Population dynamics of Baelama anchovy *Thryssa baelama* (Forsskål, 1775) on the coast of Kabauw Village, Haruku Island, Central Maluku, Indonesia

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Abstract. Baelama anchovy (*Thryssa baelama*) is one of the small pelagic fish from the family Engraulidae used by the local community in Kabauw village, Haruku island-Central Maluku. The intensive fishing of *T. baelama* as consumption and baitfish with pole and line fisheries by the local communities has been carried out for a long time, but information on the biological parameters of their populations has never been used as a basis for fisheries management. This study aimed to analyze the population dynamics of *T. baelama* on the coast of Kabauw Village. Fish sampling was carried out twice a month, every two weeks from October to December 2020. The fishing of *T. baelama* used a net with a mesh size of 0.75 inches. All fish samples were measured for total length. Length frequency data were analyzed using FiSAT II software to estimate growth, mortality, and recruitment parameters. The results showed that the estimated growth parameters; $L\infty$, K, and t0 were 12.85 cm, 1.01 $years^{-1}$, and -0.199 $years^{-1}$, respectively, and asymptotic length can be achieved at the age of 4.0. Natural mortality 1.82 $year^{-1}$ is higher than fishing mortality 0.52 $year^{-1}$. With a total mortality of 2.80 $years^{-1}$, and the exploitation rate is still low 0.19 $years^{-1}$. Based on the prediction of the recruitment pattern, the peak of recruitment occurred in October at 25.14%. A management strategy is needed for the sustainable use of *T. baelama*; technically, it can be done by determining the fishing season, selectivity of fishing gear, and fishing quotas. These three strategies can be implemented simultaneously through Sasi or similar systems, which can be revitalized through collaboration between stakeholders, with a dominant role attributed to the village government.

Key Words: growth, mortality, exploitation rate, recruitment pattern, fisheries management.

Introduction. *Thryissa baelama* (Forsskål, 1775) is a species of ichthyofauna from the family Engraulidae and the Order Clupeiformes; it has morphological characteristics of an elongated body like a torpedo, a rounded belly in front of the pelvic fins. There are no dorsal and anal spines, with 14-16 dorsal-fin rays and 29-34 anal soft rays (https://www.fishbase.se/summary/582). It has 4-9 thick scales in front of the pelvic fins, starting below the base of the pectoral fins, the rear end of the jawbone tapers slightly past the front of the gill cover bones, the head and body are silver, the back is dark (Peristiwadi 2002).

T. baelama is a small pelagic fish that can reach a length of 16 cm TL, generally found in the 9-14 cm size range (Wongratana et al 1999; Mainassy et al 2011; https://www.fishbase.se/summary/582; Tetelepta 2022), which form schooling in coastal waters, lagoons, estuaries with mangrove vegetation and can tolerate wider salinity (euryhaline) (Wongratana et al 1999). It is widely distributed in the Indo Pacific region (Indonesia, Philippines, Papua New Guinea, north and northeast coast of Australia to Great Barrier Reef, Queensland, Caroline and Mariana Islands, New Caledonia, Tonga, the Indian Ocean and West Pacific, the east coast of Africa, Sri Lanka and Indo-Australian Archipelago (Wongratana et al 1999; Events 2002).

The community of Central Maluku calls *T. baelama* by the local name of "Lompa fish", some are managed using the system of Sasi, such as on Haruku island, which has been going on since the XVII century (Latuconsina 2009; Asrul et al 2017; Karepesina et al 2013; Persada et al 2018; Tetelepta et al 2022). Sasi is a term that refers to a system of beliefs, rules, and rituals related to the temporary prohibition on utilizing specific resources or certain areas, that are controlled individually or collectively, in order to be used sustainably. Sasi is traditional community wisdom in Maluku that has social value, cultural, ecological, and is used as an instrument in community-based fisheries resource management (Adhuri 2004; Nikijuluw 2002; Latuconsina 2009; Asrul et al 2017).

T. baelama is used as fish for consumption because it can contain beta carotene which can contribute to meeting the community's need for vitamin A (Mainassy et al 2011). *T. baelama* contributes to clupeoid catches in general, but there is no specific fishery for this species, and it is commonly used as a food fish by local communities and as baitfish in the capture of large pelagic fish (Wongratana et al 1999; Mainassy 2015; https://www.fishbase.se/summary/582).

The coastal waters of Kabauw Village on Haruku Island-Central Maluku have resources of *T. baelama*, which appear seasonally from October to December of the year. Generally caught using nets and used as food fish and baitfish in pole and line fisheries. It is feared that the intensive capture of *T. baelama* will reduce its population in the wild, on the long term. This condition is exacerbated by the absence of fisheries management for a sustainable use. The lack of scientific information on the population biology of *T. baelama* makes it essential to conduct population dynamics research as basic information for its management. According to Hilborn (2020), managing the estimated fish stocks (based on scientific studies) will provide long-term catch sustainability. In addition, some population parameters such as: growth, mortality, and recruitment are necessary for a suitable application of the fishing regulations related to the season and quotas, and to analyze the fishing strategies (Effendie 2002; Widodo & Suadi 2006; Muhammad 2011). This study aimed to estimate the growth, mortality, exploitation rate and recruitment pattern of *T. baelama* in the waters of Kabauw village, Haruku Island, Central Maluku, as information for fisheries management.

Material and Method

Description of the study sites. The study was conducted for three months (October–December) 2020. *T. baelama* collected during the study came from the catch of nets belonging to local fishermen (Figure 1).

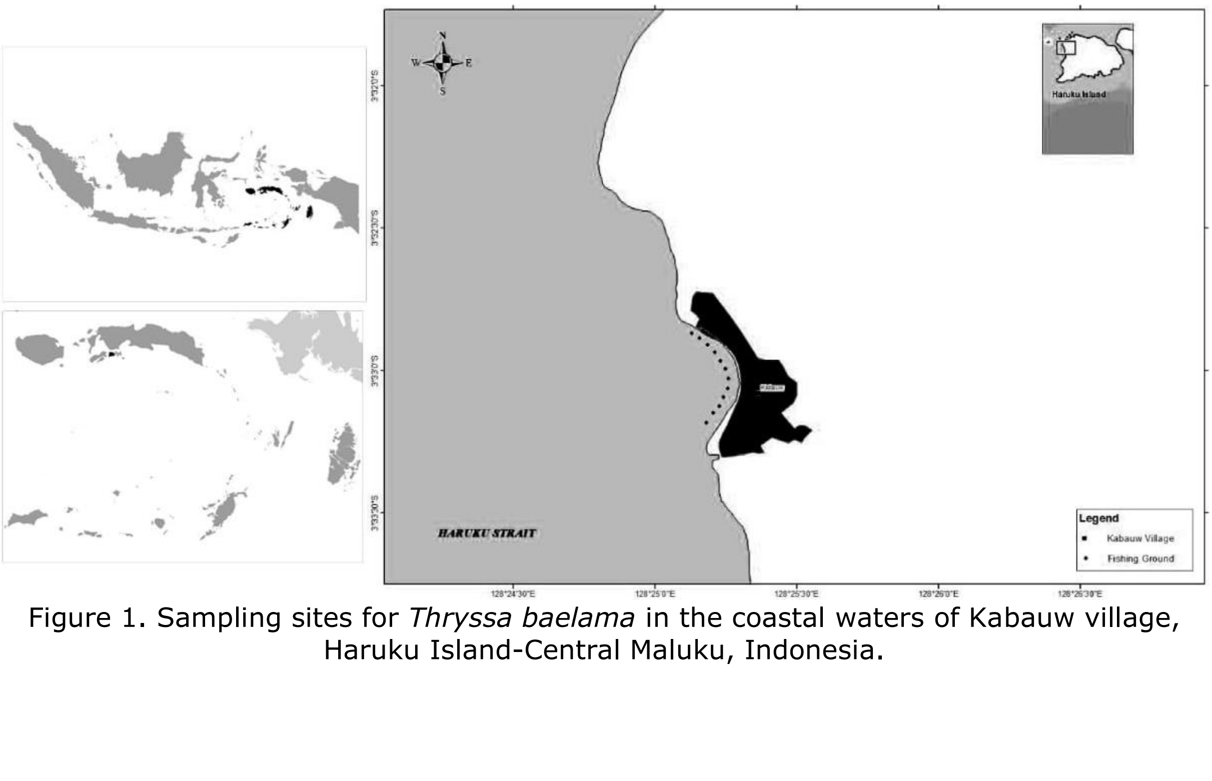

Figure 1. Sampling sites for *Thryssa baelama* in the coastal waters of Kabauw village, Haruku Island-Central Maluku, Indonesia.

Fish sample collection. A sampling of *T. baelama* was carried out every two weeks from the catch of nets with a mesh size of 0.75 inches (1.9 cm), using a representative sample size selection guide (Kurnia & Setyobudiandi 2006). In addition, water temperature measurement was carried out at every fish sampling session. Fish samples caught were stored in cold boxes, and length and weight measurements were taken at the Laboratory of Ichthyology, Faculty of Fisheries and Marine Science, Darussalam University Ambon.

Data analysis. Data on the total length of fish obtained were tabulated based on a length-frequency distribution with class intervals of 0.6 cm. The data on the length frequency distribution is then analyzed to estimate the growth, mortality, exploitation rate, and recruitment pattern parameters. Growth parameters were estimated using the Von Bertalanffy formula (Sparre & Venema 1998):

$$Lt = L\infty\ (1-e^{-K(t-t0)})$$

Where:
Lt - length of fish at age t (unit of time);
L∞ - maximum theoretical length (asymptotic length);
K - coefficient of growth (per unit time);
t0 - theoretical age when length equals zero.

The length of the asymptote (L∞) and the coefficient of growth (K) determined with the ELEFAN I sub-program, containing in the FISSAT II software package. The theoretical age of fish when the length is equal to zero (t_0) is estimated separately using Pauly's (1983) empirical equation:

$$Log(-t_0) = -\ 0.3922 - 0.2752\ (Log\ L\infty) - 1.038\ Log\ K$$

Where:
L∞ - asymptotic length of fish (cm);
K - coefficient of growth rate (years);
t_0 - theoretical age of fish when the length is zero (years).

The estimation of total mortality (Z) was carried out using the length conversion curve method with the FiSAT II program package. Catch mortality (F) was determined by the equation F=Z-M. Natural mortality rate (M) was estimated by Pauly's (1983) empirical equation (using the annual mean water surface temperature (T) data; M is corrected by multiplying with 0.8, for fish species that live in groups like *T. baelama*):

$$Log(M) = -0.0066 - 0.2795\ Log(L\infty) + 0.6543 Log\ (K) + 0.4634\ Log\ (T)$$

The exploitation rate (E) was determined by comparing fishing mortality (F) to total mortality (Z) with the formula E=F/Z (Sparre & Venema 1998). The optimum exploitation rate is reached when E_{opt}=0.5.
Growth parameter data (L∞, K) obtained from the analysis of extended frequency data were then used to reconstruct the recruitment pattern with the help of the FiSAT II program package (Gayanilo et al 2005).

Results

Length size distribution. The total number of *T. baelama* samples collected during the study was 967 individuals, with a range of 6.5–12.6 cm TL, with an average length of 10.2±1.48 cm TL. The frequency distribution of the length, based on the total length class interval, was presented in Figure 2.

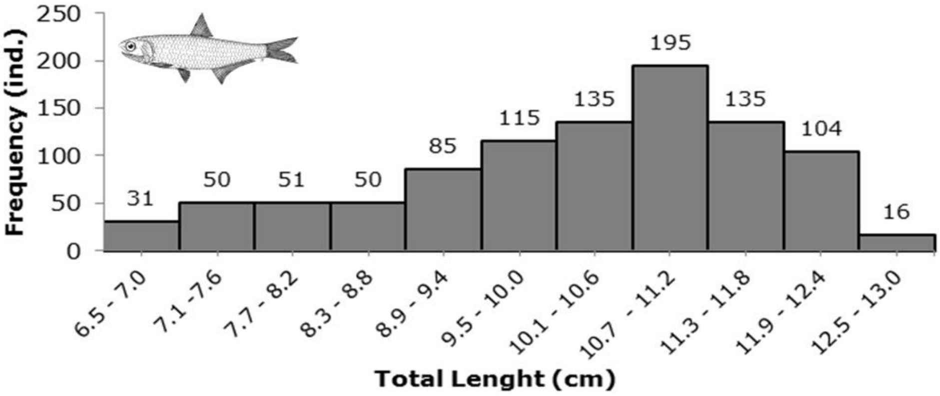

Figure 2. Distribution of the length frequency of *Thryssa baelama* during observations in coastal waters of Kabauw Village, Haruku Island, Central Maluku.

Based on the advanced mode analysis using the Bhattacharya method it can be seen that the three-month sampling consisted of 1-3 age groups (Figure 3). The Bhattacharya method is a graphical method for separating age groups. This method consists of separating some normal distributions, each representing a cohort of fish, from the overall distribution, starting from the left-hand side of the total distribution.

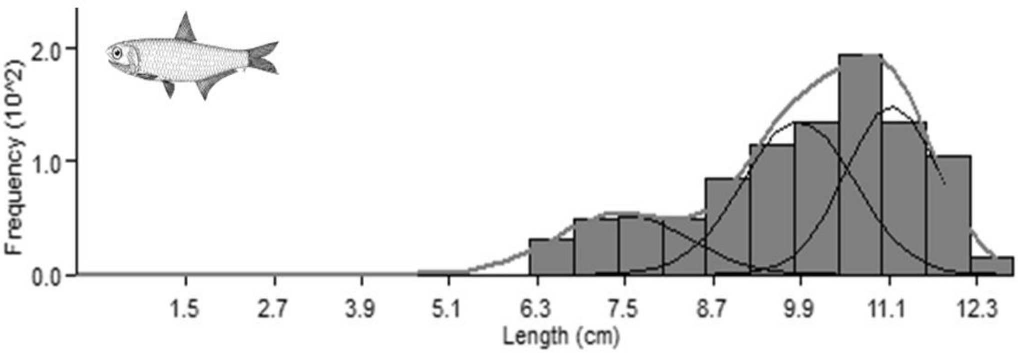

Figure 3. Length frequency of *Thryssa baelama* collected in coastal waters of Kabauw Village, Haruku Island, Central Maluku, based on analysis using the Bhattacharya method.

Table 1 presents the results of the separation of the fish population length into three groups, namely: juvenile (approximately 6.54-8.32 cm TL), pre-adults (9.10-10.62 m TL), and adults (10.7–12.76 cm TL).

Table 1

Distribution of age groups of *Thryssa baelama* during observations in the coastal waters of Kabau2 village, Haruku Island, Central Maluku

Age	*Lenghth range (cm TL)*	*Average ±SD*	*Number of samples (%)*	*Statistics*
Juvenile	6.54-8.32	7.43±0.89	199 (20.58)	-
Pre-Adult	9.10-10.62	9.86±0.76	402 (41.57)	2.190
Adult	10.7-11.78	11.14±0.64	366 (37.85)	1.980

Growth. The estimated growth coefficient (K) of *T. baelama* is 1.01 $years^{-1}$, with an asymptotic length (L∞) of 12.85 cm which is achieved in approximately 4 years, with a theoretical age (t_0) of 0.199 years. Thus, the growth equation is formulated as Lt=12.85 $(1-e^{-1,01(t+0,199)})$ (Figure 4).

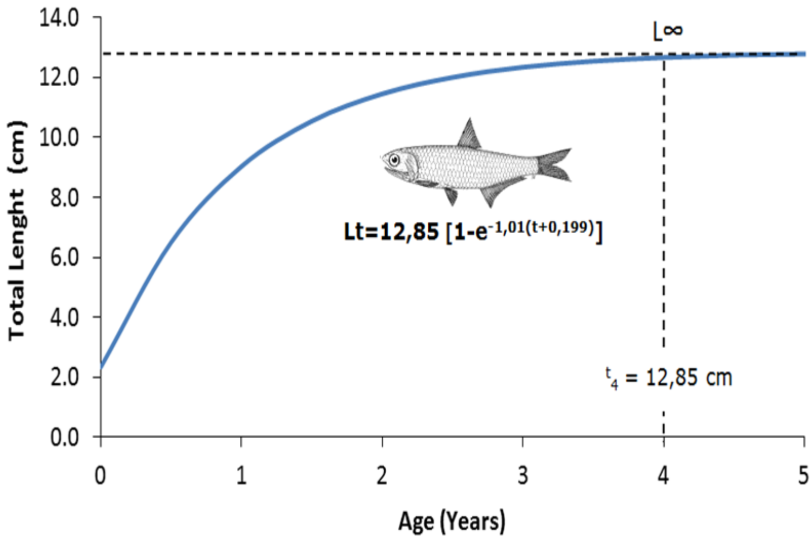

Figure 4. Graph of the length growth curve of *Thryssa baelama* in coastal waters of Kabauw village, Haruku Island, Central Maluku.

Figure 4 shows the growth rate of *T. baelama* increasing until two years, starting to slow once entering the age of 3-4 years, towards the asymptote point. Based on the minimum length found to be 6.5 cm TL, and a maximum length of 12.6 cm TL, the *T. baelama* caught are predicted to be around 0.5–3.8 years old, while it starts reaching adult size at two years old.

Mortality and exploitation rate. Figure 5 shows that the natural mortality (M) of *T. baelama* in coastal waters of Kabauw village, Haruku Island-Central Maluku, at an average temperature of 28⁰C is 2.28 years^{-1}, with a fishing mortality rate (F)=0.52 years^{-1}, so the total mortality (Z)=2.80 years^{-1}. The catch is in a relative age range between 2 and 3.5 years.

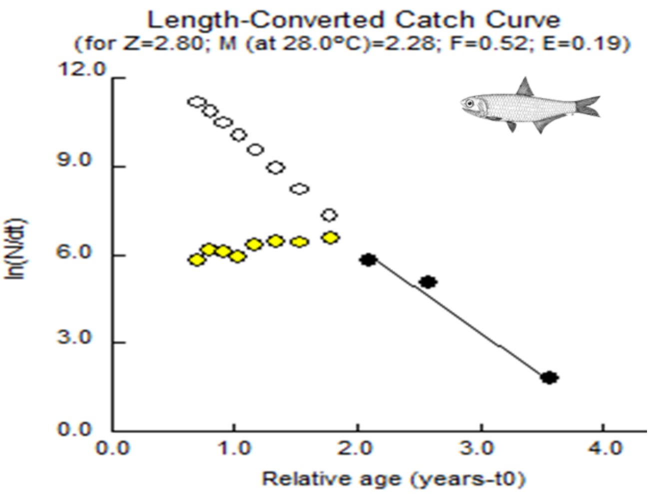

Figure 5. Conversion curve of catch length of *Thryssa baelama* in the coastal waters of Kabauw Village, Haruku Island, Central Maluku. The Y axis describes the size of the fish, the X axis shows the age of the fish, while the black circles describe groups of fish being exploited.

Figure 5 shows that *T. baelama* in the coastal waters of Kabauw Village, Haruku Island, and Central Maluku are mainly exploited at the age of 2 to 3.5 years. This means that the fish caught are theoretically fit for exploitation. However, more accurate scientific information is needed regarding the size at first maturity, as a more valid reference for the evaluation of the selectivity of fishing gear, that should be adjusted to the size of fish that are biologically fit to be caught, with the assumption that they have spawned once.

Recruitment pattern. The recruitment pattern of *T. baelama* stock in the coastal waters of Kabauw village, Haruku Island, occurred in October by 25.14%, while in December there was no recruitment, as resulted from the total annual recruitment distribution graph (Figure 6).

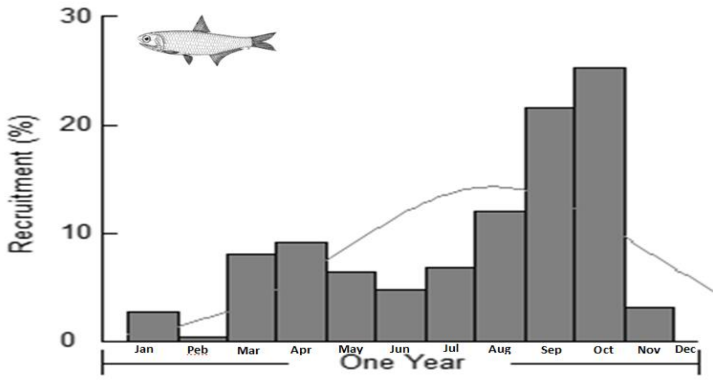

Figure 6. Recruitment pattern of *Thryssa baelama* in coastal waters of Kabauw Village, Haruku Island, Central Maluku.

Discussion. *T. baelama* is a small pelagic fish that can reach a standard length of 16 cm and is generally found in the 9-14 cm size range (Wongratana et al 1999; Mainasy et al 2011; Foese & Pauly 2022; Tetelepta et al 2022). Figure 2 shows that from 967 individuals of *T. baelama*, many were caught in a juvenile stage or pre-adult to adult, but presumably immature, namely in the length range of 6.5 cm–11.2 cm TL (73.63% of the total fish sampling). Meanwhile, fish that was thought to have gone gonadally mature and had spawned were in the length range of 11.3–13.0 cm TL (as much as 26.37% of the total sampling). Marichamy (1970) found that *T. baelama* in the Andaman Sea reached the first maturity size at a length of 11.7 cm TL. On the other hand, Patadiya et al (2021), who found *Thryssa setirostris* in the coastal waters of Thoothukudi, Tamil Nadu-India, reached a maximum size of 8.9–14.5 cm TL, but the most caught were immature specimens of 10 cm TL. This species was recorded to have a first maturity size of 11.3 cm TL, and more than 50% of adult species were found at 11.5 cm TL.

The separation of size groups using the Bhattacharya method showed that the total population of *T. baelama* caught during three months consisted of 3 different age groups (Figure 3). According to Latuconsina (2020), a fish population generally consists of three age classes (ecological age): pre-reproductive, reproductive, and post-reproductive.

The results of the length-frequency graph restructuring (Figure 4) show that the *T. baelama* population consists of three age groups, indicating that the population is stable and relatively sustainable in the wild, on the long term, because of its good regeneration rate. However, the *T. baelama* population obtained from the catch of fishers in the coastal waters of Kabauw Village was more dominated by medium-sized specimens. According to Latuconsina (2020), a fish population in which medium-sized fish dominate shows stability, but the regeneration rate is slow.

Table 1 shows that the percentage of *T. baelama* caught by fishers in the coastal waters of Kabauw village, Haruku Island–Central Maluku, in pre-adult and juvenile sizes is also exceptionally high. This phenomenon shows that the size of the fish is still relatively large, although not yet biologically suitable to be caught, because they are presumed immature. It is feared that if fishing arrangements are not made, on the long term overfishing can reduce the chances of fish reproducing and producing offspring to maintain their population in the wild. According to Widodo & Suadi (2006) and Latuconsina (2020), over-exploitation of the fish population will initially affect the number and quality of fish resources by catching juvenile fish, which will inhibit their growth from reaching adult size, thereby eliminating the opportunity to spawn (growth overfishing) and will hinder the recruitment process for populations that are ready to be exploited (recruitment overfishing)

The growth coefficient value (K) *T. baelama* is 1.01 $years^{-1}$, with an asymptotic length (L∞) of 12.85 cm TL which is achieved in approximately four years, with a theoretical age (t_0) of 0.199 years. Thus, the growth equation is formulated as Lt=12.85 $(1-e^{-1,01(t+0,199)})$ (Figure 4). Sparre & Venema (1998) stated that fish with a K value>0.5 had a fast growth pattern. The higher the growth coefficient, the faster asymptotic length is reached. According to Beverton & Holt (1959), asymptotic length is strongly influenced by the available food supply but does not affect the growth coefficient. The difference in ambient temperature will affect K and L∞, so that an increase in water temperature will proportionally increase the value of K and L∞. According to (Pauly 1983), fish with a high growth coefficient generally have a relatively short lifespan.

The estimated exploitation rate of *T. baelama* in coastal waters of Kabauw village is 0.19 $years^{-1}$, much lower than the optimum limit for sustainable use. According to Gulland (1969), a resource is exploited in optimum conditions if F = M, i.e., E_{opt} = 0.5. The local community catches *T. baelama* only using a fishing net with a mesh size of 0.75 inches, being adapted to the target fish. However, Latuconsina (2010) classifies nets as a less destructive fishing gear, but with only 5 out of 8 environmentally friendly indicators, targeting small pelagic fish such as *T. baelama*, *Sardinella* sp., and *Stoephorus* sp.

Compared to the rate of exploitation of *T. baelama*, which was estimated by Tuhumury (2004) to have reached 0.87 in the waters of Haruku village-Haruku Island, due to massive fishing using various fishing technologies, including the use of mosquito nets and karoro nets with small mesh sizes (Tetelepta et al 2022). Thus, it is necessary to regulate the selectivity of fishing gear to catch *T. baelama* to be consistent in the efforts towards a sustainable use in the coastal waters of Kabauw village, Haruku Island-Central Maluku.

The comparison of mortality and exploitation rates of *T. baelama* at several study sites is shown in Table 2. The differences in mortality and exploitation rates may be due to the environmental or habitat variability, fishing pressure, and impact of anthropogenic activities, at each study site.

Table 2

Comparison of growth, mortality, and exploitation rate of *Thryssa baelama* in several water areas in Maluku – Indonesia

Location	*L∞*	*K*	*M*	*F*	*Z*	*E*	*Source*
Apui, Seram Island, Maluku	14.63	0.40	0.94	0.40	1.35	0.29	Mainassy 2015
Haruku, Haruku Island, Maluku	15.10	0.61	1.30	2.06	2.37	0.87	Tuhumury 2004
Kabauw, Haruku Island, Maluku	12.85	1.01	2.28	0.52	2.80	0.19	Present study

Table 2 shows the differences between fishing mortality and natural mortality that affect the level of exploitation in several research results. For example, Tuhumury (2004) found a high exploitation rate in Haruku Village, Haruku Island, of 0.87, due to the high fishing mortality compared to the natural mortality (F=2.06 > M=1.30), in contrast to research in the coastal waters of Kabauw Village, Haruku Island, with a low exploitation rate of 0.19, due to lower fishing mortality compared to natural mortality (F=0.40 < M=1.30). This means that the level of exploitation of *T. baelama* in Kabauw village is still below the optimum value (E_{opt}) of 0.5 for a sustainable use. According to Gulland (1969), in an optimally exploited stock, the fishing mortality is equal to the natural mortality (0.5).

Table 2 shows that the higher the growth coefficient (K) value, the higher the natural mortality (M) value. Latuconsina et al (2020) also found the same phenomenon related by comparing the natural growth and mortality coefficient of *Siganus canaliculatus* between several fishing areas in the world. According to Gulland (1969), there is a positive relationship between K and M, where fast-growing fish tend to achieve higher natural mortality than slow-growing fish with lower natural mortality values. in that study, the ratio of the natural mortality rate (M) to the growth rate (K) of *T.*

baelama in the coastal waters of Kabauw Village is 2.26. The same phenomenon was also found by Tuhumury (2004) at 2.13 and by Maniassy (2015) at 2.35. According to Beverton & Holt (1959), the ratio M/K is usually between 1.0–and 2.5. This means that the M/K ratio of *T. baelama* in the coastal waters of Kabauw Village, Haruku-Maluku Island, is still sustainable.

The Z/K ratio of 2.77 obtained in this study indicates that the *T. baelama* fishery in the coastal waters of Kabauw village, Haruku Island, is dominated by mortality, similarly to the findings of Tuhumury (2004) of 3.88, and Mainassy (2015) was 3.37. According to Beverton & Holt (1959), the total ratio mortality to growth coefficient (Z/K) of less than 1.0 is dominated by growth, while if more than two it is dominated by mortality. The same phenomenon was also found in *T. setirostris*, as reported by Patadiya et al (2021), in the coastal waters of Thoothukudi, Tamil Nadu-India, with a Z/K ratio of 3.25.

Based on the recruitment pattern of *T. baelama* information on the Kabauw Village coastal waters (Figure 6), the recruitment peak is in October. Therefore, a policy for determining the fishing season is needed by referring to the recruitment pattern from August to December every year. The recruitment process for the *T. baelama* population in the coastal waters of Kabauw village is protected from over-exploitation, which can reduce its population. According to Widodo & Suadi (2006), fish population dynamics in nature are highly dependent on growth and recruitment for stock increasing, while stock reduction is determined by natural mortality and fishing mortality. Thus, to maintain fish stocks in the wild, it is necessary to balance growth and recruitment and mortality (fishing mortality and natural mortality).

Based on the estimated value of fishing mortality, exploitation rate, and recruitment pattern, the increase in exploitation of *T. baelama* in coastal waters of Kabauw village, Haruku Island-Central Maluku can still be done by referring to the population dynamics information obtained, as a reference in designing management strategies for utilization efforts, for example, by implementing three management strategies, namely: 1) fishing season, 2) selectivity of fishing gear, and 3) fishing quotas, as recommended by Widodo & Suadi (2006) and Muhammad (2011). Implementing these three strategies is expected to maintain the presence of *T. baelama* stocks in the wild, while used sustainably. However, according to Hilborn et al (2020), lack of estimate information on the abundance of fishery resources and of fisheries management will determine poor stocks, therefore scientific recommendations are pivotal in fisheries management for sustainable use.

These three *T. baelama* management strategies can be implemented simultaneously through Sasi or similar systems. According to Adhuri (2004), Sasi is a system of beliefs, rules, and rituals related to the temporary prohibition of utilizing specific resources in certain areas controlled individually or collectively for a sustainable use. Thus, according to Nikijuluw (2002), Latuconsina (2009), and Asrul et al (2017), Sasi is a traditional community wisdom in Maluku-eastern Indonesia, which has social, cultural, and ecological values, and is used as an instrument in community-based fisheries resource management. Harkes & Novaczek (2002) found the system of Sasi to be a practical approach for the development of a more effective, adaptive, and culturally embedded system of fisheries management and coastal area management in eastern Indonesia, with a positive performance in terms of biological and social sustainability, efficiency and equity, and thereby contributing to the social-ecological resilience.

Conclusions. *T. baelama* in coastal waters of Kabauw village, Haruku Island-Central Maluku has a high growth coefficient and a natural mortality value inversely proportional to its relatively short asymptotic age and length. The fishing mortality value (F) is smaller than the natural mortality, with the exploitation rate (E) still below the optimal point <0.5, denoting a sustainable use. The recruitment pattern is predicted from August – to November, and the peak occurs in October. Further studies related to reproductive biology are needed to provide comprehensive information to the management. The strategy for managing *T. baelama* can be done technically through several alternatives, including i) determining the fishing season according to the rectum pattern of *T.*

baelama, ii) selectivity of fishing gear to avoid the use of fishing gear that damages the environment and fish resources and iii) determine each fishing effort's catch quota. These three strategies can be implemented with a Sasi system (or similar), which may need revitalization through collaboration between stakeholders, with the village government having the dominant role.

Conflict of interest. The authors declare no conflict of interest.

References

Adhuri D. S., 2004 How can traditional marine resources management support a responsible fishery? Lesson learn from Maluku. IIFET Japan Proceedings, 13 p.

Asrul, Rindarjono M. G., Sarwono, 2017 [The existence of Sasi in environmental management and community participation in Haruku Country, Central Maluku Regency, Maluku Province in 2013]. Jurnal GeoEko 3(1):69-81. [In Indonesian].

Beverton R. J. H., Holt S. J., 1959 A review of the lifespans and mortality rates of fish in nature and their relation to growth and other physiological characteristics. In: The lifespan of animals. Wolstenholme G. E. W., Connor M. O. (eds), pp. 142–180, CIBA Foundation Symposium.

Effendie M. I., 2002 [Fisheries biology]. Pusataka Nusantara Fondation, Yogyakarta, Indonesia, 163 p. [In Indonesian].

Gulland J. A., 1969 Manual of methods for fish stock assessment, Part I. Fish population analysis. FAO Manual Fisheries Science, 154 p.

Gayanilo F. C. Jr., Sparre P., Pauly D., 2005 FAO-ICLARM stock assessment tools II (FiSAT II). User’s guide. FAO Computerized Information Series (Fisheries), FAO, Rome, 168 p.

Harkes I., Novaczek I., 2002 Presence, performance, and institutional resilience of sasi, a traditional management institution in Central Maluku, Indonesia. Ocean & Coastal Management 45:237–260.

Hilborn R., Amoroso R. O., Anderson C. M., Baum J. K., Branch T. A., Costello C., de Moore C. L., Faraz A., Hively D., Jensen O. P., Kurota H., Little L. R., Mace P., Mc Clanahan P., Melnychuk M. C., Minto C., Osio G. C., Parma A. M., Pons M., Segurado S., Szuwalski C. S., Wilson J. R., Ye Y., 2020 Effective fisheries management instrumental in improving fish stock status. Biological Sciences 117(4):2218–2224.

Karepesina S. S., Susilo E., Indrayani E., 2013 [The existence of customary law in protecting the preservation of Sasi lompa fish in Haruku village, Central Maluku district]. Journal ECSOFiM 1(1):25-41. [In Indonesian].

Kurnia R., Setyobudiandi I., 2006 [Sampling technique training and data analysis and sampling technique training]. Fisheries Resource Management Department, Faculty of Fisheries and Marine Sciences, IPB, Bogor, 27 p. [In Indonesian].

Latuconsina H., 2009 [The existence of “Sasi Laut” in management sustainable fisheries as local community based in Molucas]. Triton, Journal of Aquatic Resources Management 5(1):63-71. [In Indonesian].

Latuconsina H., 2010 [Identification of environmentally friendly fishing gear in the marine conservation area of Pombo Island, Maluku Province]. Agribusiness and Fisheries Scientific Journal 3(2):23-30. [In Indonesian].

Latuconsina H., 2020 [Tropical aquatic fish ecology: Biodiversity, adaptation, threats, and their management]. UGM Press, Yogyakarta, 598 p. [In Indonesian]

Latuconsina H., Affandi R., Kamal M. M., Butet N. A., 2020 On the assessment of white-spotted rabbitfish (*Siganus canaliculatus* Park, 1797) stock in the Inner Ambon Bay, Indonesia. AACL Bioflux 13(4):1827-1835.

Mainassy M. C., Uktolseja J. L. A., Martosupono M., 2011 [Estimation of beta carotene content of Lompa fish (*Thyrissa baelama*) at coastal area of Apui, Central Maluku]. Jurnal Perikanan 8(2):51-59. [In Indonesian].

Mainassy M. C., 2015 [Size, structure, mortality, exploitation ratio and recruitment of Lompa fish (*Thryssa baelama* Forsskal) population in Apui Beach, Masohi City,

Central Maluku Regency]. Journal of Marine and Fisheries Resources 9(1):40-50. [In Indonesian].
Marichamy R., 1970 Maturity and spawning of the anchovy, *Thryssina baelama* (Forskal) from the Andaman Sea. Indian Journal of Fisheries 17:179-189.
Muhammad M., 2011 [Fisheries and marine development policies: Systems approach]. Brawijaya University Press, Malang, Indonesia, 508 p. [In Indonesian].
Nikijuluw V. P. H., 2002 [Regime of fisheries resource management]. Pustaka Cidesindo. Jakarta, Indonesia, 254 p. [In Indonesian].
Pauly D., 1983 Some simple methods for the assessment of tropical fish stocks. FAO Fisheries Technical Paper 234, 52 p.
Patadiya D. S., Mogalekar H. S., Sudhan C., Jawahar P., Jayakumar N., Pereira J. J., 2021 Length weight relationship and biology of *Thryssa setirostris* (Broussonet 1782) from the coast of Thoothukudi, Tamil Nadu, India. Journal of the Marine Biological Association of India 63(1):49-55.
Persada N. P. R., Mangunjaya F. M., Tobing I. S. L., 2018 Sasi as a culture of natural resource conservation in the Maluku islands. Journal of Science and Culture 41(59):6869-6900.
Sparre P., Venema S. C., 1998 Introduction to tropical fish assessment. Part 1. Manual. FAO, Rome, 407 p.
Tetelepta J. M. S., Natan Y., Pattikawa J. A., Bernardus A. S., 2022 Population parameters and sustainable status of lompa fish *Thryssa baelama* (Forsskal, 1775) manage through Sasi approach at Haruku Village. Fish & Aquatic Sciences 25(2):101-116.
Tuhumuri E., 2004 Development of the Sasi system as an effort to conserve Lompa fish (*Thryssa baelama*, Forskall) in Haruku Village, Maluku Middle. PhD Thesis, Institute Technology Bandung, Bandung, Indonesia, 110 p.
Widodo S., Suadi, 2006 [Management of marine fisheries resources]. Gadjah Mada University Press, Yogyakarta, Indonesia, 252 p. [In Indonesian].
Wongratana T., Munroe T. A., Nizinski M. S., 1999 Order Culpeiformes, family Engraulidae. In: FAO species identification guide for fishery purposes. The living marine resources of the Western Central Pacific. Carpenter K. E., Niem V. H. (eds), pp. 1397-2068, FAO, Rome.
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