprehensive, and up-to-date data on layang fish's condition in nature is needed to monitor these fish resources' availability and sustainability. This study aimed to determine length-weight relationships and the growth pattern of laying fish *D. russelli* in Tomini Bay. This study results can enrich the information on the resource conditions to support the sustainable management of layang fish in Tomini Bay.

Materials and Methods

Time, Location, and Sampling Technique

The sampling was conducted once per month at Gorontalo City Fish Landing Spot from April to June 2020. Mini purse seines with a minimum mesh size of ¾ inch were fishermen's gears for catching layang fish in Tomini Bay. The number of 896 layang fish samples were collected randomly from the fisher's landing their catch to the landing site (Figure 1). The total length and body-weight data of the fish samples were quantified using a ruler and a scale separately. Furthermore, abdomen dissection was performed to determine sample sexuality.

Data Analysis

The relationship between total length and body weight of data samples were calculated and determined through the following equations (De Robertis and Williams, 2008):

$W = a\,L^{b}$ …… (i)

where: W = body weight (gram); L = total length (mm); a = constant value; b = growth parameter

A natural logarithmic transformation was applied to make a relationship linear as follow:

$\ln W = \ln a + b \ln L$ ……..……..(ii)

Result and Discussion

The length ranges of sample fish found in this study were 77-290 mm and 87-286 mm for males and females, respectively. The length range of *D. russelli* in Trincomalee District, Sri Lanka, from October 2019 to January 2020 ranged 110 - 225 mm (Anushika *et al*., 2020). The Indian scad's length caught by mini purse seine in the waters around Tasikagung Fishing Port of Rembang ranged from 102 to 185 mm (Khasanah *et al*., 2020). The total number and distribution frequency of *D. ruselli* found during the three months of sampling varied based on the size of the total length and body weight (Figure 2). Among the three-time samplings, *D. russelli* in Tomini Bay were mostly found in the total length range of 77 - 98 mm for males and 121 - 142 for females.

The fish length-weight analysis is essential to monitor the stocks and fish's biological conditions to ease the implementation of fish sustainability and biodiversity management (Agista et al., 2019). The relationship model of total length and weight of male and female *D. russelli* based on monthly and combined data is shown in Figure 3. Additionally, the length-weight relationship data of the layang fish in Tasikagung Fishing Port of Rembang collected twice a month from January to April 2019 obtained an equation of $W = 0.0000546\ TL^{2.73}$ (Khasanah *et al*., 2020), in Probolinggo Regency, Indonesia during January to May 2017 was $W = 0.0049\ L^{3.2882}$ (Bintoro *et*

al., 2019). In Mayangan Probolinggo, Indonesia, from December 2017 to April 2018, W = 0.014 $L^{2.8513}$ (Bintoro *et al*., 2019).

The determination coefficient (R^2) that describes how well the model fits the data (Nakagawa et al. 2017) on the polynomial equation in this study is relatively high, above 95%. The R^2 value in this study is quite diverse when compared to several previous studies. In comparison, data of *D. russelli* caught by purse seine conducted from March to August 2014 in waters around Pemangkat Fisheries Port, West Kalimantan expressed by equation W = 0.0093 $L^{3.1309}$ with R^2 = 87.19 % for male and W=0.0094 $L^{3.1359}$ with R^2 = 85.76 % for female (Faizah and Sadiyah, 2020). In addition, the laying fish in Malaka Strait taken from April to September 2016 expressed the relationship of W = 0,0057 $L^{3,2984}$ (R^2 = 97.45 %) for male and W = 0,0079 $L^{3,183}$ (R^2 = 98.25 %) for female (Faizah and Sadiyah, 2020). From a fisheries biology perspective, the length and weight relationship of finfish is one of the corresponding information that needs to provide regarding fisheries resources management, Particularly in determining the selectivity of fishing gear; therefore, the only fish caught are of a catch-fit size (Bernas, 2016).

Many studies use data on the relationship between length and body weight of fish to predict the growth patterns. Fish might attain either isometric, negative allometric, or positive allometric growths. An isometric pattern is associated with no alteration of body shape as individual growth. Furthermore, a negative allometric indicates the fish becomes more slender as it increases in weight, while positive allometric growth denotes relatively deeper bodies or stouter since it increases in length (Riedel *et al*., 2007). All growth patterns of layang fish in this study performs positive allometric, unless for female in April 2020 (Table 1). It is related to reproductive conditions and the spawning season. Suppose the spawning season of *D. russelli* in this study is just the same as in the waters of the Malacca Strait which took place from April to October with a peak in October (Hariati et al., 2017).

The growth pattern of Indian scad for males and females in the south of China Sea (Faizah and Sadiyah, 2020), and in Paiton, Probolinggo Regency from January 2017 to May 2017 *(Bintoro et al*., 2019) also revealed positive allometric. However, a negative allometric growth pattern was shown by layang fish *D. russelli* in Trincomalee District, Sri Lanka based on the data taken from October 2019 to January 2020 (Anushika *et al*., 2020) and in Mayangan Probolinggo, Indonesia, from December 2017 to April 2018 (Bintoro *et al*., 2019). The layang fish in Latuhalat waters, Ambon in June, July, and August 2016, showed that almost all the data had positive allometric growths except for males in August 2016, which showed an isometric growth pattern (Ongkers *et al*., 2016).

The variation in growth patterns is might be caused by differences in species, gonad maturity, spawning factors, food, sex, and age (Randongkir *et al*., 2018). Availability of supportive food and aquatic habitat characteristics might influence the variation of fish growth patterns (Nugroho *et al.*, 2018) due to the food taken will affect the growth, maturity of each individual, and the successful life of the fish (Effendie, 2002).

Conclusion

The polynomial equation for the length and weight of layang scad fish *Decapterus russelli* is 0.000004 $L^{3.1972}$ (R^2 = 97.57 %) for male and W = 0.0000007 $L^{3.0613}$ (R^2 = 98.99 %) for female. Based on sampling data during April, May, and June 2020, it can be presented that the growth of males and females in Tomini Bay has a positive allometric pattern, except the female pattern in April 2020.

References

Agista L, Muhammadar AA, Chaliluddin MA. 2019. The relationship of length-weight and condition factors of layang fish (Decapterus russelli) landed at KUD Gabion of Oceanic Fishing Port, North Sumatra. In: IOP Conference Series: Earth and Environmental Science.Vol. 348 Institute of Physics Publishing p. 012084. doi: 10.1088/1755-1315/348/1/012084.

Alnanda R, Setyobudiandi I, Boer M. 2020. Dinamila Populasi Ikan Layang (Decapterus russelli) di Perairan Selat Malaka. Manfish J. 1:1–8. http://ejurnal.polnep.ac.id/index.php/manfish/article/view/37 (Accessed December 1, 2020).

Anushika P, Herath H, Dias P, Gayathry L. 2020. Some Aspects of the Population Characteristics of Selected Marine Fish Species (Ambligaster sirm, Hyporhamphus dussumieri, Decapterus russelli and Atule mate) in Trincomalee District. In: Proceedings of the International Research Conference of Uva Wellassa University. pp. 105–110.

Cahyono E, Mardani I. 2020. Identifikasi Asam Amino Ikan Layang (Decapterus russelli) pada Lokasi Penangkapan Berbeda. J. Pengolah. Pangan. 5:1–6. doi: 10.31970/pangan.v5i1.33.

Chiesa S, Azzurro E, Bernardi G. 2019. The genetics and genomics of marine fish invasions: a global review. Rev. Fish Biol. Fish. 29:837–859. doi: 10.1007/s11160-019-09586-8.

Effendie MI. 2002. *Biologi Perikanan*. Yayasan Pustaka Nusatama: Yogyakarta.

Faizah R, Sadiyah L. 2020. Some biology aspects of Indian Scad (Decapterus russelli, Rupell, 1928) in Pemangkat Fisheries Port, West Kalimantan. In: IOP Conference Series: Earth and Environmental Science.Vol. 429 Institute of Physics Publishing p. 12063. doi: 10.1088/1755-1315/429/1/012063.

Fatma N, Metusalach, Taslim NA, Nurilmala M. 2020. The protein and albumin contents in some species of marine and brackishwater fish of South Sulawesi, Indonesia. Aquac. Aquarium, Conserv. Legis. Bioflux. 13:1976–1985. http://www.bioflux.com.ro/aacl (Accessed December 2, 2020).

Hariati T, Taufik M, Zamroni A. 2017. Beberapa Aspek Reproduksi Ikan Layang (Decapterus russelli) dan Ikan Banyar (Rastrelliger kanaguna) di Perairan Selat Malaka Indonesia. J. Penelit. Perikan. Indones. 11:47–56. http://ejournal-balitbang.kkp.go.id/index.php/jppi/article/view/4000 (Accessed December 3, 2020).

Henra H, Yusuf N, Naiu AS. 2020. Karakteristik Mutu Hedonik Kerupuk Ubi Jalar Dan Rumput Laut (Kappaphycus alvarezii) Yang Difortifikasi dengan Ikan Layang (Decapterus russelli). Jambura Fish Process. J. 1:35–45. doi: 10.37905/jfpj.v1i2.5426.

Kadim MK, Pasisingi N, Alinti ER, Panigoro C. 2022. Biodiversity and community assemblages of freshwater and marine macrozoobenthos in Gorontalo Waters , Indonesia. Bio. 23:637–647. doi: 10.13057/biodiv/d230204.

Kadim MK, Pasisingi N, Arsad S. 2019. Horizontal distribution of chlorophyll-α in the gorontalo bay. Nat. Environ. Pollut. Technol. 18.

Kadim MK, Pasisingi N, Kasim F. 2018. Spatial and temporal distribution of phytoplankton in the Gorontalo Bay, Indonesia. AACL Bioflux. 11.

Kalhoro MT et al. 2017. Stock Assessment of Indian Scad, Decapterus Russelli in Pakistani Marine Waters and Its Impact on the National Economy. Indian J. Geo Mar. Sci. 49:1222–1228. doi: 10.4172/2150-3508.1000200.

Khasanah AN, Saputra SW, Taufani WT. 2020. Population dynamic of indian scad (Decapterus russelli) based on data in tasikagung fishing Port of Rembang. In: IOP Conference Series: Earth and Environmental Science.Vol. 530 IOP Publishing Ltd p. 012004. doi: 10.1088/1755-1315/530/1/012004.

Kurniawan A, Permadi A, Purnomo AH. 2020a. Children's Responses to the Addition of Indian Scad (Decapterus russelli) Fish Protein Concentrated and Flavor to Traditional Food. J. Airaha. 9:096–104. doi: 10.15578/JA.V9I01.165.

Kurniawan A, Permadi A, Purnomo AH. 2020b. Optimum Proportion of Indian Scad (Decapterus russelli) Protein Concentrate in Traditional Food Cake Designated for Undernourished Children Diet. Russ. J. Agric. Socio-Economic Sci. 99:170–183. doi: 10.18551/rjoas.2020-03.19.

Lawadjo FW, Tuli M, Pasisingi N. 2021. Length-Weight Relationship and Condition Factor of Layang Fish (Decapterus russelli) Landed at Tenda Fish Landing Base, Gorontalo. J.

Pengelolaan Perikan. Trop. (Journal Trop. Fish. Manag. 5:44–51. doi: 10.29244/jppt.v5i1.34604.
Mardlijah S, Patria MP. 2016. Biologi Reproduksi Ikan Madidihang (Thunnus albacares Bonnatere 1788) di Teluk Tomini. BAWAL Widya Ris. Perikan. Tangkap. 4:27–34. doi: 10.15578/BAWAL.4.1.2012.27-34.
Miller MJ et al. 2016. High biodiversity of leptocephali in Tomini Bay Indonesia in the center of the Coral Triangle. Reg. Stud. Mar. Sci. 8:99–113. doi: 10.1016/j.rsma.2016.09.006.
Mustika PLK, Wonneberger E, Erzini K, Pasisingi N. 2021. Marine megafauna bycatch in artisanal fisheries in Gorontalo, northern Sulawesi (Indonesia): An assessment based on fisher interviews. In: Ocean and Coastal Management.Vol. 208 Elsevier Ltd p. 105606. doi: 10.1016/j.ocecoaman.2021.105606.
Nakagawa S, Johnson PCD, Schielzeth H. 2017. The coefficient of determination R^2 and intra-class correlation coefficient from generalized linear mixed-effects models revisited and expanded. J. R. Soc. Interface. 14:20170213. doi: 10.1098/rsif.2017.0213.
Nugroho SC, Jatmiko I, Wujdi A. 2018. Pola pertumbuhan dan faktor kondisi madidihang, Thunnus albacares (Bonnaterre, 1788) di Samudra Hindia Bagian Timur. J. Iktiologi Indones. 18:13–21.
Obie M. 2018. Exploitation of coastal and marine resources along Tomini Bay: Livelihood base versus concession rights Eksploitasi sumber daya pesisir dan laut di Teluk Tomini: Basis mata pencaharian versus konsesi. Masyarakat, Kebud. dan Polit. 31:36–45.
Olii AH, Sahami FM, Hamzah SN, Pasisingi N. 2019. Molecular approach to identify gobioid fishes, “nike” and “hundala” (Local name), from gorontalo waters, Indonesia. Online J. Biol. Sci. 19:51–56. doi: 10.3844/ojbsci.2019.51.56.
Olii AH, Sahami FM, Hamzah SN, Pasisingi N. 2017. Preliminary findings on distribution pattern of larvae of nike fish (Awaous sp.) in the estuary of Bone River, Gorontalo Province, Indonesia. AACL Bioflux. 10:1110–1118.
Ongkers OT., Pattikawa JA, Rijoly F. 2016. Aspek Biologi Ikan Layang (Decapterus russelli) di Perairan Latuhalat, Kecamatan Nusaniwe, Pulau Ambon. Omni-Akuatika. 12:79–87. http://www.ojs.omniakuatika.net/index.php/joa/article/view/128 (Accessed December 2, 2020).
Panda D et al. 2012. Fishery and population dynamics of two species of carangids, Decapterus russelli (Ruppell, 1830) and Megalaspis cordyla (Linnaeus, 1758) from Mumbai waters. Indian J. Fish. 59:53–60.
Paparang RW. 2013. Studi Pengaruh Variasi Konsentrasi Garam Terhadap Citarasa Peda Ikan Layang (Decapterus russelli). Media Teknol. Has. Perikan. 1:17–20. doi: 10.35800/mthp.1.1.2013.4141.
Pasisingi N, Abdullah S. 2018. Pola kemunculan ikan nike (Gobiidae) di Perairan Teluk Gorontalo, Indonesia. DEPIK J. Ilmu-Ilmu Perairan, Pesisir dan Perikan. 7:111–118. doi: 10.13170/depik.7.2.11442.
Pasisingi N, Habibie SA, Olii AH. 2020. Are awaous ocellaris and belobranchus belobranchus the two species of nike fish schools ? Aceh J. Anim. Sci. 5:87–91. doi: 10.13170/ajas.5.2.16557.
Pasisingi Nuralim, Kasim F, Moo ZA. 2021. Estimation of Fishing Mortality Rate and Exploitation Status of Yellowstrip Scad (Selaroides leptolepis) in Tomini Bay using Von Bertalanffy Growth Model Approach. J. Ilm. Perikan. Dan Kelaut. 13:288–296. doi: 10.20473/jipk.v13i2.27465.
Pasisingi N., Katili VRA, Mardin H, Ibrahim PS. 2021. Variation in morphometric characteristics of nike fish (Amphidromous goby larva) in leato waters, gorontalo bay, Indonesia. AACL Bioflux. 14.
Pasisingi N, Olii AH, Habibie SA. 2020. Morphology and growth pattern of Nike fish (amphidromous goby larvae) in Gorontalo Waters, Indonesia. Tomini J. Aquat. Sci. 1:1–7. http://ejurnal.ung.ac.id/index.php/tjas/ (Accessed March 19, 2021).
Pasisingi Nuralim, Pramesthy TD, Musyali A. 2021. Length-weight relationships and sex ratio of Selaroides leptolepis , Cuvier Length-weight relationships and sex ratio of Selaroides leptolepis , Cuvier 1833 in Tomini Bay , Indonesia. In: IOP Conference Series: Earth and

Environmental Science 744 012052. doi: 10.1088/1755-1315/744/1/012052.
Pasisingi N, Sapira Ibrahim P, Arsalam Moo Z, Tuli M. 2020. Reproductive Biology of Oci Fish Selaroides leptolepis in Tomini Bay. J. Mar. Res. 9:407–415. doi: 10.14710/jmr.v9i4.28340.
Poojary N, Tiwari L, Jaiswar A. 2010. Food and feeding habits of the Indian scad, Decapterus russelli (Ruppell, 1830) from Mumbai waters, north-west coast of India. Indian J. Fish. 57:93–99.
Randongkir YE, Simatauw F, Handayani T. 2018. Growth Aspects of Scad Decapterus macrosoma on Fish Point Sanggeng-Manokwari Regency. J. Sumberd. Akuatik Indopasifik. 2. www.ejournalfpikunipa.ac.id (Accessed December 3, 2020).
Riedel R, Caskey LM, Hurlbert SH. 2007. Length-weight relations and growth rates of dominant fishes of the Salton Sea: Implications for predation by fish-eating birds. Lake Reserv. Manag. 23:528–535. doi: 10.1080/07438140709354036.
De Robertis A, Williams K. 2008. Weight-Length Relationships in Fisheries Studies: The Standard Allometric Model Should Be Applied with Caution. Trans. Am. Fish. Soc. 137:707–719. doi: 10.1577/t07-124.1.
Siti Masreah Bernas. 2016. Hubungan Panjang-Berat dan Pola Pertumbuhan Ikan di Muara Sungai Musi Kabupaten Banyuasin Sumatera Selatan. Maspari J. 8:111–118.
Sunaryo, Syahrihaddin A, Imfianto PS. 2019. Solar Energy for a Traditional Coastal Fishing Platform. J. Mar. Sci. Appl. 18:366–371. doi: 10.1007/s11804-019-00087-5.
Suwarso S, Zamroni A. 2015. Analisis Struktur Populasi Tiga Species Layang (Decapterus spp.) di Laut Jawa dan Sekitar Sulawesi: Saran Pengelolaan Berkelanjutan Ikan Pelagis Kecil dan Evaluasi WPP. J. Kebijak. Perikan. Indones. 6:75. doi: 10.15578/jkpi.6.2.2014.75-86.
Tangke U. 2020. Produksi dan Nilai Jual Ikan Pelagis Dominan di TPI Higienis Pelabuhan Perikanan Nusantara Ternate. Agrikan J. Agribisnis Perikan. 13:108. doi: 10.29239/j.agrikan.13.1.97-107.
Tondais J et al. 2020. Ekstraksi Flavour dari Tepung Ikan Layang (Decapterus sp.) Menggunakan Enzim Protease Biduri (Calotropis gigantea). J. FishtecH. 9:6–12. doi: 10.36706/fishtech.v9i1.11481.

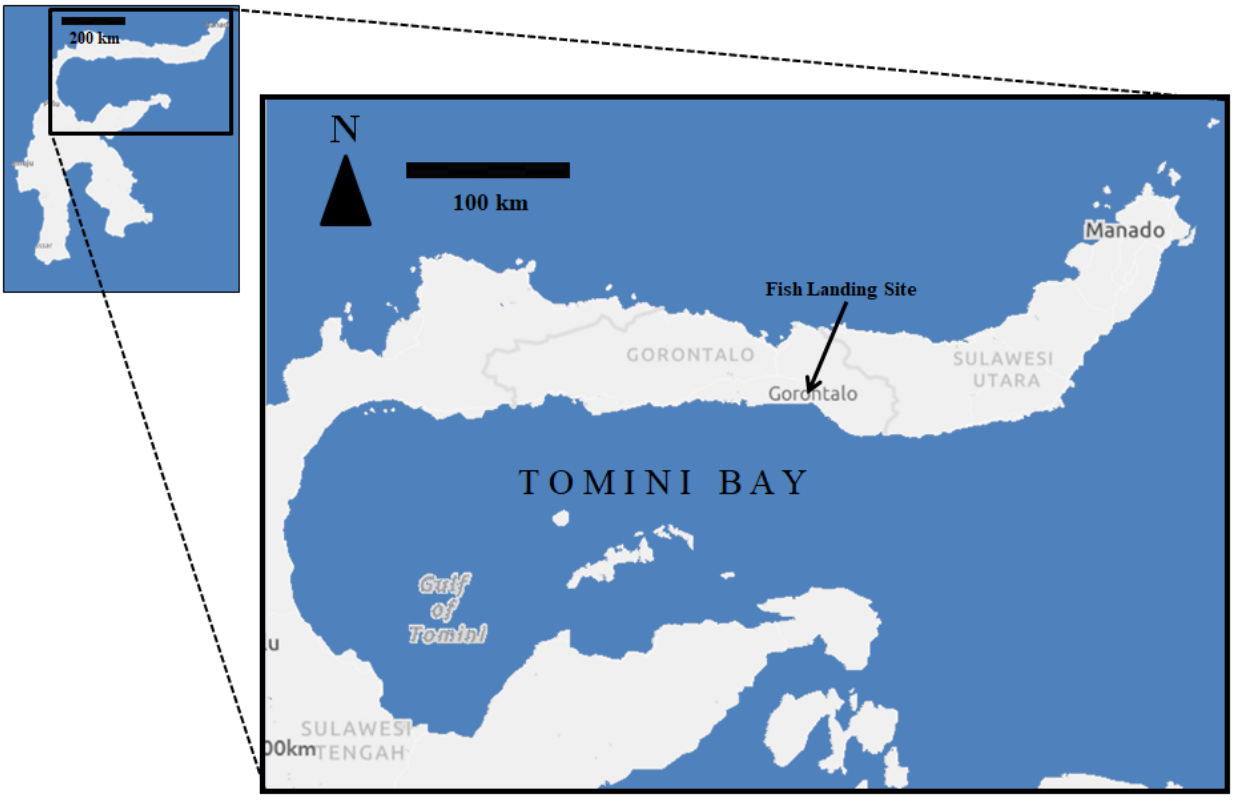
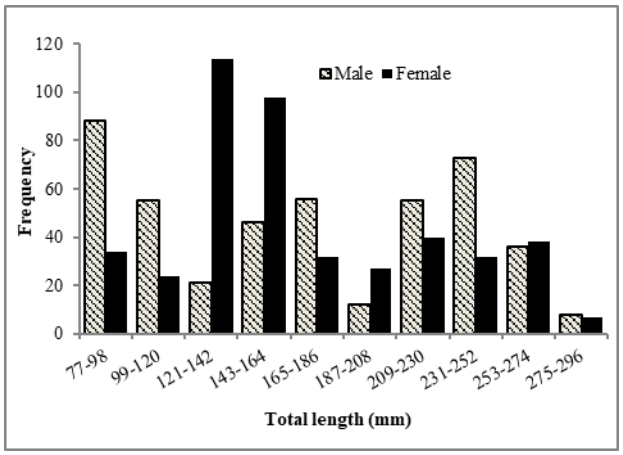
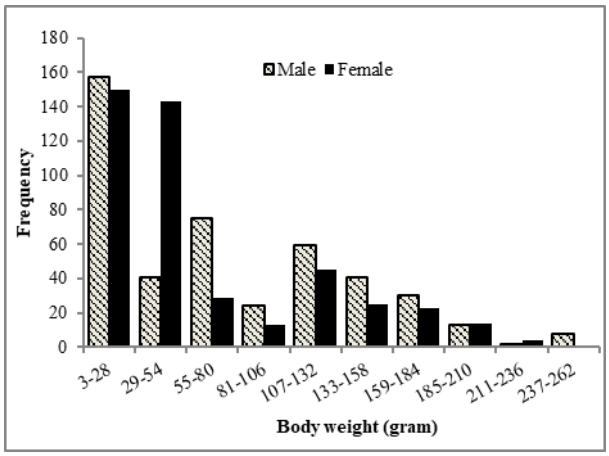


Figure 1. Fishing Area and Gorontalo Fish Landing Site of Layang Fish *Decapterus russelli*

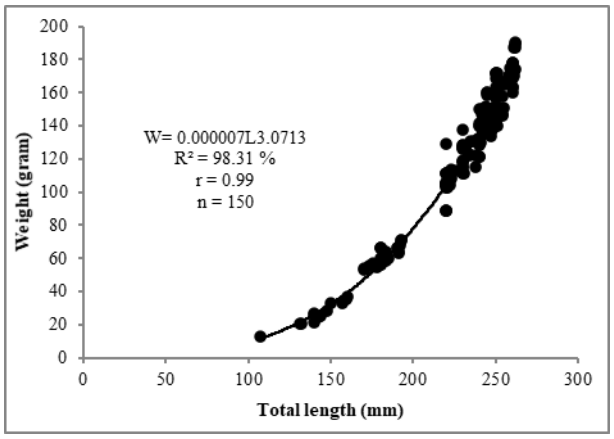




(a) **(b)**

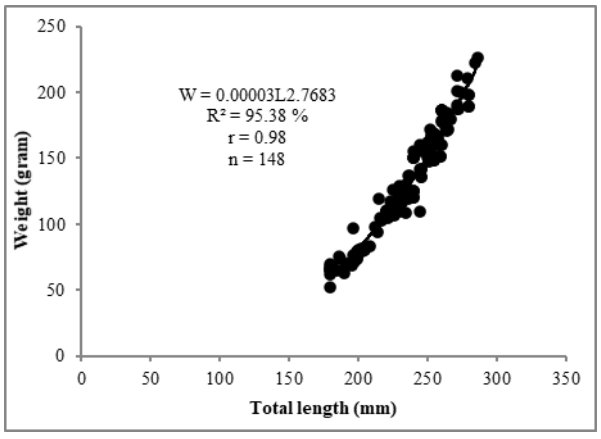
Figure 2. Frequency distribution of *Decapterus russelli* in Tomini Bay based on (a) total length and (b) body weight

Male

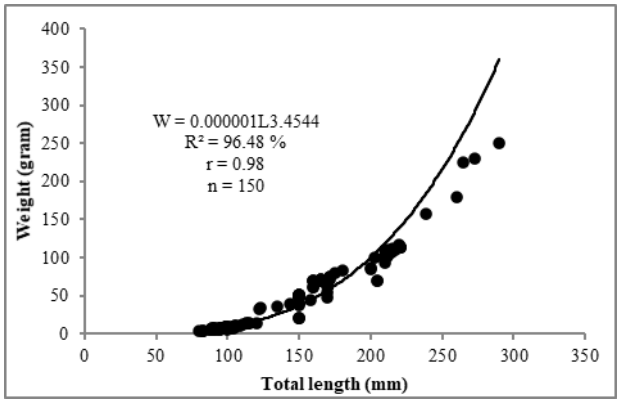


April 2020

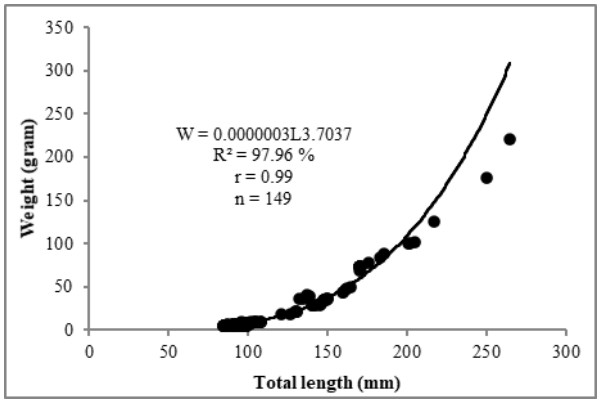
Female



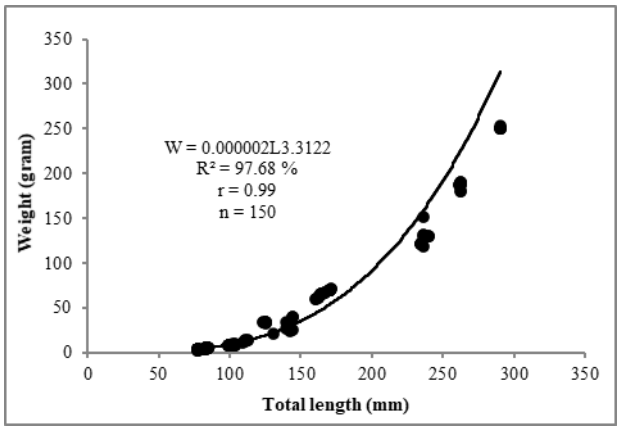
April 2020



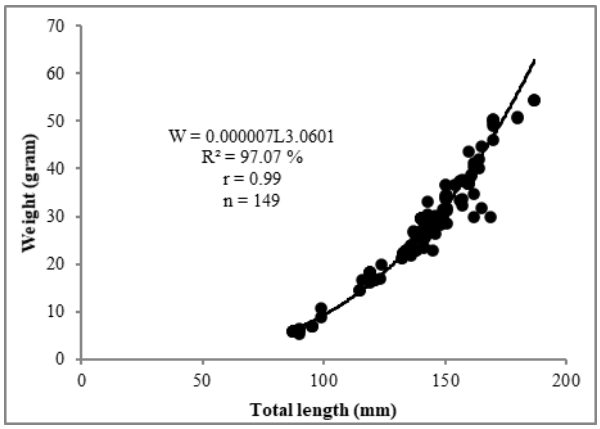
May 2020



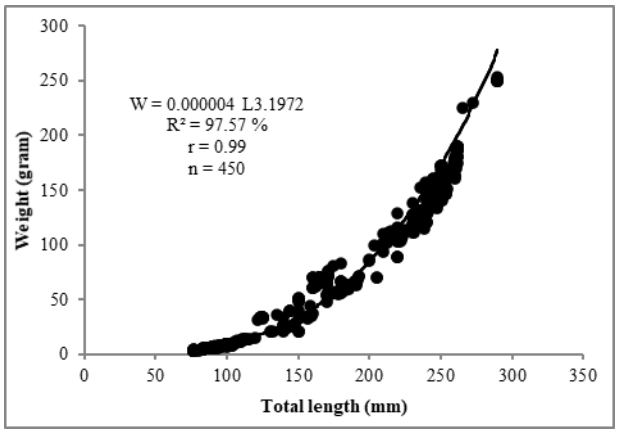
May 2020



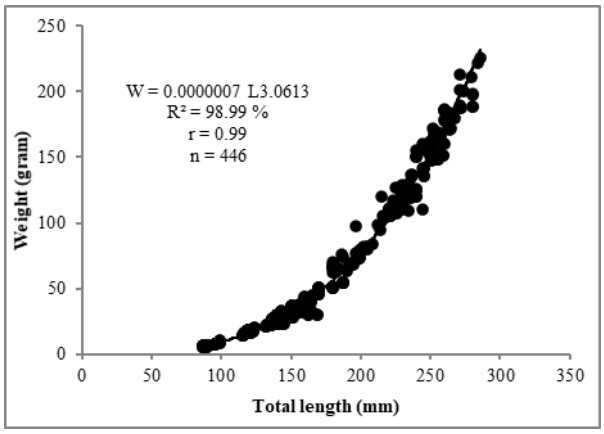
June 2020



June 2020



Combined



Combined

Figure 3. Length Weight Relations of *Decapterus russelli* in Tomini Bay

Table 1. Linear relation of length-weight data and growth patterns of *D. russelli* in Tomini Bay

Sampling	Male	Female

periods	Length-Weight linear relationships	Growth pattern	Length-Weight linear relationships	Growth pattern
April 2020	ln W = -11.9189 + 3.0713 ln L	postive allometric	ln W = -10.264 + 2.7683 ln L	negative allomteric
May 2020	ln W = -13.6983 + 3.4544 ln L	postive allometric	ln W = -14.9327 + 3.7037 Ln L	postive allometric
June 2020	ln W = -13.0305 + 3.3122 ln L	postive allometric	ln W = -11.8668 - 3.0602 ln L	postive allometric
Total	ln W = -12.5017 + 3.1972 ln L	postive allometric	ln W = -11.8687 + 3.0613 ln L	postive allometric

NASKAH DALAM PROSES PERBAIKAN

Abdul Hafidz Olii <oliihafidz@ung.ac.id>

[IK.IJMS] Editor Decision

1 message

Indonesian Journal of Marine Science <ijms.undip@gmail.com>
Reply-To: Indonesian Journal of Marine Science <ijms.undip@gmail.com>
To: "Nuralim Pasisingi" <nuralim@ung.ac.id>
Cc: Abdul Hafidz Olii <oliihafidz@ung.ac.id>, Elena Wonneberger <E.Wonneberger@gmx.de>

Mon, Feb 21, 2022 at 10:46 PM

Dear
Nuralim Pasisingi, Abdul Hafidz Olii, Elena Wonneberger

We have reached a decision regarding your submission to ILMU KELAUTAN: Indonesian Journal of Marine Sciences, "Growth Performance of Layang (Scad) Fish (Decapterus russelli, Ruppell 1830) Caught from Tomini Bay, Indonesia".

Our decision is to:
Revision Required

Indonesian Journal of Marine Science
ijms.undip@gmail.com

Reviewer D:

Introduction, Paragraph 3: Is there any research about D.russeli in Tomini Bay or the surrounding waters? Maybe about the biology information? If there is any, author can add the information.

Material and Methods, Section 1 (time, location, and sampling technique): Is there any information about where is the fishermen catch fish (Fishing ground area)? Maybe author can add the information about that.

Result and Discussion, Paragraph 4: Is there any research that support this statement? Research about spawning session of D.Russeli in Tomini Bay.

44452-137914-2-ReviewD.docx
261K

Universitas Negeri Gorontalo
UNGmail

Abdul Hafidz Olii <oliihafidz@ung.ac.id>

[IK.IJMS] [ID-44452] Revised Version Acknowledgement

3 messages

Ambariyanto <ijms@live.undip.ac.id> Fri, Feb 25, 2022 at 11:47 AM
Reply-To: "Nuralim Pasisingi" <nuralim@ung.ac.id>
To: "Nuralim Pasisingi" <nuralim@ung.ac.id>
Cc: Abdul Hafidz Olii <oliihafidz@ung.ac.id>, Elena Wonneberger <E.Wonneberger@gmx.de>

Nuralim Pasisingi, Abdul Hafidz Olii, Elena Wonneberger

Thank you for submitting the revision of manuscript, "Growth Performance of Layang (Scad) Fish (Decapterus russelli, Ruppell 1830) Caught from Tomini Bay, Indonesia" to ILMU KELAUTAN: Indonesian Journal of Marine Sciences. With the online journal management system that we are using, you will be able to track its progress through the editorial process by logging in to the journal web site:

Manuscript URL: https://ejournal.undip.ac.id/index.php/ijms/author/submission/44452
Username: nuralim_789
Editor: Indonesian Journal of Marine Science

If you have any questions, please contact me. Thank you for considering this journal as a venue for your work.

Ambariyanto
ILMU KELAUTAN: Indonesian Journal of Marine Sciences

INDONESIAN JOURNAL OF MARINE SCIENCE
http://ejournal.undip.ac.id/index.php/ijms

Ambariyanto <ijms@live.undip.ac.id> Fri, Feb 25, 2022 at 11:47 AM
Reply-To: "Nuralim Pasisingi" <nuralim@ung.ac.id>
To: "Nuralim Pasisingi" <nuralim@ung.ac.id>
Cc: Abdul Hafidz Olii <oliihafidz@ung.ac.id>, Elena Wonneberger <E.Wonneberger@gmx.de>

[Quoted text hidden]

Abdul Hafidz Olii <oliihafidz@ung.ac.id> Wed, Mar 9, 2022 at 5:32 AM
To: "Ambariyanto" <ijms@live.undip.ac.id>
Cc: Nuralim Pasisingi" <nuralim@ung.ac.id>, Elena Wonneberger <E.Wonneberger@gmx.de>

Dear Editorial Team,

Please let us know if any revision and/or further action is needed with regard to our manuscript entitled "Growth Performance of Layang (Scad) Fish (Decapterus russelli, Ruppell 1830) Caught from Tomini Bay, Indonesia"
Thank you very much.

Best regards,
Abdul Hafidz Olii

Lecturer | Aquatic Resources Management Department |
Gorontalo State University, Indonesia| +62 811-4319-531
facebook icon linkedin icon twitter icon
instagram icon

[Quoted text hidden]

Growth Performance of Layang (Scad) Fish (*Decapterus russelli*, Ruppell 1830) Caught from Tomini Bay, Indonesia

[hidden]

Abstract

Regarding ~~an~~ exploitation optimizing of fisheries resources management in Tomini Bay, Layang fish (*Decapterus ruselli*, Ruppell 1830) is one of the various small pelagic fishes inhabiting the bay that still has lacks biological fisheries information. ~~Whereas t~~he species becomes the main target commodity for local fishers as it is commonly consumed as a protein source in the human diet. The samples were collected once per month at Gorontalo City Fish Landing Spot from April to June 2020. Tomini Bay was confirmed as the fishing ground of all the landed fish. Mini purse seines with a minimum mesh size of ¾ inch are the gears used by the fishers for catching layang fish. Samples were collected randomly from the fishermen's~~'~~ catch during their unloading activity at the landing site. Abdomen dissection was performed ~~to~~ on all samples for determining the fish sexuality. ~~Additionally, t~~he fish samples' total length and body weight were quantified using a ruler (nearest = 1 mm) and a scale (nearest = 0.01 gram) separately. The result analysis revealed that the length-weight equation of male was $W = 0.000004\ L^{3.1972}$ (R^2 = 97.57%), and that of female was $W = 0.0000007\ L^{3.0613}$ (R^2 = 98.99%). Male and female layang fish *D. russelli* in Tomini Bay based on the sampling during these three-monthly sampling periods implied a positive allometric growth pattern, excluding the female in April 2020.

Keywords: allometric growth; Gorontalo; scad; length-weight relationship; population dynamics; Tomini

---

Introduction

Tomini Bay forms as a semi-enclosed water area (Miller *et al*., 2016) which is fertile (Kadim *et al*., 2019) with high marine biodiversity supported by the availability of phytoplanktons (Kadim *et al*., 2018) as primary food sources. The bay is also inhabited by diverse species of marine mammals (Mustika *et al*., 2021), various pelagic fishes (Mardlijah and Patria, 2016; Pasisingi *et al*., 2020; Pasisingi *et al*., 2020; Pasisingi *et al*., 2021; Pasisingi *et al*., 2021), small amphidromous fishes (Olii *et al*., 2017; Pasisingi and Abdullah, 2018; Olii *et al*., 2019; Pasisingi *et al*., 2021; Pasisingi *et al*., 2020; Pasisingi *et al*., 2020), as well as macrozoobenthos (Kadim *et al*., 2022). Moreover, local wisdom supports the sustainable management of coastal and marine resources in Tomini Bay (Obie, 2018).

Scientific data of Tomini Bay pelagic fish population dynamics are still minimal, making the level and utilization of the fish resources uncontrollable. Therefore, efforts to optimize fish resources to maximize the community's welfare around the bay area are still not optimal. Layang fish (*Decapterus russelli*, Ruppell 1830) that has a common name Scad (Sunaryo *et al*., 2019; Suwarso and Zamroni, 2015) or Indian Scad (Poojary *et al*., 2010; Chiesa *et al*., 2019) is one of ~~the~~ pelagic species of the Carangids group which is widely distributed including Tomini Bay as a part of Indo-Pacific region (Panda *et al*., 2012), western Indian Ocean, and northern Arabian Sea (Kalhoro *et al*., 2017). Apart from having a substantial economic value (Khasanah *et al*., 2020) and being in demand by the broader community due to its taste, the fish also contains protein (Cahyono and Mardani 2020; Fatma *et al*., 2020) to be consumed as a source of food nutrition. Layang fish diversification and processing (Tondais *et al*., 2020; Kurniawan *et al*., 2020b; Kurniawan *et al*., 2020a; Henra *et al*., 2020; Paparang, 2013) were also being developed in order to meet market demand for the commodity.

User
Please provide the study objective(s)
Abdul Hafidz Olii
we have added this information
Reply

User
State the number of samples
Abdul Hafidz Olii
Done. we have mentioned the number of samples
Reply

User
fishers
Abdul Hafidz Olii
we have adjusted
Reply

User
Max 5 word
Abdul Hafidz Olii
we have reduced the keywords turning to 5 words
Reply

User
Make this sentence simpler
Abdul Hafidz Olii
we have adjusted
Reply

Lack of scientific data on layang fish resources in Tomini Bay is a challenge in determining and formulating the proper management direction by considering layang fish *D. russelli* as the target fish caught by ~~fishermen~~ fishers in Indonesian as in Tomini Bay (Lawadjo *et al.*, 2021), Malacca Strait (Alnanda *et al.*, 2020), Makassar Strait (Cahyono and Mardani, 2020), and Ternate (Tangke, 2020). Therefore, comprehensive, and up-to-date data on layang fish's condition in nature is needed to monitor these fish resources' availability and sustainability. This study aimed to determine length-weight relationships and the growth pattern of laying fish *D. russelli* in Tomini Bay. This study results can enrich the information on the resource conditions to support the sustainable management of layang fish in Tomini Bay.

Materials and Methods

Time, Location, and Sampling Technique

The sampling was conducted once per month at Gorontalo City Fish Landing Spot from April to June 2020. Mini purse seines with a minimum mesh size of ¾ inch were fishermen's gears for catching layang fish in Tomini Bay. The number of 896 layang fish samples were collected randomly from the fisher's landing their catch to the landing site (Figure 1). The total length and body-weight data of the fish samples were quantified using a ruler and a scale separately. Furthermore, abdomen dissection was performed to determine sample sexuality.

Data Analysis

The relationship between total length and body weight of data samples were calculated and determined through the following equations (De Robertis and Williams, 2008):

$W = a\,L^{b}$ ..... (i)

where: W = body weight (gram); L = total length (mm); a = constant value; b = growth parameter

A natural logarithmic transformation was applied to make a relationship linear as follow:

$\ln W = \ln a + b \ln L$ .....(ii)

Result and Discussion

The length ranges of sample fish found in this study were 77-290 mm and 87-286 mm for males and females, respectively. The length range of *D. russelli* in Trincomalee District, Sri Lanka, from October 2019 to January 2020 ranged 110 - 225 mm (Anushika *et al.*, 2020). The Indian scad's length caught by mini purse seine in the waters around Tasikagung Fishing Port of Rembang ranged from 102 to 185 mm (Khasanah *et al.*, 2020). The total number and distribution frequency of *D. ruselli* found during the three months of sampling varied based on the size of the total length and body weight (Figure 2). Among the three-time samplings, *D. russelli* in Tomini Bay ~~were mostly~~ mainly were found in the total length range of 77 - 98 mm for males and 121 - 142 for females.

The fish length-weight analysis is essential to monitor the stocks and fish's biological conditions to ease the implementation of fish sustainability and biodiversity management (Agista et al., 2019). The relationship model of total length and weight of male and female *D. russelli* based on monthly and combined data is shown in Figure 3. Additionally, the length-weight relationship data of the layang fish in Tasikagung Fishing Port of Rembang collected twice a month from January to April 2019 obtained an equation of $W = 0.0000546\ TL^{2.73}$ (Khasanah *et al.*, 2020), in Probolinggo Regency, Indonesia during January to May 2017 was $W = 0.0049\ L^{3.2882}$ (Bintoro *et al.*, 2019). In Mayangan Probolinggo, Indonesia, from December 2017 to April 2018, $W = 0.014\ L^{2.8513}$ (Bintoro *et al.*, 2019).

The determination coefficient (R^2) that describes how well the model fits the data (Nakagawa et al. 2017) on the polynomial equation in this study is relatively high, above 95%. The R^2 value in this study is quite diverse when compared to several previous studies. In comparison, data of *D. russelli* caught by purse seine conducted from March to August 2014 in waters around Pemangkat

User
Is there any research about D.russeli in Tomini Bay or the surrounding waters? Maybe about the biology information? If there is any, author can add the information.
Abdul Hafidz Olii
we have provided further explanation as requested
Reply

User
Is there any information about where is the fishermen catch fish (Fishing ground area)? Maybe author can add the information about that.
Abdul Hafidz Olii
Yes. We have added the fishing ground information here
Reply

User
Provide the information on smallest unit tools you used
Abdul Hafidz Olii
Ok. done
Reply

User
Elaborate interpretation of the equations you mentioned. Please support it with any relevant and appropriate reference(s)
Abdul Hafidz Olii
we have elaborated the information as well as the supporting references
Reply

Fisheries Port, West Kalimantan expressed by equation W = 0.0093 $L^{3.1309}$ with R^2 = 87.19 % for male and W=0.0094 $L^{3.1359}$ with R^2 = 85.76 % for female (Faizah and Sadiyah, 2020). In addition, the laying fish in Malaka Strait taken from April to September 2016 expressed the relationship of W = 0,0057 $L^{3,2984}$ (R^2 = 97.45 %) for male and W = 0,0079 $L^{3,183}$ (R^2 = 98.25 %) for female (Faizah and Sadiyah, 2020). From a fisheries biology perspective, the length and weight relationship of finfish is one of the corresponding information that needs to provide regarding fisheries resources management, Particularly in determining the selectivity of fishing gear; therefore, the only fish caught are of a catch-fit size (Bernas, 2016).

Many studies use data on the relationship between length and body weight of fish to predict the growth patterns. Fish might attain either isometric, negative allometric, or positive allometric growths. An isometric pattern is associated with no alteration of body shape as individual growth. Furthermore, a negative allometric indicates the fish becomes more slender as it increases in weight, while positive allometric growth denotes relatively deeper bodies or stouter since it increases in length (Riedel *et al*., 2007). All growth patterns of layang fish in this study performs positive allometric, unless for female in April 2020 (Table 1). It is related to reproductive conditions and the spawning season. Suppose the spawning season of *D. russelli* in this study is just the same as in the waters of the Malacca Strait which took place from April to October with a peak in October (Hariati et al., 2017).

The growth pattern of Indian scad for males and females in the south of China Sea (Faizah and Sadiyah, 2020), and in Paiton, Probolinggo Regency from January 2017 to May 2017 *(Bintoro et al*., 2019) also revealed positive allometric. However, a negative allometric growth pattern was shown by layang fish *D. russelli* in Trincomalee District, Sri Lanka based on the data taken from October 2019 to January 2020 (Anushika *et al*., 2020) and in Mayangan Probolinggo, Indonesia, from December 2017 to April 2018 (Bintoro *et al*., 2019). The layang fish in Latuhalat waters, Ambon in June, July, and August 2016, showed that almost all the data had positive allometric growths except for males in August 2016, which showed an isometric growth pattern (Ongkers *et al*., 2016).

The variation in growth patterns is might be caused by differences in species, gonad maturity, spawning factors, food, sex, and age (Randongkir *et al*., 2018). Availability of supportive food and aquatic habitat characteristics might influence the variation of fish growth patterns (Nugroho *et al*., 2018) due to the food taken will affect the growth, maturity of each individual, and the successful life of the fish (Effendie, 2002).

Conclusion

The polynomial equation for the length and weight of layang scad fish *Decapterus russelli* is 0.000004 $L^{3.1972}$ (R^2 = 97.57 %) for male and W = 0.0000007 $L^{3.0613}$ (R^2 = 98.99 %) for female. Based on sampling data during April, May, and June 2020, it can be presented that the growth of males and females in Tomini Bay has a positive allometric pattern, except the female pattern in April 2020. Add implication of research

References

Agista, L., Muhammadar, A.A., & Chaliluddin, M.A.. 2019. The relationship of length-weight and condition factors of layang fish (Decapterus russelli) landed at KUD Gabion of Oceanic Fishing Port, North Sumatra. *In: IOP Conference Series: Earth and Environmental Science*.Vol. 348 Institute of Physics Publishing p. 012084. doi: 10.1088/1755-1315/348/1/012084.

Alnanda R, Setyobudiandi I, Boer M. 2020. Dinamila Populasi Ikan Layang (Decapterus russelli) di Perairan Selat Malaka. Manfish J. 1:1–8. http://ejurnal.polnep.ac.id/index.php/manfish/article/view/37 (Accessed December 1, 2020).

User
Is there any research that support this statement? Research about spawning session of D.Russeli in Tomini Bay.

Abdul Hafidz Olii
Yes and we have provided the requested information

Reply

User
use harvard style

Abdul Hafidz Olii
Done. we have made some changes following Harvard style

Reply

Anushika P, Herath H, Dias P, Gayathry L. 2020. Some Aspects of the Population Characteristics of Selected Marine Fish Species (Ambligaster sirm, Hyporhamphus dussumieri, Decapterus russelli and Atule mate) in Trincomalee District. In: Proceedings of the International Research Conference of Uva Wellassa University. pp. 105–110.
Cahyono E, Mardani I. 2020. Identifikasi Asam Amino Ikan Layang (Decapterus russelli) pada Lokasi Penangkapan Berbeda. J. Pengolah. Pangan. 5:1–6. doi: 10.31970/pangan.v5i1.33.
Chiesa S, Azzurro E, Bernardi G. 2019. The genetics and genomics of marine fish invasions: a global review. Rev. Fish Biol. Fish. 29:837–859. doi: 10.1007/s11160-019-09586-8.
Effendie MI. 2002. *Biologi Perikanan*. Yayasan Pustaka Nusatama: Yogyakarta.
Faizah R, Sadiyah L. 2020. Some biology aspects of Indian Scad (Decapterus russelli, Rupell, 1928) in Pemangkat Fisheries Port, West Kalimantan. In: IOP Conference Series: Earth and Environmental Science.Vol. 429 Institute of Physics Publishing p. 12063. doi: 10.1088/1755-1315/429/1/012063.
Fatma N, Metusalach, Taslim NA, Nurilmala M. 2020. The protein and albumin contents in some species of marine and brackishwater fish of South Sulawesi, Indonesia. Aquac. Aquarium, Conserv. Legis. Bioflux. 13:1976–1985. http://www.bioflux.com.ro/aacl (Accessed December 2, 2020).
Hariati T, Taufik M, Zamroni A. 2017. Beberapa Aspek Reproduksi Ikan Layang (Decapterus russelli) dan Ikan Banyar (Rastrelliger kanaguna) di Perairan Selat Malaka Indonesia. J. Penelit. Perikan. Indones. 11:47–56. http://ejournal-balitbang.kkp.go.id/index.php/jppi/article/view/4000 (Accessed December 3, 2020).
Henra H, Yusuf N, Naiu AS. 2020. Karakteristik Mutu Hedonik Kerupuk Ubi Jalar Dan Rumput Laut (Kappaphycus alvarezii) Yang Difortifikasi dengan Ikan Layang (Decapterus russelli). Jambura Fish Process. J. 1:35–45. doi: 10.37905/jfpj.v1i2.5426.
Kadim MK, Pasisingi N, Alinti ER, Panigoro C. 2022. Biodiversity and community assemblages of freshwater and marine macrozoobenthos in Gorontalo Waters , Indonesia. Bio. 23:637–647. doi: 10.13057/biodiv/d230204.
Kadim MK, Pasisingi N, Arsad S. 2019. Horizontal distribution of chlorophyll-α in the gorontalo bay. Nat. Environ. Pollut. Technol. 18.
Kadim MK, Pasisingi N, Kasim F. 2018. Spatial and temporal distribution of phytoplankton in the Gorontalo Bay, Indonesia. AACL Bioflux. 11.
Kalhoro MT et al. 2017. Stock Assessment of Indian Scad, Decapterus Russelli in Pakistani Marine Waters and Its Impact on the National Economy. Indian J. Geo Mar. Sci. 49:1222–1228. doi: 10.4172/2150-3508.1000200.
Khasanah AN, Saputra SW, Taufani WT. 2020. Population dynamic of indian scad (Decapterus russelli) based on data in tasikagung fishing Port of Rembang. In: IOP Conference Series: Earth and Environmental Science.Vol. 530 IOP Publishing Ltd p. 012004. doi: 10.1088/1755-1315/530/1/012004.
Kurniawan A, Permadi A, Purnomo AH. 2020a. Children's Responses to the Addition of Indian Scad (Decapterus russelli) Fish Protein Concentrated and Flavor to Traditional Food. J. Airaha. 9:096–104. doi: 10.15578/JA.V9I01.165.
Kurniawan A, Permadi A, Purnomo AH. 2020b. Optimum Proportion of Indian Scad (Decapterus russelli) Protein Concentrate in Traditional Food Cake Designated for Undernourished Children Diet. Russ. J. Agric. Socio-Economic Sci. 99:170–183. doi: 10.18551/rjoas.2020-03.19.
Lawadjo FW, Tuli M, Pasisingi N. 2021. Length-Weight Relationship and Condition Factor of Layang Fish (Decapterus russelli) Landed at Tenda Fish Landing Base, Gorontalo. J. Pengelolaan Perikan. Trop. (Journal Trop. Fish. Manag. 5:44–51. doi: 10.29244/jppt.v5i1.34604.
Mardlijah S, Patria MP. 2016. Biologi Reproduksi Ikan Madidihang (Thunnus albacares Bonnatere 1788) di Teluk Tomini. BAWAL Widya Ris. Perikan. Tangkap. 4:27–34. doi: 10.15578/BAWAL.4.1.2012.27-34.
Miller MJ et al. 2016. High biodiversity of leptocephali in Tomini Bay Indonesia in the center of the Coral Triangle. Reg. Stud. Mar. Sci. 8:99–113. doi: 10.1016/j.rsma.2016.09.006.
Mustika PLK, Wonneberger E, Erzini K, Pasisingi N. 2021. Marine megafauna bycatch in artisanal fisheries in Gorontalo, northern Sulawesi (Indonesia): An assessment based on fisher

interviews. In: Ocean and Coastal Management.Vol. 208 Elsevier Ltd p. 105606. doi: 10.1016/j.ocecoaman.2021.105606.
Nakagawa S, Johnson PCD, Schielzeth H. 2017. The coefficient of determination R^2 and intra-class correlation coefficient from generalized linear mixed-effects models revisited and expanded. J. R. Soc. Interface. 14:20170213. doi: 10.1098/rsif.2017.0213.
Nugroho SC, Jatmiko I, Wujdi A. 2018. Pola pertumbuhan dan faktor kondisi madidihang, Thunnus albacares (Bonnaterre, 1788) di Samudra Hindia Bagian Timur. J. Iktiologi Indones. 18:13–21.
Obie M. 2018. Exploitation of coastal and marine resources along Tomini Bay: Livelihood base versus concession rights Eksploitasi sumber daya pesisir dan laut di Teluk Tomini: Basis mata pencaharian versus konsesi. Masyarakat, Kebud. dan Polit. 31:36–45.
Olii AH, Sahami FM, Hamzah SN, Pasisingi N. 2019. Molecular approach to identify gobioid fishes, "nike" and "hundala" (Local name), from gorontalo waters, Indonesia. Online J. Biol. Sci. 19:51–56. doi: 10.3844/ojbsci.2019.51.56.
Olii AH, Sahami FM, Hamzah SN, Pasisingi N. 2017. Preliminary findings on distribution pattern of larvae of nike fish (Awaous sp.) in the estuary of Bone River, Gorontalo Province, Indonesia. AACL Bioflux. 10:1110–1118.
Ongkers OT., Pattikawa JA, Rijoly F. 2016. Aspek Biologi Ikan Layang (Decapterus russelli) di Perairan Latuhalat, Kecamatan Nusaniwe, Pulau Ambon. Omni-Akuatika. 12:79–87. http://www.ojs.omniakuatika.net/index.php/joa/article/view/128 (Accessed December 2, 2020).
Panda D et al. 2012. Fishery and population dynamics of two species of carangids, Decapterus russelli (Ruppell, 1830) and Megalaspis cordyla (Linnaeus, 1758) from Mumbai waters. Indian J. Fish. 59:53–60.
Paparang RW. 2013. Studi Pengaruh Variasi Konsentrasi Garam Terhadap Citarasa Peda Ikan Layang (Decapterus russelli). Media Teknol. Has. Perikan. 1:17–20. doi: 10.35800/mthp.1.1.2013.4141.
Pasisingi N, Abdullah S. 2018. Pola kemunculan ikan nike (Gobiidae) di Perairan Teluk Gorontalo, Indonesia. DEPIK J. Ilmu-Ilmu Perairan, Pesisir dan Perikan. 7:111–118. doi: 10.13170/depik.7.2.11442.
Pasisingi N, Habibie SA, Olii AH. 2020. Are awaous ocellaris and belobranchus belobranchus the two species of nike fish schools ? Aceh J. Anim. Sci. 5:87–91. doi: 10.13170/ajas.5.2.16557.
Pasisingi Nuralim, Kasim F, Moo ZA. 2021. Estimation of Fishing Mortality Rate and Exploitation Status of Yellowstrip Scad (Selaroides leptolepis) in Tomini Bay using Von Bertalanffy Growth Model Approach. J. Ilm. Perikan. Dan Kelaut. 13:288–296. doi: 10.20473/jipk.v13i2.27465.
Pasisingi N., Katili VRA, Mardin H, Ibrahim PS. 2021. Variation in morphometric characteristics of nike fish (Amphidromous goby larva) in leato waters, gorontalo bay, Indonesia. AACL Bioflux. 14.
Pasisingi N, Olii AH, Habibie SA. 2020. Morphology and growth pattern of Nike fish (amphidromous goby larvae) in Gorontalo Waters, Indonesia. Tomini J. Aquat. Sci. 1:1–7. http://ejurnal.ung.ac.id/index.php/tjas/ (Accessed March 19, 2021).
Pasisingi Nuralim, Pramesthy TD, Musyali A. 2021. Length-weight relationships and sex ratio of Selaroides leptolepis , Cuvier Length-weight relationships and sex ratio of Selaroides leptolepis , Cuvier 1833 in Tomini Bay , Indonesia. In: IOP Conference Series: Earth and Environmental Science 744 012052. doi: 10.1088/1755-1315/744/1/012052.
Pasisingi N, Sapira Ibrahim P, Arsalam Moo Z, Tuli M. 2020. Reproductive Biology of Oci Fish Selaroides leptolepis in Tomini Bay. J. Mar. Res. 9:407–415. doi: 10.14710/jmr.v9i4.28340.
Poojary N, Tiwari L, Jaiswar A. 2010. Food and feeding habits of the Indian scad, Decapterus russelli (Ruppell, 1830) from Mumbai waters, north-west coast of India. Indian J. Fish. 57:93–99.
Randongkir YE, Simatauw F, Handayani T. 2018. Growth Aspects of Scad Decapterus macrosoma on Fish Point Sanggeng-Manokwari Regency. J. Sumberd. Akuatik Indopasifik. 2. www.ejournalfpikunipa.ac.id (Accessed December 3, 2020).
Riedel R, Caskey LM, Hurlbert SH. 2007. Length-weight relations and growth rates of dominant fishes of the Salton Sea: Implications for predation by fish-eating birds. Lake Reserv. Manag. 23:528–535. doi: 10.1080/07438140709354036.
De Robertis A, Williams K. 2008. Weight-Length Relationships in Fisheries Studies: The Standard

Allometric Model Should Be Applied with Caution. Trans. Am. Fish. Soc. 137:707–719. doi: 10.1577/t07-124.1.
Siti Masreah Bernas. 2016. Hubungan Panjang-Berat dan Pola Pertumbuhan Ikan di Muara Sungai Musi Kabupaten Banyuasin Sumatera Selatan. Maspari J. 8:111–118.
Sunaryo, Syahrihaddin A, Imfianto PS. 2019. Solar Energy for a Traditional Coastal Fishing Platform. J. Mar. Sci. Appl. 18:366–371. doi: 10.1007/s11804-019-00087-5.
Suwarso S, Zamroni A. 2015. Analisis Struktur Populasi Tiga Species Layang (Decapterus spp.) di Laut Jawa dan Sekitar Sulawesi: Saran Pengelolaan Berkelanjutan Ikan Pelagis Kecil dan Evaluasi WPP. J. Kebijak. Perikan. Indones. 6:75. doi: 10.15578/jkpi.6.2.2014.75-86.
Tangke U. 2020. Produksi dan Nilai Jual Ikan Pelagis Dominan di TPI Higienis Pelabuhan Perikanan Nusantara Ternate. Agrikan J. Agribisnis Perikan. 13:108. doi: 10.29239/j.agrikan.13.1.97-107.
Tondais J et al. 2020. Ekstraksi Flavour dari Tepung Ikan Layang (Decapterus sp.) Menggunakan Enzim Protease Biduri (Calotropis gigantea). J. FishtecH. 9:6–12. doi: 10.36706/fishtech.v9i1.11481.

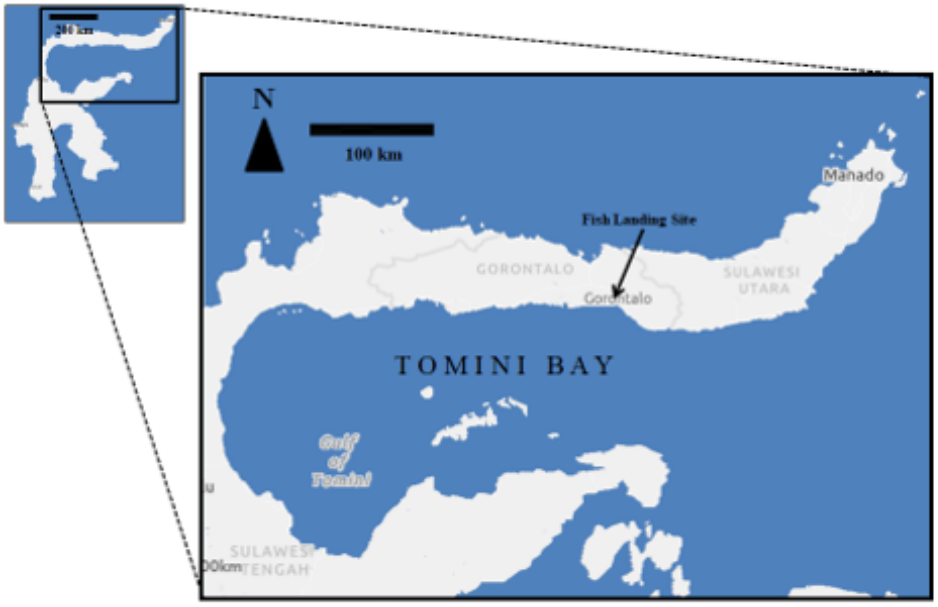
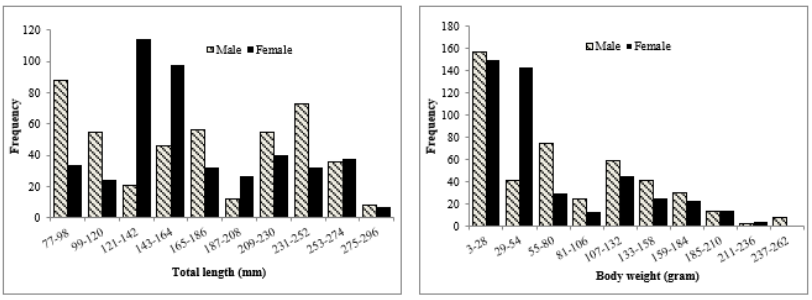
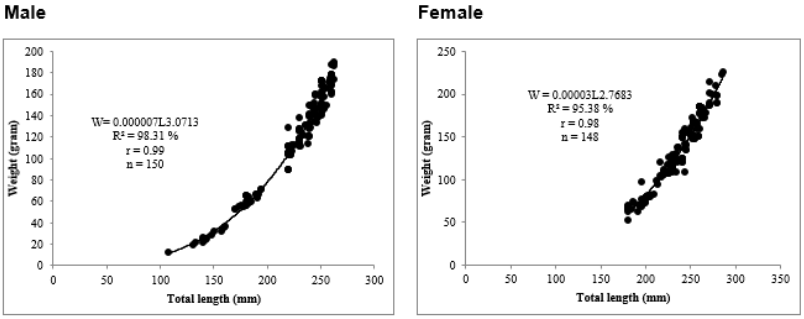


Figure 1. Fishing Area and Gorontalo Fish Landing Site of Layang Fish *Decapterus russelli*



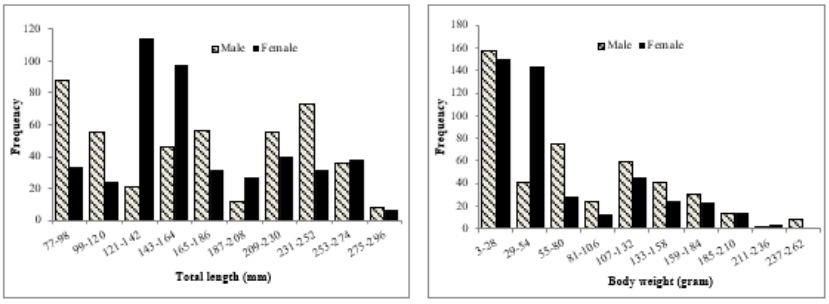
(a) (b)

Figure 2. Frequency distribution of *Decapterus russelli* in Tomini Bay based on (a) total length and (b) body weight



April 2020 April 2020

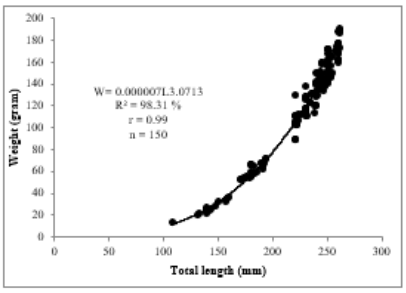
User
legend move to bottom
Abdul Hafidz Olii
Done.
Reply



(a) (b)

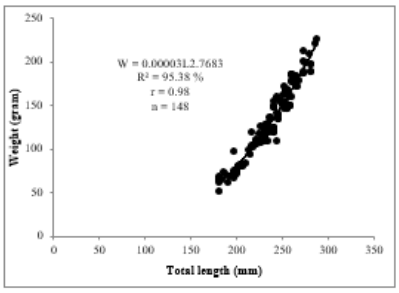
Figure 2. Frequency distribution of *Decapterus russelli* in Tomini Bay based on (a) total length and (b) body weight

Male



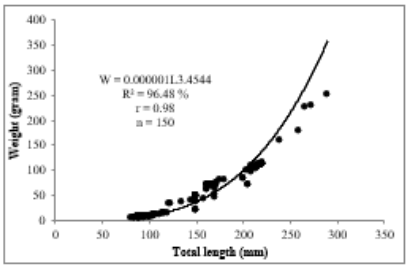
April 2020

Female

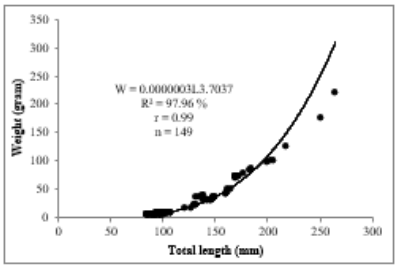


April 2020

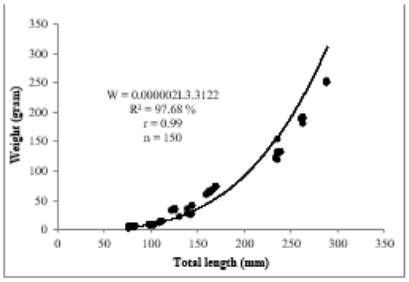
User
legend move to bottom
Abdul Hafidz Olii
Done.
Reply



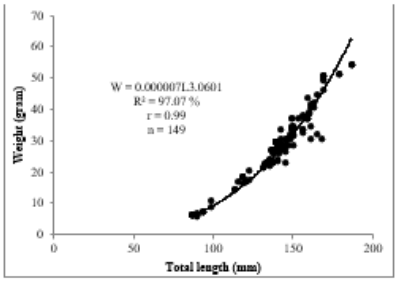
May 2020



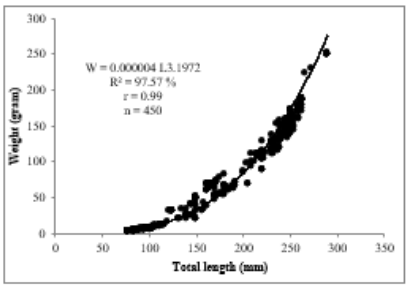
May 2020



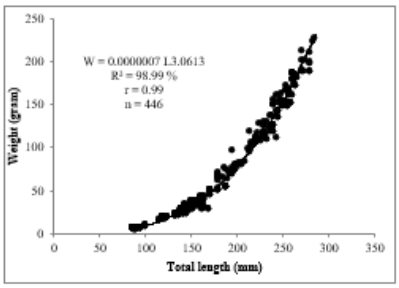
June 2020



June 2020



Combined



Combined

Figure 3. Length Weight Relations of *Decapterus russelli* in Tomini Bay

Table 1. Linear relation of length-weight data and growth patterns of *D. russelli* in Tomini Bay

Male	Female

User
Provide the significant p- value you used to analyze your data below the table
Abdul Hafidz Olii

Sampling periods	Length-Weight linear relationships	Growth pattern	Length-Weight linear relationships	Growth pattern
		postive		negative
April 2020	ln W = -11.9189 + 3.0713 ln L	allometric	ln W = -10.264 + 2.7683 ln L	allometric
		postive		postive
May 2020	ln W = -13.6983 + 3.4544 ln L	allometric	ln W = -14.9327 + 3.7037 Ln L	allometric
		postive		postive
June 2020	ln W = -13.0305 + 3.3122 ln L	allometric	ln W = -11.8668 - 3.0602 ln L	allometric
		postive		postive
Total	ln W = -12.5017 + 3.1972 ln L	allometric	ln W = -11.8687 + 3.0613 ln L	allometric

File Home Insert Draw Design Layout References Mailings Review View Help Acrobat Comments Editing Share

Growth Performance of Layang (Scad) Fish (*Decapterus russelli*, Ruppell 1830) Caught from Tomini Bay, Indonesia

[hidden]

Abstract

Regarding ~~an~~ exploitation optimizing of fisheries resources management in Tomini Bay, Layang fish (*Decapterus ruselli*, Ruppell 1830) is one of the various small pelagic fishes inhabiting the bay that still has lacks biological fisheries information. ~~Whereas t~~he species becomes the main target commodity for local fishers as it is commonly consumed as a protein source in the human diet. The samples were collected once per month at Gorontalo City Fish Landing Spot from April to June 2020. Tomini Bay was confirmed as the fishing ground of all the landed fish. Mini purse seines with a minimum mesh size of ¾ inch are the gears used by the fishers for catching layang fish. Samples were collected randomly from the fishermen's[catch during their unloading activity at the landing site. Abdomen dissection was performed ~~to~~ on all samples for determining the fish sexuality. ~~Additionally,~~ the fish samples' total length and body weight were quantified using a ruler (nearest = 1 mm) and a scale (nearest = 0.01 gram) separately. The result analysis revealed that the length-weight equation of male was W = 0.000004 $L^{3.1972}$ (R^2 = 97.57%), and that of female was W = 0.0000007 $L^{3.0613}$ (R^2 = 98.99%). Male and female layang fish *D. russelli* in Tomini Bay based on the sampling during these three-monthly sampling periods implied a positive allometric growth pattern, excluding the female in April 2020.

User
Please provide the study objective(s)
19 February 2022, 10:40

Abdul Hafidz Olii
we have added this information
24 February 2022, 21:11

Reply

User
State the number of samples
19 February 2022, 10:41

Abdul Hafidz Olii
Done. we have mentioned the number of samples
24 February 2022, 21:12

Reply

User
fishers

User
fishers
19 February 2022, 10:42

Abdul Hafidz Olii
we have adjusted
24 February 2022, 21:12

Reply

sampling during these three-monthly sampling periods implied a positive allometric growth pattern, excluding the female in April 2020.

Keywords: allometric growth; Gorontalo; scad; length-weight relationship; population dynamics; Tomini

Introduction

Tomini Bay forms as a semi-enclosed water area (Miller *et al.*, 2016) which is fertile (Kadim *et al.*, 2019) with high marine biodiversity supported by the availability of phytoplanktons (Kadim *et al.*, 2018) as primary food sources. The bay is also inhabited by diverse species of marine mammals (Mustika *et al.*, 2021), various pelagic fishes (Mardlijah and Patria, 2016; Pasisingi *et al.*, 2020; Pasisingi *et al.*, 2020; Pasisingi *et al.*, 2021; Pasisingi *et al.*, 2021), small amphidromous fishes (Olii *et al.*, 2017; Pasisingi and Abdullah, 2018; Olii *et al.*, 2019; Pasisingi *et al.*, 2021; Pasisingi *et al.*, 2020; Pasisingi *et al.*, 2020), as well as macrozoobenthos (Kadim *et al.*, 2022). Moreover, local wisdom supports the sustainable management of coastal and marine resources in Tomini Bay (Obie, 2018).

Reply

User
Max 5 word
19 February 2022, 10:42

Abdul Hafidz Olii
we have reduced the keywords turning to 5 words
24 February 2022, 21:13

Reply

User
Make this sentence simpler

Tomini Bay forms as a semi-enclosed water area (Miller *et al.*, 2016) which is fertile (Kadim *et al.*, 2019) with high marine biodiversity supported by the availability of phytoplanktons (Kadim *et al.*, 2018) as primary food sources. The bay is also inhabited by diverse species of marine mammals (Mustika *et al.*, 2021), various pelagic fishes (Mardlijah and Patria, 2016; Pasisingi *et al.*, 2020; Pasisingi *et al.*, 2020; Pasisingi *et al.*, 2021; Pasisingi *et al.*, 2021), small amphidromous fishes (Olii *et al.*, 2017; Pasisingi and Abdullah, 2018; Olii *et al.*, 2019; Pasisingi *et al.*, 2021; Pasisingi *et al.*, 2020; Pasisingi *et al.*, 2020), as well as macrozoobenthos (Kadim *et al.*, 2022). Moreover, local wisdom supports the sustainable management of coastal and marine resources in Tomini Bay (Obie, 2018).

Scientific data of Tomini Bay pelagic fish population dynamics are still minimal, making the level and utilization of the fish resources uncontrollable. Therefore, efforts to optimize fish resources to maximize the community's welfare around the bay area are still not optimal. Layang fish (*Decapterus russelli,* Ruppell 1830) that has a common name Scad (Sunaryo *et al.*, 2019; Suwarso and Zamroni, 2015) or Indian Scad (Poojary *et al.*, 2010; Chiesa *et al.*, 2019) is one of the pelagic species of the Carangids group which is widely distributed including Tomini Bay as a part of Indo-Pacific region (Panda *et al.*, 2012), western Indian Ocean, and northern Arabian Sea (Kalhoro *et al.*, 2017). Apart from having a substantial economic value (Khasanah *et al.*, 2020) and being in demand by the broader community due to its taste, the fish also contains protein (Cahyono and Mardani 2020; Fatma *et al.*, 2020) to be consumed as a source of food nutrition. Layang fish diversification and processing (Tondais *et al.*, 2020; Kurniawan *et al.*, 2020b; Kurniawan *et al.*, 2020a; Henra *et al.*, 2020; Paparang, 2013) were also being developed in order to meet market demand for the commodity.

User
Make this sentence simpler
19 February 2022, 10:43

Abdul Hafidz Olii
we have adjusted
24 February 2022, 21:13

Reply

Lack of scientific data on layang fish resources in Tomini Bay is a challenge in determining and formulating the proper management direction by considering layang fish *D. russelli* as the target fish caught by ~~fishermen~~ fishers in Indonesian as in Tomini Bay (Lawadjo *et al.*, 2021), Malacca Strait (Alnanda *et al.*, 2020), Makassar Strait (Cahyono and Mardani, 2020), and Ternate (Tangke, 2020). Therefore, comprehensive, and up-to-date data on layang fish's condition in nature is needed to monitor these fish resources' availability and sustainability. This study aimed to determine length-weight relationships and the growth pattern of laying fish *D. russelli* in Tomini Bay. This study results can enrich the information on the resource conditions to support the sustainable management of layang fish in Tomini Bay.

User
Is there any research about D.russeli in Tomini Bay or the surrounding waters? Maybe about the biology information? If there is any, author can add the information.
19 February 2022, 21:14

Abdul Hafidz Olii
we have provided further explanation as requested
24 February 2022, 21:18

Reply

Materials and Methods

Time, Location, and Sampling Technique

The sampling was conducted once per month at Gorontalo City Fish Landing Spot from April to June 2020. Mini purse seines with a minimum mesh size of ¾ inch were fishermen's gears for catching layang fish in Tomini Bay. The number of 896 layang fish samples were collected randomly from the fisher's landing their catch to the landing site (Figure 1). The total length and body-weight data of the fish samples were quantified using a ruler and a scale separately. Furthermore, abdomen dissection was performed to determine sample sexuality.

Data Analysis

The relationship between total length and body weight of data samples were calculated and determined through the following equations (De Robertis and Williams, 2008):

$W = a L^{b}$ ..... (i)

where: W = body weight (gram); L = total length (mm); a = constant value; b = growth parameter

A natural logarithmic transformation was applied to make a relationship linear as follow:

$\ln W = \ln a + b \ln L$ .....(ii)

Result and Discussion

User
Is there any information about where is the fishermen catch fish (Fishing ground area)? Maybe author can add the information about that.
19 February 2022, 20:39

Abdul Hafidz Olii
Yes. We have added the fishing ground information here
24 February 2022, 21:15

Reply

User

data of the fish samples were quantified using a ruler and a scale separately. Furthermore, abdomen dissection was performed to determine sample sexuality.

Data Analysis

The relationship between total length and body weight of data samples were calculated and determined through the following equations (De Robertis and Williams, 2008):

$W = a L^b$ ..... (i)

where: W = body weight (gram); L = total length (mm); a = constant value; b = growth parameter

A natural logarithmic transformation was applied to make a relationship linear as follow:

$\ln W = \ln a + b \ln L$ .....(ii)

Result and Discussion

The length ranges of sample fish found in this study were 77-290 mm and 87-286 mm for

User
Provide the information on smallest unit tools you used
19 February 2022, 10:45

Abdul Hafidz Olii
Ok. done
24 February 2022, 21:15

Reply

determined through the following equations (De Robertis and Williams, 2008):

$W = a L^b$ ..... (i)

where: W = body weight (gram); L = total length (mm); a = constant value; b = growth parameter

A natural logarithmic transformation was applied to make a relationship linear as follow:

$\ln W = \ln a + b \ln L$ .....(ii)

Result and Discussion

The length ranges of sample fish found in this study were 77-290 mm and 87-286 mm for males and females, respectively. The length range of *D. russelli* in Trincomalee District, Sri Lanka, from October 2019 to January 2020 ranged 110 - 225 mm (Anushika *et al*., 2020). The Indian scad's length caught by mini purse seine in the waters around Tasikagung Fishing Port of Rembang ranged from 102 to 185 mm (Khasanah *et al*., 2020). The total number and distribution frequency of *D. ruselli* found during the three months of sampling varied based on the size of the total length and body weight (Figure 2). Among the three-time samplings, *D. russelli* in Tomini Bay ~~were mostly~~ mainly were found in the total length range of 77 - 98 mm for males and 121 - 142 for females.

The fish length-weight analysis is essential to monitor the stocks and fish's biological conditions to ease the implementation of fish sustainability and biodiversity management (Agista et al., 2019). The relationship model of total length and weight of male and female *D. russelli* based on monthly and combined data is shown in Figure 3. Additionally, the length-weight relationship data of the layang fish in Tasikagung Fishing Port of Rembang collected twice a month from January to April 2019 obtained an equation of $W = 0.0000546\ TL^{2.73}$ (Khasanah *et al*., 2020), in Probolinggo Regency, Indonesia during January to May 2017 was $W = 0.0049\ L^{3.2882}$ (Bintoro *et al*., 2019). In Mayangan Probolinggo, Indonesia, from December 2017 to April 2018, $W = 0.014\ L^{2.8513}$ (Bintoro *et al*., 2019).

User
Elaborate interpretation of the equations you mentioned. Please support it with any relevant and appropriate reference(s)
19 February 2022, 10:47

Abdul Hafidz Olii
we have elaborated the information as well as the supporting references
24 February 2022, 21:16

Reply

are of a catch-fit size (Bernas, 2016).

Many studies use data on the relationship between length and body weight of fish to predict the growth patterns. Fish might attain either isometric, negative allometric, or positive allometric growths. An isometric pattern is associated with no alteration of body shape as individual growth. Furthermore, a negative allometric indicates the fish becomes more slender as it increases in weight, while positive allometric growth denotes relatively deeper bodies or stouter since it increases in length (Riedel *et al*., 2007). All growth patterns of layang fish in this study performs positive allometric, unless for female in April 2020 (Table 1). It is related to reproductive conditions and the spawning season. Suppose the spawning season of *D. russelli* in this study is just the same as in the waters of the Malacca Strait which took place from April to October with a peak in October (Hariati et al., 2017).

The growth pattern of Indian scad for males and females in the south of China Sea (Faizah and Sadiyah, 2020), and in Paiton, Probolinggo Regency from January 2017 to May 2017 *(Bintoro et al*., 2019) also revealed positive allometric. However, a negative allometric growth pattern was shown by layang fish *D. russelli* in Trincomalee District, Sri Lanka based on the data taken from October 2019 to January 2020 (Anushika *et al*., 2020) and in Mayangan Probolinggo, Indonesia, from December 2017 to April 2018 (Bintoro *et al*., 2019). The layang fish in Latuhalat waters, Ambon in June, July, and August 2016, showed that almost all the data had positive allometric growths except for males in August 2016, which showed an isometric growth pattern (Ongkers *et al*., 2016).

The variation in growth patterns is might be caused by differences in species, gonad maturity, spawning factors, food, sex, and age (Randongkir *et al*., 2018). Availability of supportive food and aquatic habitat characteristics might influence the variation of fish growth patterns (Nugroho *et al*.,

User
Is there any research that support this statement? Research about spawning session of D.Russeli in Tomini Bay.
19 February 2022, 20:42

Abdul Hafidz Olii
Yes and we have provided the requested information
24 February 2022, 21:16

Reply

2018) due to the food taken will affect the growth, maturity of each individual, and the successful life of the fish (Effendie, 2002).

Conclusion

The polynomial equation for the length and weight of layang scad fish *Decapterus russelli* is 0.000004 $L^{3.1972}$ (R^2 = 97.57 %) for male and W = 0.0000007 $L^{3.0613}$ (R^2 = 98.99 %) for female. Based on sampling data during April, May, and June 2020, it can be presented that the growth of males and females in Tomini Bay has a positive allometric pattern, except the female pattern in April 2020. Add implication of research

References

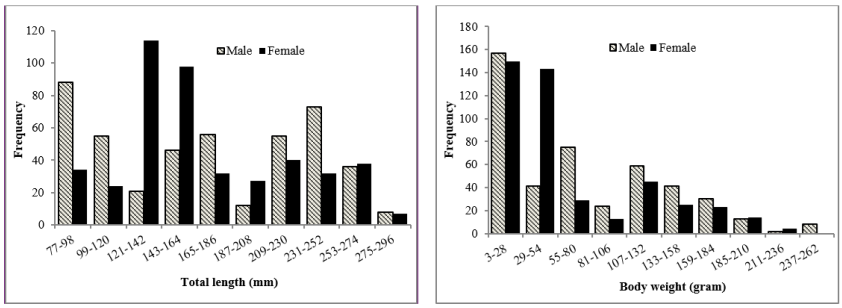
Agista, L., Muhammadar, A.A., & Chaliluddin, M.A.. 2019. The relationship of length-weight and condition factors of layang fish (Decapterus russelli) landed at KUD Gabion of Oceanic Fishing Port, North Sumatra. *In: IOP Conference Series: Earth and Environmental Science*.Vol. 348 Institute of Physics Publishing p. 012084. doi: 10.1088/1755-1315/348/1/012084.

Alnanda R, Setyobudiandi I, Boer M. 2020. Dinamila Populasi Ikan Layang (Decapterus russelli) di Perairan Selat Malaka. Manfish J. 1:1–8. http://ejurnal.polnep.ac.id/index.php/manfish/article/view/37 (Accessed December 1, 2020).

User
use harvard style
19 February 2022, 10:52

Abdul Hafidz Olii
Done. we have made some changes following Harvard style
24 February 2022, 21:16

Reply



(a) (b)

Figure 2. Frequency distribution of *Decapterus russelli* in Tomini Bay based on (a) total length and (b) body weight

User
legend move to bottom
19 February 2022, 20:46

Abdul Hafidz Olii
Done.
24 February 2022, 21:17

Reply

Figure 3. Length Weight Relations of *Decapterus russelli* in Tomini Bay

Table 1. Linear relation of length-weight data and growth patterns of *D. russelli* in Tomini Bay

	Male		Female	
Sampling periods	**Length-Weight linear relationships**	**Growth pattern**	**Length-Weight linear relationships**	**Growth pattern**
April 2020	ln W = -11.9189 + 3.0713 ln L	postive allometric	ln W = -10.264 + 2.7683 ln L	negative allomteric
May 2020	ln W = -13.6983 + 3.4544 ln L	postive allometric	ln W = -14.9327 + 3.7037 Ln L	postive allometric

User
Provide the significant p- value you used to analyze your data below the table
19 February 2022, 10:54

Abdul Hafidz Olii
Ok. done
24 February 2022, 21:17

Reply

NASKAH AKHIR SAAT ACCEPTED

ILMU KELAUTAN
Indonesian Journal of Marine Sciences
p-ISSN : 0853-7291
e-ISSN : 2406-7598

#44452 Review

Summary (https://ejournal.undip.ac.id/index.php/ijms/author/submission/44452)
Review (https://ejournal.undip.ac.id/index.php/ijms/author/submissionReview/44452)
Editing (https://ejournal.undip.ac.id/index.php/ijms/author/submissionEditing/44452)

Submission

Authors	Abdul Hafidz Olii, Elena Wonneberger, Nuralim Pasisingi (https://ejournal.undip.ac.id/index.php/ijms/user/email?redirectUrl=https%3A%2F%2Fejournal.undip.ac.id%2Findex.php%2Fijms%2Fauthor%2FsubmissionReview%2F44452&to%5B%5D=%22Abdul%20Hafidz%20Olii%22%20%3Colihafidz%40gmail.com%3E&to%5B%5
Title	Growth Performance of Layang (Scad) Fish (Decapterus russelli, Ruppell 1830) Caught from Tomini Bay, Indonesia
Section	Research Articles
Editor	Indonesian Journal of Marine Science (https://ejournal.undip.ac.id/index.php/ijms/user/email?redirectUrl=https%3A%2F%2Fejournal.undip.ac.id%2Findex.php%2Fijms%2Fauthor%2FsubmissionReview%2F44

Peer Review

Round 1

Review Version	44452-137915-1-RV.doc (https://ejournal.undip.ac.id/index.php/ijms/author/downloadFile/44452/137915/1) 28-01-2022
Initiated	05-02-2022
Last modified	21-02-2022
Uploaded file	Reviewer D 44452-139589-1-RV.docx (https://ejournal.undip.ac.id/index.php/ijms/author/downloadFile/44452/139589/1) 21-02-2022

Editor Decision

Decision	Accept Submission 10-03-2022
Notify Editor	(https://ejournal.undip.ac.id/index.php/ijms/author/emailEditorDecisionComment?articleId=44452) Editor/Author Email Record (javascript:openComments('https://ejournal.undip.ac.id/index.php/ijms/author/viewEditorDecisionComments/44452#28739');) 14-04-2022
Editor Version	None
Author Version	44452-139905-1-ED.docx (https://ejournal.undip.ac.id/index.php/ijms/author/downloadFile/44452/139905/1) 25-02-2022 44452-139905-2-ED.docx (https://ejournal.undip.ac.id/index.php/ijms/author/downloadFile/44452/139905/2) 25-02-2022
Upload Author Version	Choose File No file chosen Upload

https://ejournal.undip.ac.id/index.php/ijms/author/submissionReview/44452

Editor Decision

Decision	Accept Submission 10-03-2022
Notify Editor	Editor/Author Email Record 14-04-2022
Editor Version	None
Author Version	44452-139905-1-ED.docx 25-02-2022 44452-139905-2-ED.docx 25-02-2022
Upload Author Version	Choose File No file chosen Upload

Growth Performance of Layang (Scad) Fish (*Decapterus russelli,* Ruppell 1830) Caught from Tomini Bay, Indonesia

Abdul Hafidz Olii[1], Elena Wonneberger[2], and Nuralim Pasisingi[1*]

[1]Aquatic Resources Management Study Programme, Faculty of Fisheries and Marine Science, Gorontalo State University, Jl. Jenderal Sudirman No. 6, Gorontalo City, Gorontalo Province, 96128, Indonesia
[2]Centre of Marine Sciences (CCMAR), Universidade do Algarve, 8005-139, Faro, Portugal
*Email: nuralim@ung.ac.id

Abstract

Regarding exploitation optimizing of fisheries resources management in Tomini Bay, Layang fish (*Decapterus ruselli*, Ruppell 1830) is one of the various small pelagic fishes inhabiting the bay that still has lacks biological fisheries information. The species becomes the main target commodity for local fishers as it is commonly consumed as a protein source in the human diet. This study aimed to determine length-weight relationships and the growth pattern of layang fish caught by fishers from Tomini Bay. The samples were collected once per month at Gorontalo City Fish Landing Spot from April to June 2020. Tomini Bay was confirmed as the fishing ground of all the landed fish. Mini purse seines with a minimum mesh size of ¾ inch are the gears used by the fishers for catching layang fish. Total samples of 896 layang fish were collected randomly from the fishers's catch during their unloading activity at the landing site. Abdomen dissection was performed on all samples for determining the fish sexuality. The fish samples' total length and body weight were quantified using a ruler (nearest = 1 mm) and a scale (nearest = 0.01 gram) separately. The result analysis revealed that the length-weight equation of male was $W = 0.000004\ L^{3.1972}$ (R^2 = 97.57%), and that of female was $W = 0.0000007\ L^{3.0613}$ (R^2 = 98.99%). Male and female layang fish *D. russelli* in Tomini Bay based on the sampling during these three-monthly sampling periods implied a positive allometric growth pattern, excluding the female in April 2020.

Keywords: Gorontalo; scad; length-weight relationship

Introduction

Tomini Bay forms as a semi-enclosed water area (Miller *et al*., 2016) which is fertile (Kadim *et al*., 2019) with high marine biodiversity supported by the availability of phytoplanktons (Kadim *et al*., 2018) as primary food sources. Diverse species of marine mammals also inhabit the bay (Mustika *et al*., 2021), various pelagic fishes (Mardlijah and Patria, 2016; Pasisingi *et al*., 2020; Pasisingi *et al*., 2020; Pasisingi *et al*., 2021; Pasisingi *et al*., 2021), small amphidromous fishes (Olii *et al*., 2017; Pasisingi and Abdullah, 2018; Olii *et al*., 2019; Pasisingi *et al*., 2021; Pasisingi *et al*., 2020; Pasisingi *et al*., 2020), as well as macrozoobenthos (Kadim *et al*., 2022). Moreover, local wisdom supports the sustainable management of coastal and marine resources in Tomini Bay (Obie, 2018).

Scientific data of Tomini Bay pelagic fish population dynamics are still minimal, making the level and utilization of the fish resources uncontrollable. Therefore, efforts to optimize fish resources to maximize the community's welfare around the bay area are still not optimal. Layang fish (*Decapterus russelli,* Ruppell 1830) that has a common name Scad (Sunaryo *et al*., 2019; Suwarso and Zamroni, 2015) or Indian Scad (Poojary *et al*., 2010; Chiesa *et al*., 2019) is one of the pelagic species of the Carangids group which is widely distributed including Tomini Bay as a part of Indo-Pacific region (Panda *et al.*, 2012), western Indian Ocean, and northern Arabian Sea (Kalhoro *et al*., 2017). Apart from having a substantial economic value (Khasanah *et al*., 2020) and being in demand

by the broader community due to its taste, the fish also contains protein (Cahyono and Mardani 2020; Fatma *et al*., 2020) to be consumed as a source of food nutrition. Layang fish diversification and processing (Tondais *et al*., 2020; Kurniawan *et al*., 2020b; Kurniawan *et al*., 2020a; Henra *et al*., 2020; Paparang, 2013) were also being developed in order to meet market demand for the commodity.

Lack of scientific data on layang fish resources in Tomini Bay is a challenge in determining and formulating the proper management direction by considering layang fish *D. russelli* as the target fish caught by fishers in Indonesian as in Tomini Bay (Lawadjo *et al.*, 2021), Malacca Strait (Alnanda *et al*., 2020), Makassar Strait (Cahyono and Mardani, 2020), and Ternate (Tangke, 2020). *D. russelli* is one of four species commonly caught by fishers from Ambon Island waters (Pattikawa et al., 2018) and those sampled from Java Sea has a main food of Ochrophyta phylum with the number of IP more than 72% (Bintoro et al., 2019b). In Tomini Bay, such information has not been reported. Therefore, comprehensive and up-to-date data on layang fish's condition in nature is needed to monitor these fish resources' availability and sustainability. This study aimed to determine length-weight relationships and the growth pattern of laying fish *D. russelli* in Tomini Bay. This study results can enrich the information on the resource conditions to support the sustainable management of layang fish in Tomini Bay.

Materials and Methods

Time, Location, and Sampling Technique

The sampling was conducted once per month at Gorontalo City Fish Landing Spot from April to June 2020. It was confirmed that the fishing ground was in Tomini Bay. Mini purse seines with a minimum mesh size of ¾ inch were fishermen's gears for catching layang fish in Tomini Bay. The number of 896 layang fish samples were collected randomly from the fisher's landing their catch to the landing site (Figure 1). The total length and body-weight data of the fish samples were quantified using a ruler (minimum accuracy = 1 mm) and a scale (minimum accuracy = 0.01 gram) separately. Furthermore, abdomen dissection was performed to determine sample sexuality.

Data Analysis

The relationship between total length and body weight of data samples were calculated and determined through the following equations (De Robertis and Williams, 2008):

$$W = a\,L^{b} \quad \text{..... (i)}$$

where: W = body weight (gram); L = total length (mm); a = constant value; b = growth parameter

A natural logarithmic transformation was applied to make a relationship linear as follow:

$$\ln W = \ln a + b \ln L \quad \text{.....(ii)}$$

The a and b length-weight relationship parameters and the coefficient of determination (R^2) were obtained through the least-squares regression. The slope b value was performed the growth dimension of width, length, and depth. The fish growth pattern was figured out by testing the value b from the equation through the t-test at the 95% confidence level (Steel *et al.*, 1993). If b = 3, growth has an isometric pattern; if b < 3, it has a negative allometric pattern; if b > 3, it has a positive allometric pattern (De Guzman and Rosario, 2020).

Result and Discussion

The length ranges of sample fish found in this study were 77-290 mm and 87-286 mm for males and females, respectively. The length range of *D. russelli* in Trincomalee District, Sri Lanka, from October 2019 to January 2020 ranged 110 - 225 mm (Anushika *et al*., 2020). The Indian scad's length caught by mini purse seine in the waters around Tasikagung Fishing Port of Rembang ranged from 102 to 185 mm (Khasanah *et al*., 2020). The total number and distribution frequency of *D. ruselli*

found during the three months of sampling varied based on the size of the total length and body weight (Figure 2). Among the three-time samplings, *D. russelli* in Tomini Bay mainly were found in the total length range of 77 - 98 mm for males and 121 - 142 for females.

The fish length-weight analysis is essential to monitor the stocks and fish's biological conditions to ease the implementation of fish sustainability and biodiversity management (Agista et al., 2019). The relationship model of total length and weight of male and female *D. russelli* based on monthly and combined data is shown in Figure 3. Additionally, the length-weight relationship data of the layang fish in Tasikagung Fishing Port of Rembang collected twice a month from January to April 2019 obtained an equation of $W = 0.0000546\ TL^{2.73}$ (Khasanah *et al*., 2020), in Probolinggo Regency, Indonesia during January to May 2017 was $W = 0.0049\ L^{3.2882}$ (Bintoro *et al*., 2019). In Mayangan Probolinggo, Indonesia, from December 2017 to April 2018, $W = 0.014\ L^{2.8513}$ (Bintoro *et al*., 2019).

The determination coefficient (R^2) that describes how well the model fits the data (Nakagawa et al., 2017) on the polynomial equation in this study is relatively high, above 95%. The R^2 value in this study is quite diverse when compared to several previous studies. In comparison, data of *D. russelli* caught by purse seine conducted from March to August 2014 in waters around Pemangkat Fisheries Port, West Kalimantan expressed by equation $W = 0.0093\ L^{3.1309}$ with $R^2 = 87.19$ % for male and $W=0.0094\ L^{3.1359}$ with $R^2 = 85.76$ % for female (Faizah and Sadiyah, 2020). In addition, the laying fish in Malaka Strait taken from April to September 2016 expressed the relationship of $W = 0{,}0057\ L^{3,2984}$ ($R^2 = 97.45$ %) for male and $W = 0{,}0079\ L^{3,183}$ ($R^2 = 98.25$ %) for female (Faizah and Sadiyah, 2020). From a fisheries biology perspective, the length and weight relationship of finfish is one of the corresponding information that needs to provide regarding fisheries resources management, Particularly in determining the selectivity of fishing gear; therefore, the only fish caught are of a catch-fit size (Bernas, 2016).

Many studies use data on the relationship between length and body weight of fish to predict the growth patterns. Fish might attain either isometric, negative allometric, or positive allometric growths. An isometric pattern is associated with no alteration of body shape as individual growth. Furthermore, a negative allometric indicates the fish becomes more slender as it increases in weight, while positive allometric growth denotes relatively deeper bodies or stouter since it increases in length (Riedel *et al*., 2007). All growth patterns of layang fish in this study performs positive allometric, unless for female in April 2020 (Table 1). A fish growth pattern is related to environmental conditions, linked to specific species morphological characteristic, and with no plausible explanation unless it might be related to stomach fullness (Jisr et al., 2018). In the present study, it is predicted that the gonadal development of *D. russelli* is in the spawning season. The spawning season of *D. russelli* in this study is just the same as in the waters of the Malacca Strait, which took place from April to October with a peak in October (Hariati et al., 2017). In that case, it is assumed that the female layang fish in Tomini Bay in April 2020 are still at the beginning of gonadic growth. Therefore, the body in April is relatively less plump than in the following months. The fish spawning season is influenced by environmental conditions (temperature, salinity, and climate) that benefit for fish spawning (Bintoro *et al*., 2019).

The growth pattern of Indian scad for males and females in the south of China Sea (Faizah and Sadiyah, 2020), and in Paiton, Probolinggo Regency from January 2017 to May 2017 *(Bintoro et al*., 2019) also revealed positive allometric. However, a negative allometric growth pattern was shown by layang fish *D. russelli* in Trincomalee District, Sri Lanka based on the data taken from October 2019 to January 2020 (Anushika *et al*., 2020) and in Mayangan Probolinggo, Indonesia, from December 2017 to April 2018 (Bintoro *et al*., 2019). The layang fish in Latuhalat waters, Ambon in June, July, and August 2016, showed that almost all the data had positive allometric growths except for males in August 2016, which showed an isometric growth pattern (Ongkers *et al*., 2016).

The variation in growth patterns is might be caused by differences in species, gonad maturity, spawning factors, food, sex, and age (Randongkir *et al*., 2018). Availability of supportive food and

aquatic habitat characteristics might influence the variation of fish growth patterns (Nugroho *et al.*, 2018) due to the food taken will affect the growth, maturity of each individual, and the successful life of the fish (Effendie, 2002).

Conclusion

The polynomial equation for the length and weight of layang scad fish *Decapterus russelli* is $0.000004\ L^{3.1972}$ ($R^2 = 97.57$ %) for male and $W = 0.0000007\ L^{3.0613}$ ($R^2 = 98.99$ %) for female. Based on sampling data during April, May, and June 2020, it can be presented that the growth of males and females in Tomini Bay has a positive allometric pattern, except the female pattern in April 2020. These values exhibited the biological and environmental factors experienced by the species. Although it needs data from more qualified time series data, these results generally reflected that species are in good biological and dwelling in optimal environmental conditions. It needs to be maintained or even improved to optimize the utilization of *D. russelli* in Tomini Bay.

References

Agista, L., Muhammadar, A.A., Chaliluddin, M.A., 2019. The relationship of length-weight and condition factors of layang fish (Decapterus russelli) landed at KUD Gabion of Oceanic Fishing Port, North Sumatra. In: IOP Conference Series: Earth and Environmental Science. Institute of Physics Publishing, p. 012084.

Alnanda, R., Setyobudiandi, I., Boer, M., 2020. Dinamila Populasi Ikan Layang (Decapterus russelli) di Perairan Selat Malaka. Manfish J. 1, 1–8.

Anushika, P., Herath, H., Dias, P., Gayathry, L., 2020. Some Aspects of the Population Characteristics of Selected Marine Fish Species (Ambligaster sirm, Hyporhamphus dussumieri, Decapterus russelli and Atule mate) in Trincomalee District. In: Proceedings of the International Research Conference of Uva Wellassa University. pp. 105–110.

Bintoro, G., Lelono, T., Rudianto, Utami, N., 2019a. Biological aspects of Indian Scad (Decapterus russelli Ruppell, 1830) in South Site of Madura Strait Waters, East Java. In: IOP Conference Series: Earth and Environmental Science 370. Institute of Physics Publishing, p. 012040.

Bintoro, G., Rudianto, Lenon, T.D., Harend, S., 2019b. Biological Aspect of Indian Scad (Decapterus russelli) Caught by Purse Seine in North Coast of Sumenep Waters, East Java. In: IOP Conference Series: Earth and Environmental Science 239. p. 012016.

Cahyono, E., Mardani, I., 2020. Identifikasi Asam Amino Ikan Layang (Decapterus russelli) pada Lokasi Penangkapan Berbeda. J. Pengolah. Pangan 5, 1–6.

Chiesa, S., Azzurro, E., Bernardi, G., 2019. The genetics and genomics of marine fish invasions: a global review. Rev. Fish Biol. Fish.

De Guzman, M.F., Rosario, G.R., 2020. Length-weight relationships of marine fishes caught by danish seine in Lingayen gulf. Int. J. Fish. Aquat. Stud. 8, 16–18.

De Robertis, A., Williams, K., 2008. Weight-Length Relationships in Fisheries Studies: The Standard Allometric Model Should Be Applied with Caution. Trans. Am. Fish. Soc. 137, 707–719.

Effendie, M.I., 2002. Biologi Perikanan. Yayasan Pustaka Nusatama, Yogyakarta.

Faizah, R., Sadiyah, L., 2020. Some biology aspects of Indian Scad (Decapterus russelli, Rupell, 1928) in Pemangkat Fisheries Port, West Kalimantan. In: IOP Conference Series: Earth and Environmental Science. Institute of Physics Publishing, p. 12063.

Fatma, N., Metusalach, Taslim, N.A., Nurilmala, M., 2020. The protein and albumin contents in some species of marine and brackishwater fish of South Sulawesi, Indonesia. Aquac. Aquarium, Conserv. Legis. Bioflux 13, 1976–1985.

Henra, H., Yusuf, N., Naiu, A.S., 2020. Karakteristik Mutu Hedonik Kerupuk Ubi Jalar Dan Rumput Laut (Kappaphycus alvarezii) Yang Difortifikasi dengan Ikan Layang (Decapterus russelli). Jambura Fish Process. J. 1, 35–45.

Jisr, N., Younes, G., Sukhn, C., El-Dakdouki, M.H., 2018. Length-weight relationships and relative condition factor of fish inhabiting the marine area of the Eastern Mediterranean city, Tripoli-

Lebanon. Egypt. J. Aquat. Res. 44, 299–305.
Kadim, M.K., Pasisingi, N., Alinti, E.R., Panigoro, C., 2022. Biodiversity and community assemblages of freshwater and marine macrozoobenthos in Gorontalo Waters , Indonesia. Bio 23, 637–647.
Kadim, M.K., Pasisingi, N., Arsad, S., 2019. Horizontal distribution of chlorophyll-α in the gorontalo bay. Nat. Environ. Pollut. Technol. 18.
Kadim, M.K., Pasisingi, N., Kasim, F., 2018. Spatial and temporal distribution of phytoplankton in the Gorontalo Bay, Indonesia. AACL Bioflux 11.
Kalhoro, M.T., Yongtong, M., Ali, K.M., Syed, S., Hussain, B., Mahmood, M.A., Muhammad, M., Ramesh, P.T., 2017. Stock Assessment of Indian Scad, Decapterus Russelli in Pakistani Marine Waters and Its Impact on the National Economy. Indian J. Geo Mar. Sci. 49, 1222–1228.
Khasanah, A.N., Saputra, S.W., Taufani, W.T., 2020. Population dynamic of indian scad (Decapterus russelli) based on data in tasikagung fishing Port of Rembang. In: IOP Conference Series: Earth and Environmental Science. IOP Publishing Ltd, p. 012004.
Kurniawan, A., Permadi, A., Purnomo, A.H., 2020a. Optimum Proportion of Indian Scad (Decapterus russelli) Protein Concentrate in Traditional Food Cake Designated for Undernourished Children Diet. Russ. J. Agric. Socio-Economic Sci. 99, 170–183.
Kurniawan, A., Permadi, A., Purnomo, A.H., 2020b. Children's Responses to the Addition of Indian Scad (Decapterus russelli) Fish Protein Concentrated and Flavor to Traditional Food. J. Airaha 9, 096–104.
Lawadjo, F.W., Tuli, M., Pasisingi, N., 2021. Length-Weight Relationship and Condition Factor of Layang Fish (Decapterus russelli) Landed at Tenda Fish Landing Base, Gorontalo. J. Pengelolaan Perikan. Trop. (Journal Trop. Fish. Manag. 5, 44–51.
Mardlijah, S., Patria, M.P., 2016. Biologi Reproduksi Ikan Madidihang (Thunnus albacares Bonnatere 1788) di Teluk Tomini. BAWAL Widya Ris. Perikan. Tangkap 4, 27–34.
Miller, M.J., Wouthuyzen, S., Sugeha, H.Y., Kuroki, M., Tawa, A., Watanabe, S., Syahailatua, A., Suharti, S., Tantu, F.Y., Otake, T., Tsukamoto, K., Aoyama, J., 2016. High biodiversity of leptocephali in Tomini Bay Indonesia in the center of the Coral Triangle. Reg. Stud. Mar. Sci. 8, 99–113.
Mustika, P.L.K., Wonneberger, E., Erzini, K., Pasisingi, N., 2021. Marine megafauna bycatch in artisanal fisheries in Gorontalo, northern Sulawesi (Indonesia): An assessment based on fisher interviews. In: Ocean and Coastal Management. Elsevier Ltd, p. 105606.
Nakagawa, S., Johnson, P.C.D., Schielzeth, H., 2017. The coefficient of determination R^2 and intra-class correlation coefficient from generalized linear mixed-effects models revisited and expanded. J. R. Soc. Interface 14, 20170213.
Nugroho, S.C., Jatmiko, I., Wujdi, A., 2018. Pola pertumbuhan dan faktor kondisi madidihang, Thunnus albacares (Bonnaterre, 1788) di Samudra Hindia Bagian Timur. J. Iktiologi Indones. 18, 13–21.
Obie, M., 2018. Exploitation of coastal and marine resources along Tomini Bay: Livelihood base versus concession rights Eksploitasi sumber daya pesisir dan laut di Teluk Tomini: Basis mata pencaharian versus konsesi. Masyarakat, Kebud. dan Polit. 31, 36–45.
Olii, A.H., Sahami, F.M., Hamzah, S.N., Pasisingi, N., 2017. Preliminary findings on distribution pattern of larvae of nike fish (Awaous sp.) in the estuary of Bone River, Gorontalo Province, Indonesia. AACL Bioflux 10, 1110–1118.
Olii, A.H., Sahami, F.M., Hamzah, S.N., Pasisingi, N., 2019. Molecular approach to identify gobioid fishes, "nike" and "hundala" (Local name), from gorontalo waters, Indonesia. Online J. Biol. Sci. 19, 51–56.
Ongkers, O.T.., Pattikawa, J.A., Rijoly, F., 2016. Aspek Biologi Ikan Layang (Decapterus russelli) di Perairan Latuhalat, Kecamatan Nusaniwe, Pulau Ambon. Omni-Akuatika 12, 79–87.
Panda, D., Chakraborty A. K., Jaiswar A. K., Sharma A. P., Jha B. C., Sawant B. T., Bhagabati S. K., Kumar Tarkeshwar, 2012. Fishery and population dynamics of two species of carangids, Decapterus russelli (Ruppell, 1830) and Megalaspis cordyla (Linnaeus, 1758) from Mumbai waters. Indian J. Fish. 59, 53–60.
Paparang, R.W., 2013. Studi Pengaruh Variasi Konsentrasi Garam Terhadap Citarasa Peda Ikan Layang (Decapterus russelli). Media Teknol. Has. Perikan. 1, 17–20.

Pasisingi, N., Abdullah, S., 2018. Pola kemunculan ikan nike (Gobiidae) di Perairan Teluk Gorontalo, Indonesia. DEPIK J. Ilmu-Ilmu Perairan, Pesisir dan Perikan. 7, 111–118.
Pasisingi, N., Habibie, S.A., Olii, A.H., 2020a. Are awaous ocellaris and belobranchus belobranchus the two species of nike fish schools ? Aceh J. Anim. Sci. 5, 87–91.
Pasisingi, Nuralim, Kasim, F., Moo, Z.A., 2021a. Estimation of Fishing Mortality Rate and Exploitation Status of Yellowstrip Scad (Selaroides leptolepis) in Tomini Bay using Von Bertalanffy Growth Model Approach. J. Ilm. Perikan. Dan Kelaut. 13, 288–296.
Pasisingi, N., Katili, V.R.A., Mardin, H., Ibrahim, P.S., 2021. Variation in morphometric characteristics of nike fish (Amphidromous goby larva) in leato waters, gorontalo bay, Indonesia. AACL Bioflux 14.
Pasisingi, N., Olii, A.H., Habibie, S.A., 2020b. Morphology and growth pattern of Nike fish (amphidromous goby larvae) in Gorontalo Waters, Indonesia. Tomini J. Aquat. Sci. 1, 1–7.
Pasisingi, Nuralim, Pramesthy, T.D., Musyali, A., 2021b. Length-weight relationships and sex ratio of Selaroides leptolepis , Cuvier Length-weight relationships and sex ratio of Selaroides leptolepis , Cuvier 1833 in Tomini Bay , Indonesia. In: IOP Conference Series: Earth and Environmental Science 744 012052.
Pasisingi, N., Sapira Ibrahim, P., Arsalam Moo, Z., Tuli, M., 2020c. Reproductive Biology of Oci Fish Selaroides leptolepis in Tomini Bay. J. Mar. Res. 9, 407–415.
Pattikawa, Jesaja Ajub, Tetelepta, J.M.S., Pattikawa, Jesaja A, Uneputty, P., Ongkers, O., Tetelepta, J., Amirudin, A., 2018. Coastal zone management View project International Journal of Fisheries and Aquatic Studies 2018; 6(4): 171-175 Some biological aspects of mackerel scad (Decapterus macarellus) in Ambon Island waters, Indonesia. Int. J. Fish. Aquat. Stud. 6, 171–175.
Poojary, N., Tiwari, L., Jaiswar, A., 2010. Food and feeding habits of the Indian scad, Decapterus russelli (Ruppell, 1830) from Mumbai waters, north-west coast of India. Indian J. Fish. 57, 93–99.
Randongkir, Y.E., Simatauw, F., Handayani, T., 2018. Growth Aspects of Scad Decapterus macrosoma on Fish Point Sanggeng-Manokwari Regency. J. Sumberd. Akuatik Indopasifik 2.
Riedel, R., Caskey, L.M., Hurlbert, S.H., 2007. Length-weight relations and growth rates of dominant fishes of the Salton Sea: Implications for predation by fish-eating birds. Lake Reserv. Manag. 23, 528–535.
Siti Masreah Bernas, 2016. Hubungan Panjang-Berat dan Pola Pertumbuhan Ikan di Muara Sungai Musi Kabupaten Banyuasin Sumatera Selatan. Maspari J. 8, 111–118.
Steel, R.G.D., Sumantri, B., Torrie, J.H., 1993. Prinsip dan prosedur statistika : suatu pendekatan biometrik, 2nd ed. Gramedia Pustaka Utama, Jakarta.
Sunaryo, Syahrihaddin, A., Imfianto, P.S., 2019. Solar Energy for a Traditional Coastal Fishing Platform. J. Mar. Sci. Appl. 18, 366–371.
Suwarso, S., Zamroni, A., 2015. Analisis Struktur Populasi Tiga Species Layang (Decapterus spp.) di Laut Jawa dan Sekitar Sulawesi: Saran Pengelolaan Berkelanjutan Ikan Pelagis Kecil dan Evaluasi WPP. J. Kebijak. Perikan. Indones. 6, 75.
Tangke, U., 2020. Produksi dan Nilai Jual Ikan Pelagis Dominan di TPI Higienis Pelabuhan Perikanan Nusantara Ternate. Agrikan J. Agribisnis Perikan. 13, 108.
Tondais, J., Sombo, D.E., Lalenoh, B.A., Mappiratu, M., Adrian, A., Cahyono, E., 2020. Ekstraksi Flavour dari Tepung Ikan Layang (Decapterus sp.) Menggunakan Enzim Protease Biduri (Calotropis gigantea). J. FishtecH 9, 6–12.

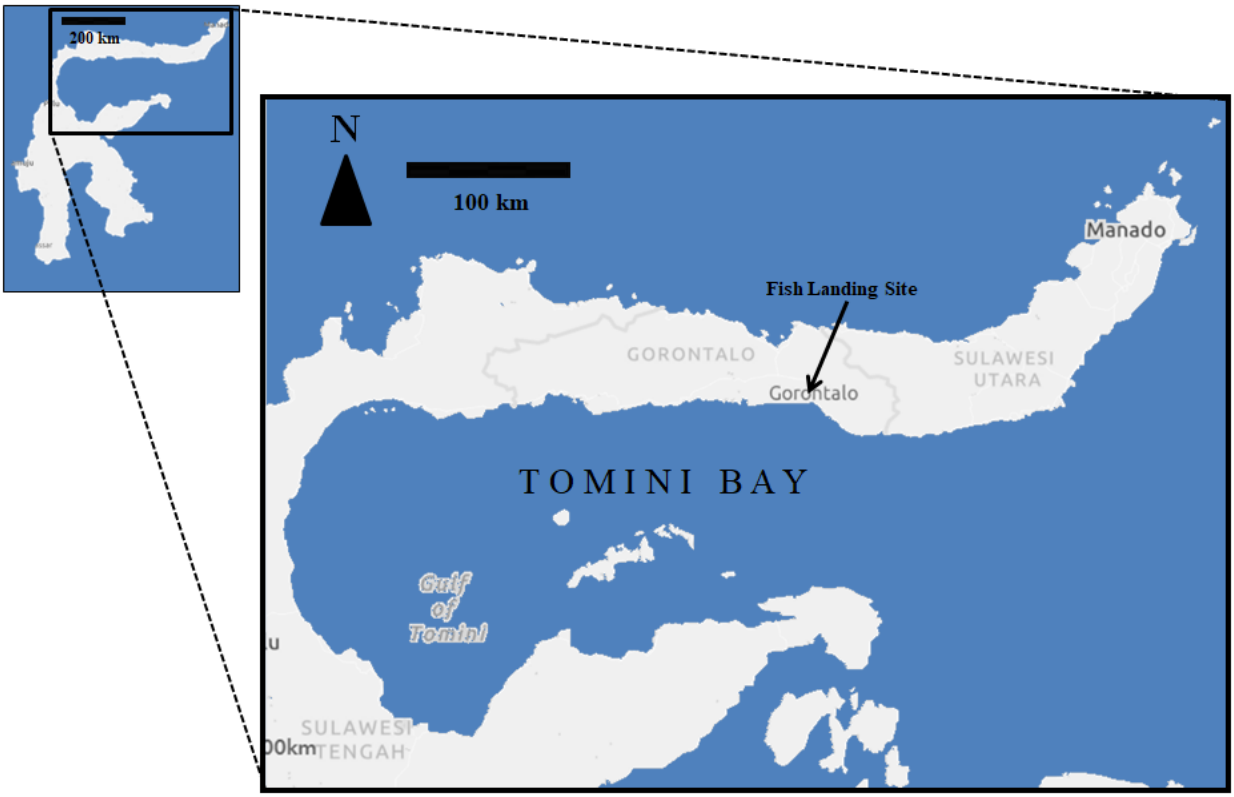
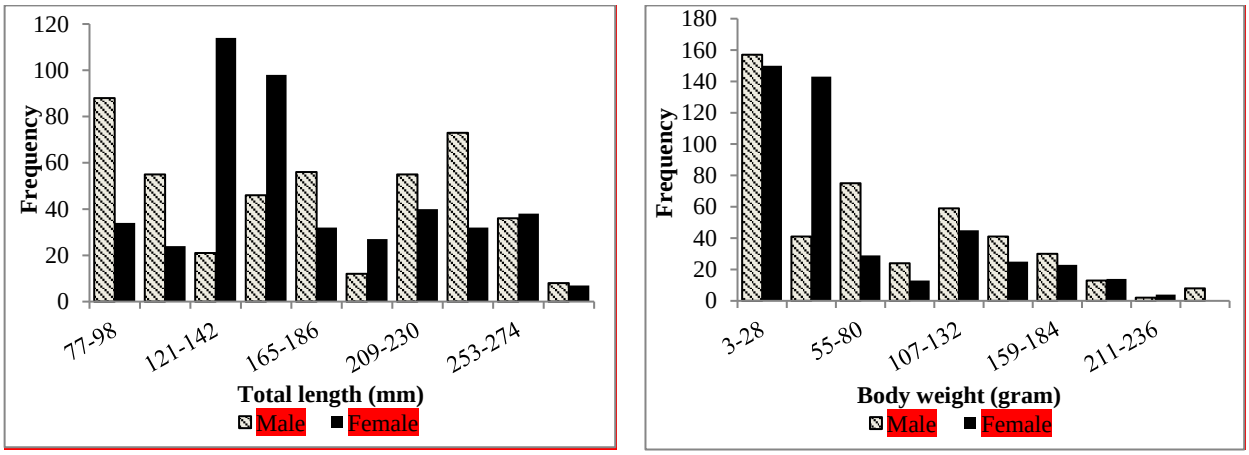


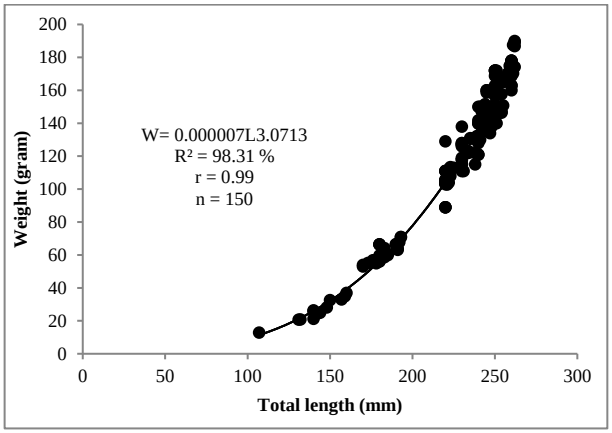
Figure 1. Fishing Area and Gorontalo Fish Landing Site of Layang Fish *Decapterus russelli*



(a) **(b)**

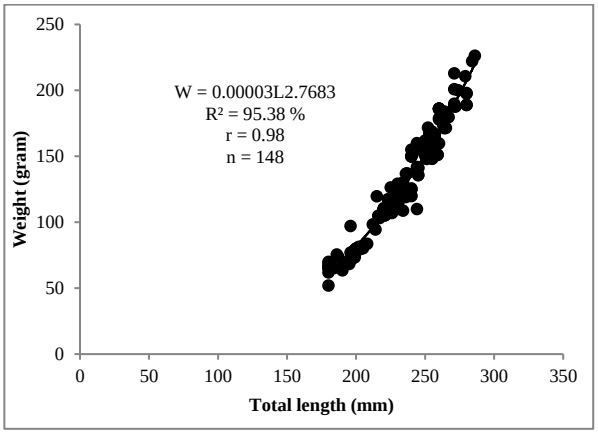
Figure 2. Frequency distribution of *Decapterus russelli* in Tomini Bay based on (a) total length and (b) body weight

Male

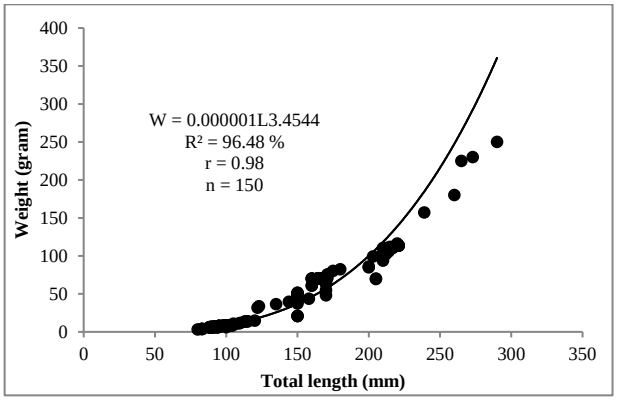


April 2020

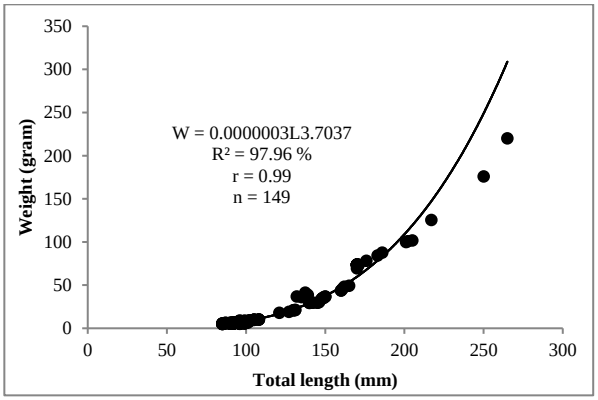
Female



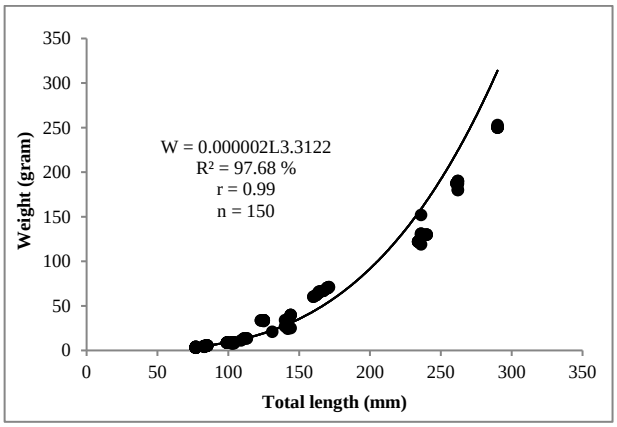
April 2020



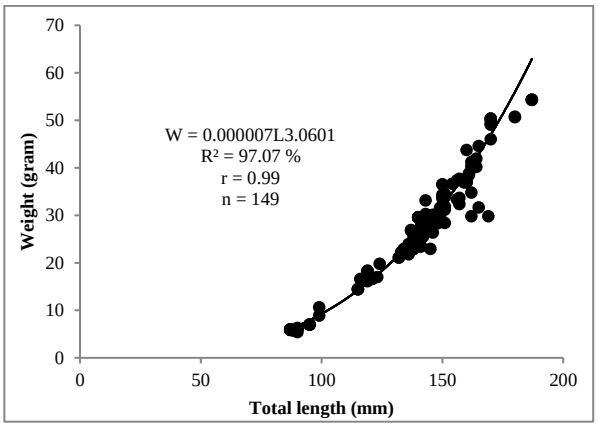
May 2020



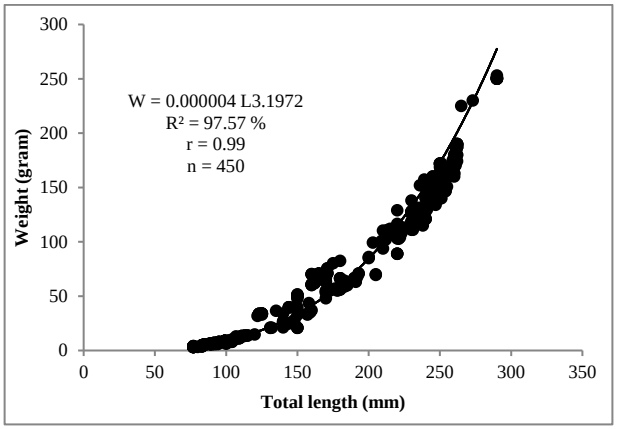
May 2020



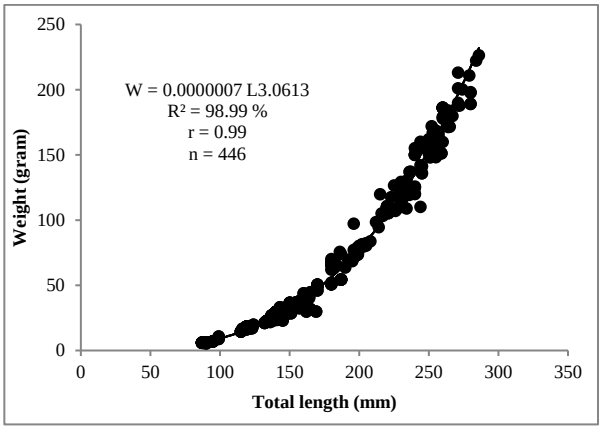
June 2020



June 2020



Combined



Combined

Figure 3. Length Weight Relations of *Decapterus russelli* in Tomini Bay

Table 1. Linear relation of length-weight data and growth patterns of *D. russelli* in Tomini Bay

Sampling periods	Male		Female	
	Length-Weight linear relationships	**Growth pattern**	**Length-Weight linear relationships**	**Growth pattern**
April 2020	ln W = -11.9189 + 3.0713 ln L	postive allometric	ln W = -10.264 + 2.7683 ln L	negative allomteric
May 2020	ln W = -13.6983 + 3.4544 ln L	postive allometric	ln W = -14.9327 + 3.7037 Ln L	postive allometric
June 2020	ln W = -13.0305 + 3.3122 ln L	postive allometric	ln W = -11.8668 - 3.0602 ln L	postive allometric
Total	ln W = -12.5017 + 3.1972 ln L	postive allometric	ln W = -11.8687 + 3.0613 ln L	postive allometric

(p value < 0.05)

NASKAH SETELAH PROOFREAD

Universitas Negeri Gorontalo
UNGmail

Abdul Hafidz Olii <oliihafidz@ung.ac.id>

[IK.IJMS] Proof Layout - 44452

2 messages

Ilmu Kelautan <ijms.undip@gmail.com> Sun, Jun 19, 2022 at 9:43 AM
To: Nuralim Pasisingi <nuralim@ung.ac.id>
Cc: Abdul Hafidz Olii <oliihafidz@ung.ac.id>, Elena Wonneberger <E.Wonneberger@gmx.de>

Dear
Nuralim Pasisingi, Abdul Hafidz Olii, Elena Wonneberger

Please read carefully your manuscript in the attachment of this email. Utilize the file contained in this email attachment to make necessary corrections to the manuscript.

Send the cost of publication (Rp. 2.500.000,-) to Widianingsih
Bank : Bank Nasional Indonesia (BNI)
Branch : UNDIP Semarang, Indonesia
Account No : 0162816376

Manuscripts revise and proof of payment are sent before June 23, 2022 to publish manuscript in June 2022.

Thank you for your contribution to this journal.

Sincerely
IJMS Editor

10 44452-139905-2-ED proof.docx
261K

Abdul Hafidz Olii <oliihafidz@ung.ac.id> To: Ilmu Kelautan <ijms.undip@gmail.com> Thu, Jun 23, 2022 at 5:39 AM
Cc: Nuralim Pasisingi <nuralim@ung.ac.id>, Elena Wonneberger <E.Wonneberger@gmx.de>

Dear Editorial Team,

Here I sent you our manuscript revision and the receipt of payment.
Thank you very much.

Regards,
Abdul Hafidz Olii
Lecturer | Aquatic Resources Management Department |
Gorontalo State University, Indonesia| +62 811-4319-531
facebook icon linkedin icon twitter icon
instagram icon

[Quoted text hidden]

2 attachments

proof of payment - Olii et al 2022.jpeg
73K

10 44452-139905-2-ED proof_EW.docx
266K

Abdul Hafidz Olii <oliihafidz@ung.ac.id>

[IK.IJMS] [44452] Article Publication of IK.IJMS-2022-44452

1 message

Indonesian Journal of Marine Science <ijms.undip@gmail.com> Fri, Jun 24, 2022 at 9:01 AM
Reply-To: Indonesian Journal of Marine Science <ijms.undip@gmail.com>
To: "Nuralim Pasisingi" <nuralim@ung.ac.id>
Cc: Abdul Hafidz Olii <oliihafidz@ung.ac.id>, Elena Wonneberger <E.Wonneberger@gmx.de>

Dear Abdul Hafidz Olii, Elena Wonneberger, Nuralim Pasisingi

As author(s) of the article entitled "Growth Performance of Layang (Scad) Fish (Decapterus russelli, Ruppell 1830) Caught from Tomini Bay, Indonesia", we are pleased to let you know that the final open access version, containing full bibliographic details, is now available online.

The URL below is a quick and easy way to share your work with colleagues, other co-authors, and friends. Anyone clicking on the link will be taken directly to the final version of your article on the ILMU KELAUTAN: Indonesian Journal of Marine Sciences website (https://ejournal.undip.ac.id/index.php/ijms).

Your article link: https://ejournal.undip.ac.id/index.php/ijms/article/view/44452
DOI: 10.14710/ik.ijms.27.2.181-188

You can also use this link to download a copy of the article for your own archive. It also provides a quick and easy way to share your work with colleagues, co-authors, and friends. And you are welcome to add it to your homepage or social media profiles, such as Facebook, Google+, and Twitter.

Kind regards,

Indonesian Journal of Marine Science
ijms.undip@gmail.com

Growth Performance of Layang (Scad) Fish (*Decapterus russelli,* Ruppell 1830) Caught from Tomini Bay, Indonesia

Abdul Hafidz Olii[1], Elena Wonneberger[2], Nuralim Pasisingi[1]*

[1]*Aquatic Resources Management Study Programme, Faculty of Fisheries and Marine Science, Gorontalo State University*
Jl. Jenderal Sudirman No. 6, Gorontalo City, Gorontalo Province, 96128, Indonesia
[2]*Centre of Marine Sciences (CCMAR), Universidade do Algarve, 8005-139, Faro, Portugal*
Email: nuralim@ung.ac.id

Abstract

Regarding exploitation and optimizing fisheries resources management in Tomini Bay, the Layang ~~r~~ scad fish (Decapterus russelli, Ruppell 1830) is one of the small pelagic fishes inhabiting the bay that still ~~has~~ lacks biological information. The species becomes the main target commodity for local fishers as it is commonly consumed as a protein source for coastal communities. This study aimed to determine the length-weight relationships and the growth pattern of Layang fish caught by fishers from Tomini Bay. The samples were collected once per month at Gorontalo City Fish Landing Spot from April to June 2020. Tomini Bay was confirmed as the fishing ground of all the landed fish. Layang is caught by Mini purse seines with a minimum mesh size of ¾ inch. A ~~T~~total ~~samples~~ of 896 samples of Layang fish were collected randomly from the fishers' catch during their unloading activity at the landing site. Abdomen dissection was performed on all samples for determining the fish's sex~~uality~~. The fish samples' total length and body weight were measured using a ruler (nearest = 1 mm) and a scale (nearest = 0.01 gram). The result revealed that the length-weight equation of male Layang was $W = 0.000004\ L^{3.1972}$ (R^2 = 97.57%), and that of female was $W = 0.0000007\ L^{3.0613}$ (R^2 = 98.99%). This result implied a positive allometric growth pattern, excluding the females in April 2020.

Keywords: *Gorontalo; scad; length-weight relationship*

Introduction

Tomini Bay forms a semi-enclosed water area (Miller *et al*., 2016) that is fertile (Kadim *et al*., 2019) with high marine biodiversity supported by the availability of phytoplankton (Kadim *et al*., 2018) as primary food sources. Diverse species of marine mammals also inhabit the bay (Mustika *et al*., 2021), various pelagic fishes (Mardlijah and Patria, 2016; Pasisingi *et al*., 2020a; 2020b; 2021a; 2021b), small amphidromous fishes (Olii *et al*., 2017; Pasisingi and Abdullah, 2018; Olii *et al*., 2019; Pasisingi *et al*., 2021c; 2020b; 2020c), as well as macrozoobenthos (Kadim *et al*., 2022). Moreover, local wisdom supports the sustainable management of coastal and marine resources in Tomini Bay (Obie, 2018).

Scientific data of Tomini Bay pelagic fish population dynamics are still minimal, making the level and utilization of the fish resources uncontrollable. Therefore, efforts to optimize fish resources to maximize the community's welfare around the bay area are still not optimal. Layang fish (*Decapterus russelli,* Ruppell 1830) that has ~~a~~ the common name Scad (Sunaryo *et al*., 2019; Suwarso and Zamroni, 2015) or Indian Scad (Poojary *et al*., 2010; Chiesa *et al*., 2019) is one of the pelagic species of the Carangids group which is widely distributed including Tomini Bay as a part of the Indo-Pacific region (Panda *et al*., 2012), western Indian Ocean, and northern Arabian Sea (Kalhoro *et al*., 2017). Apart from having a substantial economic value (Khasanah *et al*., 2020) and being in demand by the broader community due to its taste, the fish also contains protein (Cahyono and Mardani, 2020; Fatma *et al*., 2020) to be consumed as a source of food nutrition. ~~D~~Diversification of Layang fish's ~~diversification~~ products and processing (Tondais *et al*., 2020; Kurniawan *et al*., 2020a; 2020b; Henra *et al*., 2020; Paparang, 2013) were also being developed in order to meet market demand for the commodity.

The lack of scientific data on Layang fish resources in Tomini Bay is a challenge in determining and formulating the proper management direction by considering Layang fish *D. russelli* as the target fish caught by fishers in Indonesia~~n~~ as in Tomini Bay (Lawadjo *et al*., 2021), Malacca Strait (Alnanda *et al*., 2020), Makassar Strait (Cahyono and Mardani, 2020)~~,~~ and Ternate (Tangke, 2020). *D. russelli* is also one of four species commonly caught by fishers from Ambon Island waters (Pattikawa *et al*., 2018). In Tomini Bay, such information has not been reported. Therefore, comprehensive and up-to-date data on Layang fish's condition in nature is needed to monitor

their availability and sustainability. This study aimed to determine length-weight relationships and the growth pattern of Layang fish *D. russelli* in Tomini Bay.

Materials and Methods

Time, location, and sampling technique

The sampling was conducted once a month at Gorontalo City Fish Landing from April to June 2020. It was confirmed that the fishing ground was in Tomini Bay. Mini purse seines with a minimum mesh size of ¾ inch were used to catch the Layang fish in Tomini Bay. 896 Layang fish samples were collected randomly from the fisher's catch at the landing site (Figure 1.). The total length and weight of the samples were measured using a ruler (minimum accuracy = 1 mm) and a scale (minimum accuracy = 0.01 g). The abdomen dissection was performed to determine sample sexuality.

Data analysis

The relationship between total length and body weight of the samples were was calculated and determined through the following equations (De Robertis and Williams, 2008):

$$W = a\ L^b$$

where: W = body weight (gram); L = total length (mm); a = constant value; b = growth parameter

A natural logarithmic transformation was applied to make a relationship linear as follow:

$$\ln W = \ln a + b \ln L$$

The a and b length-weight relationship parameters and the coefficient of determination (R^2) were obtained through the least-squares regression. The slope b value was performed the growth dimension of width, length, and body depth. The fish growth pattern was figured out by testing the value b from the equation through the t-test at the 95% confidence level (Steel *et al.*, 1993). If b = 3, growth has an isometric pattern; b < 3, it has a negative allometric pattern; b > 3, it has a positive allometric pattern (De Guzman and Rosario, 2020).

Result and Discussion

The length ranges of samples found in this study were 77-290 mm and 87-286 mm for males and females fish, respectively. For comparison, the length range of *D. russelli* in Trincomalee District, Sri Lanka, from October 2019 to January 2020 ranged from 110 –to 225 mm (Anushika *et al.*, 2020), while the Indian scad's length caught by mini purse seine in the waters around Tasikagung Fishing Port of Rembang ranged from 102 to 185 mm (Khasanah *et al.*, 2020). The total number and distribution frequency of the total length and body weight of *D. russelli* found during the three months of sampling varied (Figure 2.). Among the three-time samplings, the total length range of 77 - 98 mm for males and 121 - 142 mm for females were commonly found.

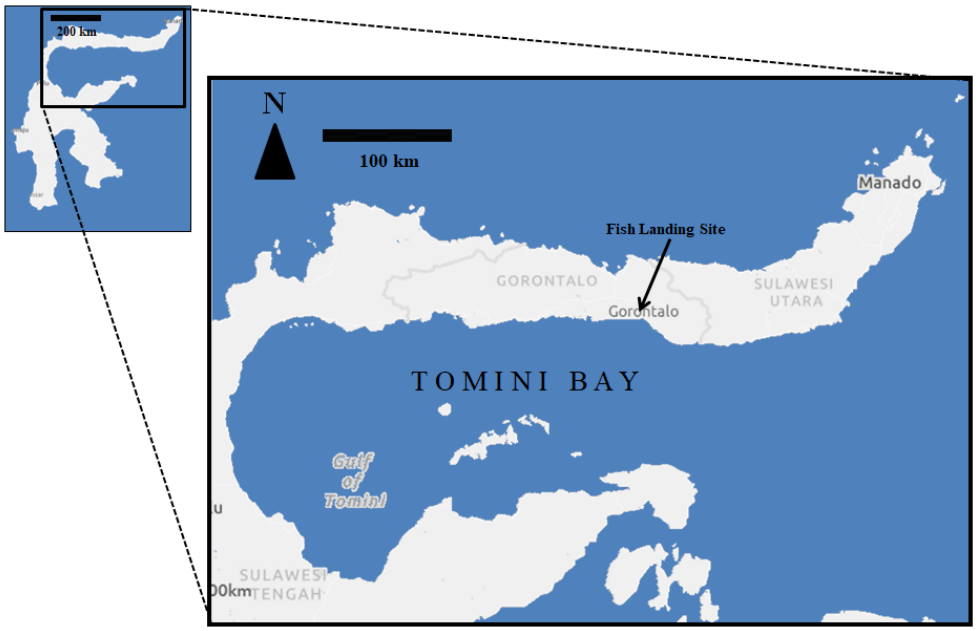


Figure 1. Fishing Area and Gorontalo Fish Landing Site of Layang Fish *Decapterus russelli*

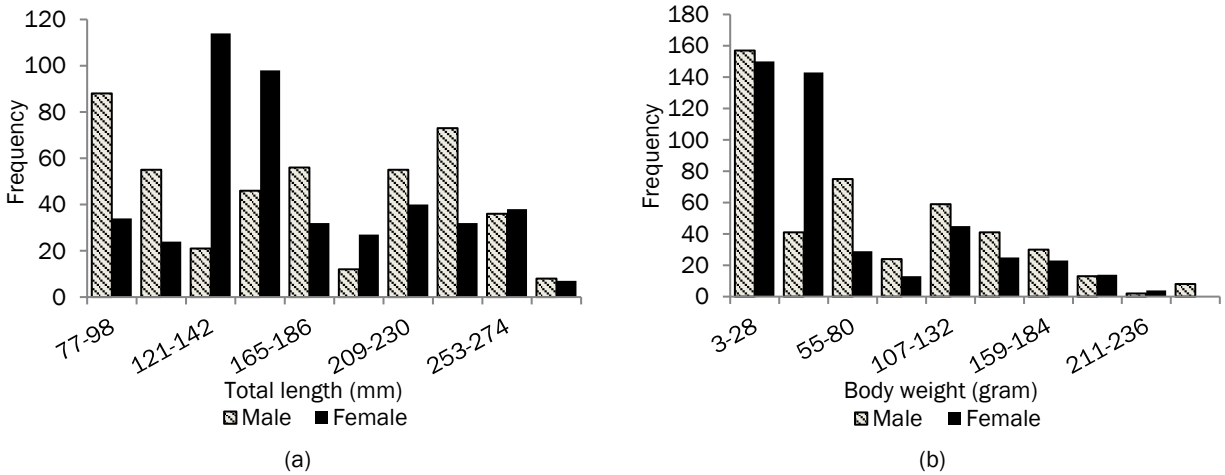


Figure 2. Frequency distribution of *Decapterus russelli* in Tomini Bay based on (a) total length and (b) body weight

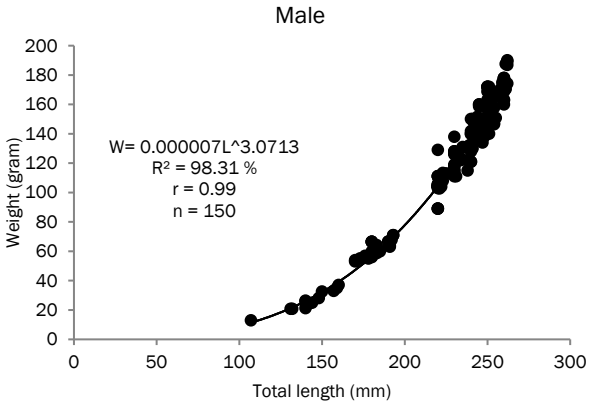
The fish length-weight analysis is essential to monitor their stocks and biological conditions to ease the implementation of fish sustainability and biodiversity management (Agista *et al.*, 2019). The relationship of total length and weight of male and female *D. russelli* based on monthly and combined data are shown in Figure 3. Khasanah *et al*. (2020) found that the length-weight relationship of the Layang fish in Tasikagung Fishing Port of Rembang from January to April 2019 was W = 0.0000546 $TL^{2.73}$, while in Probolinggo Regency, Indonesia during January to May 2017 it was W = 0.0049 $L^{3.2882}$ (Bintoro *et al*., 2019). In Mayangan Probolinggo, Indonesia, from December 2017 to April 2018, W = 0.014 $L^{2.8513}$ (Bintoro *et al*., 2019).

The determination coefficient (R^2) that describes how well the model fits the data (Nakagawa et al., 2017) on the polynomial equation in this study is relatively high, above 95%. The R^2 value in this study is quite diverse when compared to several previous studies. In comparison, the *D. russelli* caught by purse seine ~~conducted~~ from March to August 2014 in the waters around Pemangkat Fisheries Port, West Kalimantan was W = 0.0093 $L^{3.1309}$ with R^2 = 87.19 % for males and W=0.0094 $L^{3.1359}$ with R^2 = 85.76 % for females (Faizah and Sadiyah, 2020). In addition, the Layang fish in Malaka Strait taken from April to September 2016 had W = 0,0057 $L^{3,2984}$ (R^2 = 97.45 %) for males and W = 0,0079 $L^{3,183}$ (R^2 = 98.25 %) for females (Faizah and Sadiyah, 2020). From the fisheries biology perspective, the length and weight relationship of the fish are important information that need to provide for fisheries resources management (Bernas, 2016).

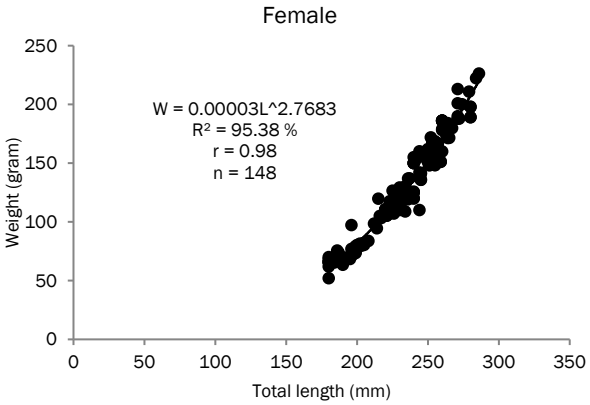
Many studies use length and body weight relationship data to predict the growth patterns of fish. Fish might attain either isometric, negative allometric, or positive allometric growths. An isometric pattern is associated with no alteration of body shape as individual growth. Furthermore, a negative allometric indicates the fish becomes more slender as it increases in weight, while positive allometric growth denotes relatively deeper ~~bodies~~ or stouter bodies since it increases in length (Riedel *et al*., 2007). All growth patterns of Layang fish in this study performs positive allometric, unless for females in April 2020 (Table 1.). The fish growth pattern is related to environmental conditions, linked to specific species morphological characteristics, and with no plausible explanation unless it might be related to stomach fullness (Jisr *et al*., 2018). In the present study, it is predicted that the gonadal development of *D. russelli* is in the spawning season. The spawning season of *D. russelli* in this study is the same as in the Malacca Strait waters in which happen from April to October with a peak in October (Hariati *et al*., 2017). In that case, it is assumed that the female Layang fish in Tomini Bay in April 2020 are still at the beginning of gonadic growth. Therefore, the body in April is relatively less plump than in the following months. The fish spawning season is influenced by environmental conditions (temperature, salinity, and climate) that benefit for fish spawning (Bintoro *et al*., 2019).

The growth pattern of Indian scad for males and females in the south of China Sea (Faizah and Sadiyah, 2020), ~~and~~ in Paiton, Probolinggo Regency from January 2017 to May 2017 *(Bintoro et al*., 2019) and in Inengo, Gorontalo from February 2021 to March 2021 (Pasisingi *et al*., 2021d) also revealed positive allometric. However, a negative allometric growth pattern was shown by *D. russelli* in Trincomalee District, Sri Lanka during October 2019 to January 2020 (Anushika *et al*., 2020) and from December 2017 to April 2018 in Mayangan Probolinggo, Indonesia (Bintoro *et al*., 2019). The

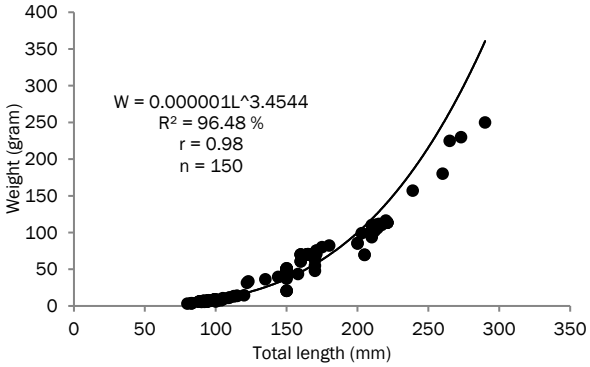
Layang fish in Latuhalat waters, Ambon in June-August 2016 showed positive allometric



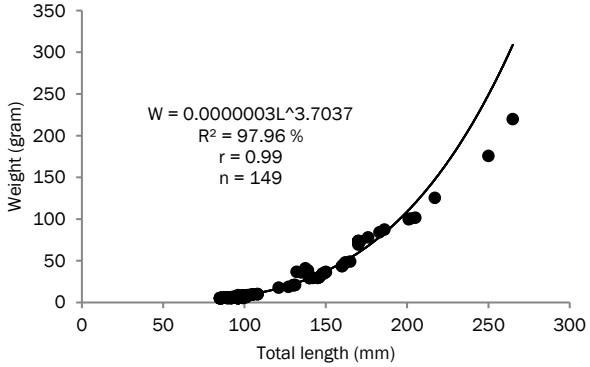
April 2020



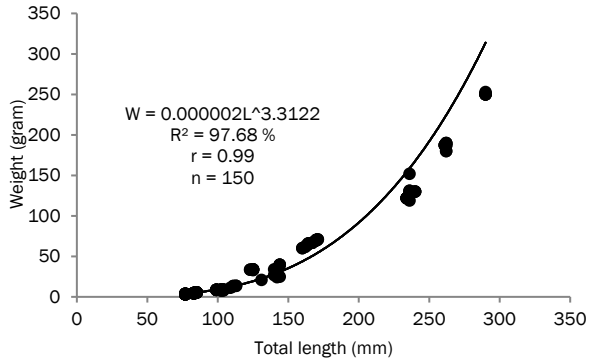
April 2020



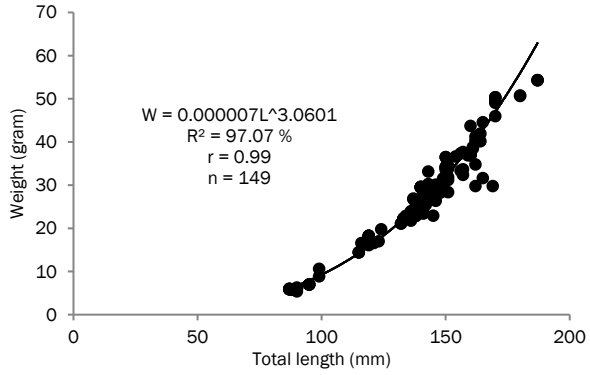
May 2020



May 2020



June 2020



June 2020

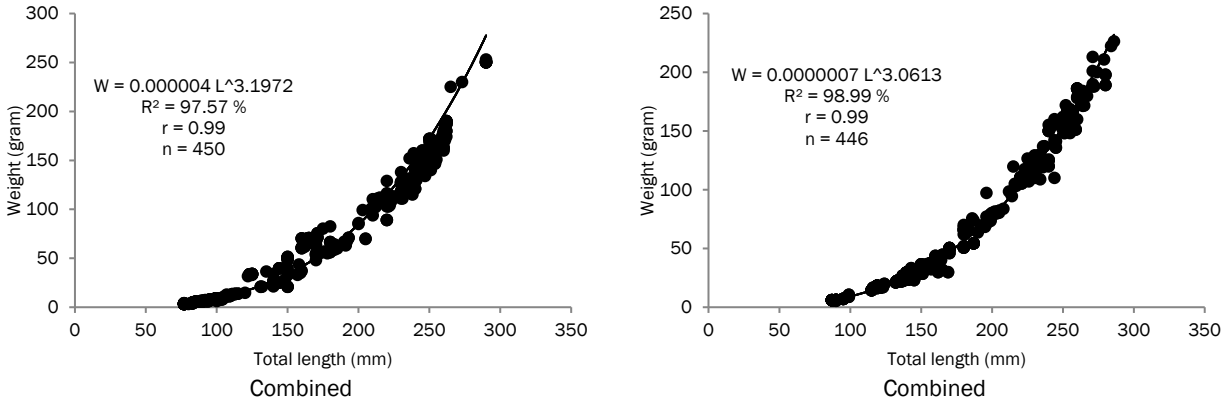


Figure 3. Length-Weight Relations of *Decapterus russelli* in Tomini Bay

Table 1. Linear relation of length-weight data and growth patterns of *D. russelli* in Tomini Bay

Sampling periods	Male		Female	
	Length-Weight linear relationships	Growth pattern	Length-Weight linear relationships	Growth pattern
April 2020	ln W = -11.9189 + 3.0713 ln L	postive allometric	ln W = -10.264 + 2.7683 ln L	negative ~~allomteric~~allometric
May 2020	ln W = -13.6983 + 3.4544 ln L	postive allometric	ln W = -14.9327 + 3.7037 Ln L	postive allometric
June 2020	ln W = -13.0305 + 3.3122 ln L	postive allometric	ln W = -11.8668 - 3.0602 ln L	postive allometric
Total	ln W = -12.5017 + 3.1972 ln L	postive allometric	ln W = -11.8687 + 3.0613 ln L	postive allometric

(p value < 0.05)

growths except for males of August 2016, which showed an isometric growth pattern (Ongkers *et al*., 2016).

The variation in growth patterns ~~is~~ might be caused by differences in species, gonad maturity, spawning factors, food, sex, and age (Randongkir *et al*., 2018). Availability of supportive food and aquatic habitat characteristics might influence the variation of fish growth patterns (Nugroho *et al*., 2018) ~~due to~~as the food taken will affect the growth, maturity of each individual~~,~~ and the successful life of the fish (Effendie, 2002).

Conclusion

The polynomial equation for the length and weight of Layang scad fish *Decapterus russelli* is 0.000004 $L^{3.1972}$ (R^2 = 97.57 %) for male and W = 0.0000007 $L^{3.0613}$ (R^2 = 98.99 %) for female. The growth of male and female Scad fish in Tomini Bay has a positive allometric pattern, except the female pattern in April 2020. These values exhibited the biological and environmental factors experienced by the species. Although it needs more qualified time series data, these results generally reflected that species are in good biological and optimal environmental conditions. It needs to be maintained or even improved to optimize the utilization of *D. russelli* in Tomini Bay.

References

Agista, L., Muhammadar, A.A. & Chaliluddin, M.A., 2019. The relationship of length-weight and condition factors of Layang fish (*Decapterus russelli*) landed at KUD Gabion of Oceanic Fishing Port, North Sumatra. *IOP Conf. Ser. Earth Environ. Sci.* p. 012084. https://doi.org/10.1088/1755-1315/348/1/012084

Alnanda, R., Setyobudiandi, I. & Boer, M., 2020. Dinamila Populasi Ikan Layang (*Decapterus russelli*) di Perairan Selat Malaka. *Manfish J.*, 1: 1–8.

Anushika, P., Herath, H., Dias, P. & Gayathry, L., 2020. Some Aspects of the Population Characteristics of Selected Marine Fish Species (*Ambligaster sirm, Hyporhamphus dussumieri, Decapterus russelli* and *Atule mate*) in Trincomalee District. Proc. Int. Res. Conf. Uva Wellassa University. pp. 105–110.

Bintoro, G., Lelono, T., Rudianto. & Utami, N., 2019a. Biological aspects of Indian Scad (*Decapterus russelli* Ruppell, 1830) in South Site of Madura Strait Waters, East Java. *IOP Conf. Ser. Earth Environ. Sci.* 370. Institute of Physics Publishing, p. 012040. https://doi.org/10.1088/1755-1315/370/1/012040

Bintoro, G., Rudianto, Lenon, T.D. & Harend, S., 2019b. Biological Aspect of Indian Scad (*Decapterus russelli*) Caught by Purse Seine in North Coast of Sumenep Waters, East Java. In: *IOP Conf. Ser. Earth Environ. Sci.* 239. p. 012016. https://doi.org/10.1088/1755-1315/239/1/012016

Cahyono, E. & Mardani, I. 2020. Identifikasi Asam Amino Ikan Layang (*Decapterus russelli*) pada Lokasi Penangkapan Berbeda. *J. Pengolah. Pangan,* 5: 1–6. https://doi.org/10.31970/pangan.v5i1.33

Chiesa, S., Azzurro, E. & Bernardi, G. 2019. The genetics and genomics of marine fish invasions: a global review. *Rev. Fish Biol. Fish.,* 29(4): 837-859. https://doi.org/10.1007/s11160-019-09586-8

De Guzman, M.F. & Rosario, G.R. 2020. Length-weight relationships of marine fishes caught by danish seine in Lingayen gulf. *Int. J. Fish. Aquat. Stud.*, 8: 16–18. https://doi.org/10.22271/fish.2020.v8.i6a.2353

De Robertis, A. & Williams, K., 2008. Weight-Length Relationships in Fisheries Studies: The Standard Allometric Model Should Be Applied with Caution. Trans. *Am. Fish. Soc.,* 137: 707–719. https://doi.org/10.1577/T07-124.1

Effendie, M.I. 2002. Biologi Perikanan. Yayasan Pustaka Nusatama, Yogyakarta.

Faizah, R. & Sadiyah, L. 2020. Some biology aspects of Indian Scad (*Decapterus russelli*, Rupell, 1928) in Pemangkat Fisheries Port, West Kalimantan. *IOP Conf. Ser. Eart Environ. Sci.,* Institute of Physics Publishing, p. 12063. https://doi.org/10.1088/1755-1315/429/1/012063

Fatma, N., Metusalach, Taslim, N.A. & Nurilmala, M., 2020. The protein and albumin contents in some species of marine and brackishwater fish of South Sulawesi, Indonesia. Aquac. Aquarium, Conserv. Legis. *Bioflux*, 13: 1976–1985.

Henra, H., Yusuf, N. & Naiu, A.S. 2020. Karakteristik Mutu Hedonik Kerupuk Ubi Jalar Dan Rumput Laut (*Kappaphycus alvarezii*) Yang Difortifikasi dengan Ikan Layang (*Decapterus russelli*). *Jambura Fish Process. J.* 1: 35–45. https://doi.org/10.37905/jfpj.v1i2.5426

Jisr, N., Younes, G., Sukhn, C. & El-Dakdouki, M.H., 2018. Length-weight relationships and relative condition factor of fish inhabiting the marine area of the Eastern Mediterranean city, Tripoli-Lebanon. *Egypt. J. Aquat. Res*. 44: 299–305. https://doi.org/10.1016/j.ejar.2018.11.004

Kadim, M.K., Pasisingi, N., Alinti, E.R. & Panigoro, C. 2022. Biodiversity and community assemblages of freshwater and marine macrozoobenthos in Gorontalo Waters , Indonesia. *Bio,* 23:637–647. https://doi.org/10.13057/biodiv/d230204

Kadim, M.K., Pasisingi, N. & Arsad, S. 2019. Horizontal distribution of chlorophyll-α in the Gorontalo bay. N*at. Environ. Pollut. Techno*l. 18(4): 1381-1385

Kadim, M.K., Pasisingi, N. & Kasim, F. 2018. Spatial and temporal distribution of phytoplankton in the Gorontalo Bay, Indonesia. *AACL Bioflux* 11(3): 833-845

Kalhoro, M.T., Yongtong, M., Ali, K.M., Syed, S., Hussain, B., Mahmood, M.A., Muhammad, M. & Ramesh, P.T., 2017. Stock Assessment of Indian Scad, *Decapterus russelli* in Pakistani Marine Waters and Its Impact on the National Economy. *Indian J. Geo Mar. Sci.,* 49: 1222–1228. https://doi.org/10.4172/2150-3508.1000200

Khasanah, A.N., Saputra, S.W. & Taufani, W.T., 2020. Population dynamic of indian scad (*Decapterus russelli*) based on data in tasikagung fishing Port of Rembang. *IOP Conf. Ser. Environ. Sci.*, IOP Publishing Ltd, p. 012004. https://doi.org/10.1088/1755-1315/530/1/012004

Kurniawan, A., Permadi, A. & Purnomo, A.H. 2020a. Optimum Proportion of Indian Scad (*Decapterus russelli*) Protein Concentrate in Traditional Food Cake Designated for Undernourished Children Diet. *Russ. J. Agric. Socio-Economic Sci.,* 99: 170–183. https://doi.org/10.18551/rjoas.2020-03.19

Kurniawan, A., Permadi, A. & Purnomo, A.H. 2020b. Children's Responses to the Addition of Indian Scad (*Decapterus russelli*) Fish Protein Concentrated and Flavor to Traditional Food. J*. Airaha*, 9: 096–104.

Lawadjo, F.W., Tuli, M. & Pasisingi, N., 2021. Length-Weight Relationship and Condition Factor of Layang Fish (*Decapterus russelli*) Landed at Tenda Fish Landing Base, Gorontalo. *J. Pengelolaan Perikan. Trop.,* 5: 44–51. https://doi.org/10.29244/jppt.v5i1.34604

Mardlijah, S. & Patria, M.P. 2016. Biologi Reproduksi Ikan Madidihang (*Thunnus albacare*s Bonnatere 1788) di Teluk Tomini. Bawal, 4: 27–34.

Miller, M.J., Wouthuyzen, S., Sugeha, H.Y., Kuroki, M., Tawa, A., Watanabe, S., Syahailatua, A., Suharti, S., Tantu, F.Y., Otake, T., Tsukamoto, K. & Aoyama, J., 2016. High biodiversity of leptocephali in Tomini Bay Indonesia in the center of the Coral Triangle. *Reg. Stud. Mar. Sci.* 8: 99–113. https://doi.org/10.1016/j.rsma.2016.09.006

Mustika, P.L.K., Wonneberger, E., Erzini, K. & Pasisingi, N., 2021. Marine megafauna bycatch in artisanal fisheries in Gorontalo, northern Sulawesi (Indonesia): An assessment based on fisher interviews. Ocean and Coastal Management 208 (2021) 105606. https://doi.org/10.1016/j.ocecoaman.2021.105606

Nakagawa, S., Johnson, P.C.D. & Schielzeth, H., 2017. The coefficient of determination R^2 and intra-class correlation coefficient from generalized linear mixed-effects models revisited and expanded. *J. R. Soc. Interface* 14: 20170213. https://doi.org/10.1098/rsif.2017.0213

Nugroho, S.C., Jatmiko, I. & Wujdi, A., 2018. Pola pertumbuhan dan faktor kondisi madidihang, *Thunnus albacares* (Bonnaterre, 1788) di Samudra Hindia Bagian Timur. *J. Iktiologi Indones.* 18: 13–21. https://doi.org/10.32491/jii.v18i1.371

Obie, M., 2018. Exploitation of coastal and marine resources along Tomini Bay: Livelihood base versus concession rights Eksploitasi sumber daya pesisir dan laut di Teluk Tomini: Basis mata pencaharian versus konsesi. *Masyarakat, Kebud. dan Polit*. 31: 36–45. https://doi.org/10.20473/mkp.V31I12018.36-45

Olii, A.H., Sahami, F.M., Hamzah, S.N. & Pasisingi, N., 2017. Preliminary findings on distribution pattern of larvae of nike fish (*Awaous* sp.) in the estuary of Bone River, Gorontalo Province, Indonesia. *AACL Bioflux*, 10: 1110–1118. https://doi.org/10.3844/ojbsci.2019.51.56

Olii, A.H., Sahami, F.M., Hamzah, S.N. & Pasisingi, N., 2019. Molecular approach to identify gobioid fishes, “nike” and “hundala” (Local name), from gorontalo waters, Indonesia. *Online J. Biol. Sci.* 19: 51–56.

Ongkers, O.T., Pattikawa, J.A. & Rijoly, F., 2016. Aspek Biologi Ikan Layang (*Decapterus russelli*) di Perairan Latuhalat, Kecamatan Nusaniwe, Pulau Ambon. *Omni-Akuatika,* 12: 79–87. https://doi.org/10.20884/1.oa.2016.12.3.128

Panda, D., Chakraborty A.K., Jaiswar A.K., Sharma A.P., Jha B.C., Sawant B.T., Bhagabati S.K. & Kumar, T. 2012. Fishery and population dynamics of two species of carangids, *Decapterus russelli* (Ruppell, 1830) and *Megalaspis cordyla* (Linnaeus, 1758) from Mumbai waters. *Indian J. Fish*., 59: 53–60.

Paparang, R.W. 2013. Studi Pengaruh Variasi Konsentrasi Garam Terhadap Citarasa Peda Ikan Layang (*Decapterus russelli*). *Media Teknol. Has. Perikan.* 1: 17–20. https://doi.org/10.35800/mthp.1.1.2013.4141

Pasisingi, N., & Abdullah, S., 2018. Pola kemunculan ikan nike (Gobiidae) di Perairan Teluk Gorontalo, Indonesia. *Depik,* 7: 111–118. https://doi.org/10.13170/depik.7.2.11442

Pasisingi, N., Habibie, S.A. & Olii, A.H., 2020a. Are *Awaous ocellaris* and *Belobranchus belobranchus* the two species of nike fish schools? *Aceh J. Anim. Sci.,* 5: 87–91. https://doi.org/10.13170/ajas.5.2.16557

Pasisingi, N., Olii, A.H. & Habibie, S.A., 2020b. Morphology and growth pattern of Nike fish (Amphidromous Goby larvae) in Gorontalo Waters, Indonesia. *Tomini J. Aquat. Sci.* 1: 1–7. https://doi.org/10.37905/tjas.v1i1.5622

Pasisingi, N., Sapira Ibrahim, P., Arsalam Moo, Z. & Tuli, M., 2020c. Reproductive Biology of Oci Fish *Selaroides leptolepis* in Tomini Bay. *J. Mar. Res*. 9: 407–415. https://doi.org/10.14710/jmr.v9i4.28340

Pasisingi, N., Kasim, F. & Moo, Z.A., 2021a. Estimation of fishing mortality rate and exploitation status of Yellowstrip Scad (*Selaroides leptolepis*) in Tomini Bay using Von Bertalanffy Growth Model Approach. *J. Ilm. Perikan. Dan Kelaut.* 13: 288–296. https://doi.org/10.20473/jipk.v13i2.27465

Pasisingi, N., Katili, V.R.A., Mardin, H. & Ibrahim, P.S., 2021b. Variation in morphometric characteristics of Nike Fish (Amphidromous Goby larva) in Leato waters, Gorontalo Bay, Indonesia. *AACL Bioflux* 14(1): 28-36

Pasisingi, N., Pramesthy, T.D. & Musyali, A., 2021c. Length-weight relationships and sex ratio of *Selaroides leptolepis*, Cuvier Length-weight relationships and sex ratio of Selaroides leptolepis , Cuvier 1833 in Tomini Bay,

Indonesia. IOP Conf. Ser. Earth Environ. Sci., 744 012052. https://doi.org/10.1088/1755-1315/744/1/012052

Pasisingi, N., Sulistyono, D., & Paramata, A. R. 2021d. Growth and Mortality Rate of Scad (Decapterus macrosoma , Bleeker 1851) landed at Inengo Fish Landing Base, Bone Bolango, Gorontalo. *Biota*, 14(2): 74–86. https://doi.org/10.20414/jb.v14i2.362

Pattikawa, Jesaja, A., Tetelepta, J.M.S., Pattikawa, Jesaja A, Uneputty, P., Ongkers, O., Tetelepta, J. & Amirudin, A. 2018. Some biological aspects of mackerel scad (*Decapterus macarellus*) in Ambon Island waters, Indonesia. *Int. J. Fish. Aquat. Stud*., 6: 171–175.

Poojary, N., Tiwari, L. & Jaiswar, A. 2010. Food and feeding habits of the Indian scad, *Decapterus russelli* (Ruppell, 1830) from Mumbai waters, north-west coast of India. *Indian J. Fish.* 57: 93–99. https://doi.org/10.6024/jmbai.2015.57.1.01792-11

Randongkir, Y.E., Simatauw, F. & Handayani, T. 2018. Growth Aspects of Scad *Decapterus macrosoma* on Fish Point Sanggeng-Manokwari Regency. *J. Sumberd. Akuatik Indopasifik,* 2(1): 15-24. https://doi.org/10.30862/jsai-fpik-unipa.2018.Vol.2.No.1.30

Riedel, R., Caskey, L.M. & Hurlbert, S.H. 2007. Length-weight relations and growth rates of dominant fishes of the Salton Sea: Implications for predation by fish-eating birds. *Lake Reserv. Manag.* 23: 528–535. https://doi.org/10.1080/07438140709354036

Steel, R.G.D., Sumantri, B. & Torrie, J.H. 1993. Prinsip dan prosedur statistika : suatu pendekatan biometrik, 2nd ed. Gramedia Pustaka Utama, Jakarta.

Sunaryo, Syahrihaddin, A. & Imfianto, P.S. 2019. Solar Energy for a Traditional Coastal Fishing Platform. *J. Mar. Sci. Appl.,* 18: 366–371. https://doi.org/10.1007/s11804-019-00087-5

Suwarso, S. & Zamroni, A., 2015. Analisis Struktur Populasi Tiga Species Layang (*Decapterus* spp.) di Laut Jawa dan Sekitar Sulawesi: Saran Pengelolaan Berkelanjutan Ikan Pelagis Kecil dan Evaluasi WPP. *J. Kebijak. Perikan. Indones.* 6: 75-86. https://doi.org/10.15578/jkpi.6.2.2014.75-86

Tangke, U. 2020. Produksi dan Nilai Jual Ikan Pelagis Dominan di TPI Higienis Pelabuhan Perikanan Nusantara Ternate. *Agrikan J. Agribisnis Perikan*. 13: 108-118. https://doi.org/10.29239/j.agrikan.13.1.97-107

Tondais, J., Sombo, D.E., Lalenoh, B.A., Mappiratu, M., Adrian, A. & Cahyono, E. 2020. Ekstraksi Flavour dari Tepung Ikan Layang (*Decapterus* sp.) Menggunakan Enzim Protease Biduri (*Calotropis gigantea*). *J. Fishtech,* 9: 6–12. https://doi.org/10.36706/fishtech.v9i1.11481