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Short Communication

Preliminary Study of Eels (Anguilla) in Sumbawa Island According to the Knowledge of Local Communities: Distributions, Pattern of Fishing, and Utilizations

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Abstract

Eels are an important fishery resource in Indonesia, but information regarding distribution, fishing patterns and utilization has not been well documented in order for it to assist in the management of eel fisheries. One of the areas in Indonesia that uses eels is the Sumbawa Island community. The local community knowledge approach is an important for fisheries management, because it is an inherent component of fishery resources. This is preliminary study of eels in Sumbawa Island. This study aimed to examine the distribution, pattern of fishing, and utilization of eels from knowledge of local communities. Data were taken through in-depth interviews with 166 respondents. The study was conducted from November to December 2021. Interviews were conducted to obtain information and knowledge from local communities about eels (locations where they were eels found, fishing gear used, time, season and, utilization of eel, and community knowledge regarding its protection status). The results showed that the eels are found in dams, rivers, and estuaries. Most eels were caught from November to December in rainy season. Most people catch eels out of a hobby. Fishing rods and stuns are the two main fishing tools used to catch eels. There are three types of eel utilization, namely (1) consumed, (2) distributed to family and neighbors, and (3) marketed. Respondents (83.64%) did not know about the limited protection for several species of eels.

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1. Introduction

Sidat is the Indonesian name for Freshwater eels (Family Anguillidae). The family includes 2 genera and 19 species. It is catadromous that can be found in freshwater, brackish, and marine (Aoyama *et al*., 2015; Cresci, 2020; Piper *et al*., 2019; Zan *et al*., 2020). All of them spend their juvenile and adult life in freshwater, and return to the sea to spawn and then die (Arai, 2020; Froese and Pauly, 2020). The genus Anguilla includes 19 species, and 13 species are distributed in the tropics (Arai, 2020; Froese and Pauly, 2022; Hagihara *et al*., 2018; Kumai *et al*., 2020). The genus Anguilla includes 19 species, and 14 species are distributed in the tropics (*Anguilla borneensis*, *A. bengalensis*, *A. bicolor*, *A. celebesensis*, *A. interioris*, *A. labiata*, *A. luzonensis*, *A. marmorata*, *A. malgumora*, *A. megastoma*, *A. mossambica*, *A.nebulosa*, *A. obscura*, and *A. reinhardtii*), one species in temperate regions, namely *A. Anguilla*, and four other species found in sub-tropical regions (*A. rostrata*, *A. australis*, *A. dieffenbachii*, dan *A. japonica*) (Arai, 2020; Froese and Pauly, 2022).

The genus Anguilla is considered an important resource for capturing fisheries and aquaculture, but in recent decades its population has declined worldwide (Shanmughan *et al*., 2020). The reasons for the stock decline and recruitment are not well understood (Arai, 2022). The results of the IUCN evaluation show that *A. japonica* and *A. rostrata* are categorized as endangered, while *A. borneensis* is categorized as vulnerable (IUCN, 2019). Responding to the decline in the global eel population, the Indonesian government has implemented limited protection for four species of eel (*A. bicolor*, *A. marmorata*, *A. interioris*, and *A. celebensis*) based on Minister of Marine Affairs and Fisheries Regulation No. 80 of 2020, but most of it is still enforced in the of Sulawesi, Java, and Bali.

The decline in eel populations worldwide, including in Indonesia, needs to be tackled immediately. In the management of fisheries, including eel fisheries, comprehensive information is required, yet nowadays a comprehensive information on eel fisheries is still lacking. For this reason, data scarcity becomes a crucial problem in the management of eel fisheries. The lack of understanding of eels in various regions makes it difficult to manage them in the future. Information related to the species, distribution, and capture of eels in Indonesia only focuses on a few areas, including Sulawesi, Java, Sumatra, and Bali, while data on eels in other areas have not been amply documented. The lack of information related to distribution, fishing patterns, sex ration and other information throughout Indonesia will result in less than optimal management of eel fisheries in Indonesia. Affandi (2005) asserted that an inventory of eel resources that are displayed in the distribution of eels in Indonesia is essential in utilizing and managing eels. This distribution information will be the basis for the management of eel fisheries in Indonesia. Research related to the bio-ecological aspects of eels in Indonesia has often been carried out, such as spawning migration and recruitment migration (Arai *et al*., 1999; Budimawan and Lecomte-Finiger, 2005; Haryani and Hehanusa, 2000; Sugeha *et al*., 2001, 2008); Distribution, composition and size structure (Krismono and Putri, 2012); mapping of crocodile habitat characteristics (Haryono and Wahyudewantoro, 2016; Sugianti *et al*., 2020); and mapping of biodiversity and its distribution in Indonesia based on morphological and genetic approaches (Fahmi, 2015; Sugeha *et al*., 2008). At the same time, research related to the bioecological aspects of eels in Indonesia such as spawning migration, recruitment migration; distribution, composition, and structure of the size and characteristics of migration habitats has often been carried out, but so far, it has only used morphological and genetic approaches. However, information on biodiversity, distribution, and patterns of capture and use of eel based on local community knowledge is still not widely available.

Although a scientific approach is needed in designing management, information related to these aspects needs to be combined and complemented with the knowledge of the local community. This is in line with who state that the knowledge of the local community concerning fishery resources is vital information in supporting scientific knowledge in the field of fisheries. The local community knowledge is an inherent component of the resource so it is imperative for researchers and fishery managers. One of the areas in Indonesia that has potential for eel fish resources Sumbawa island, West Nusa Tenggara. In Sumbawa, the local name for eel is “tuna” or “tuna brang”. So far, the information of eel fishing locations in West Nusa Tenggara is still very limited. Based on a literature study, the reported locations for catching eels in West Nusa Tenggara Province are the Labuhan Haji estuary, the Selayar estuary , and the Sambalia estuary, East Lombok Regency sire river, kapu river, dan montongpaal rivers (Setyono *et al*., 2018), but scientific information related to spatial distribution, biodiversity, size, fishing patterns, and utilization is not widely known. This information based on the knowledge of local communities is very important to know as to support eel management plans in the future. According to Lima *et al*. (2016), knowledge of local communities is very important and useful in knowing

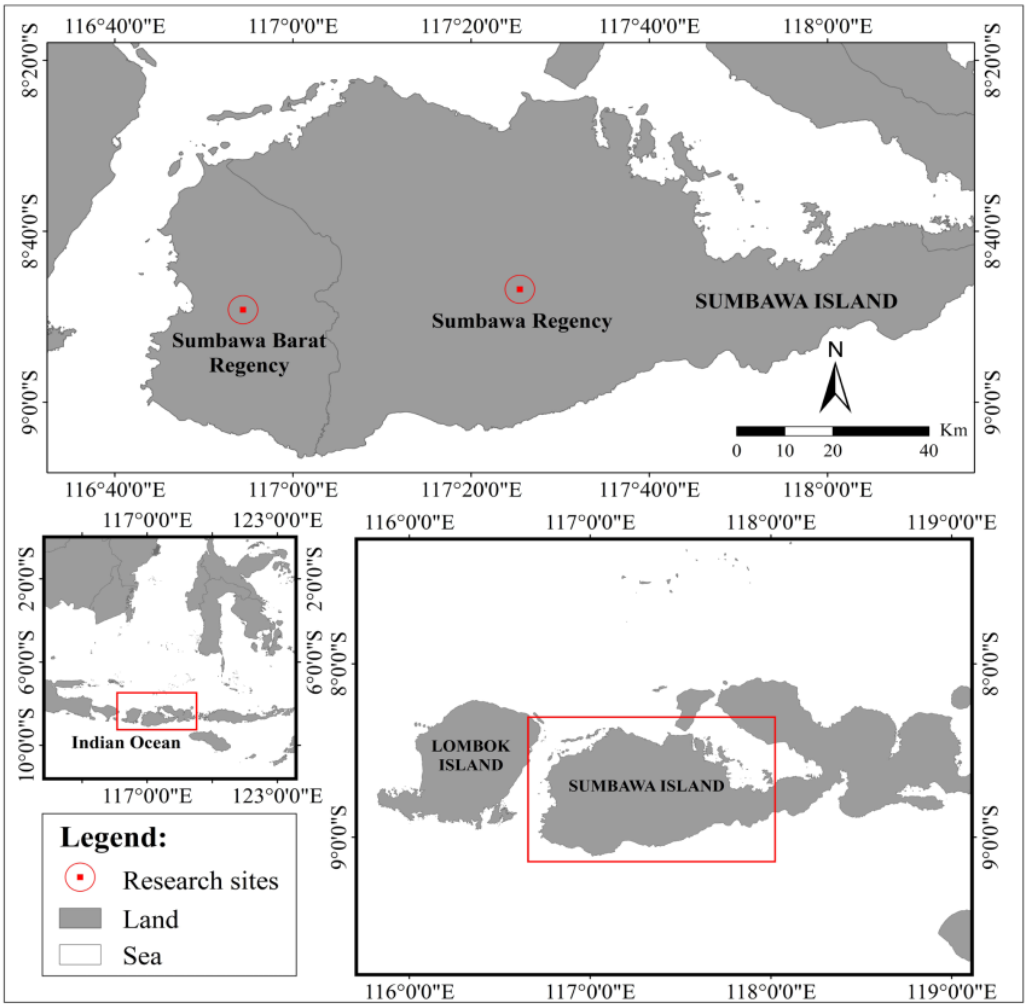

Figure 1. Map of the study area on Sumbawa Island

fishing activities and temporal changes in biomass and quantity of fishery resources. Knowledge of local communities is also important in providing advice on the conservation of fishery resources and for the management of unexplored species in an area (Cosham *et al.*, 2016). Thus, it is important to conduct research on the spatial distribution, pattern of fishing, and utilization of eels as well as knowledge of local communities regarding the management status of eels, as basic information for the management and utilization of eels. The information in this study is expected to be the basic data in determining the steps of eel management in Indonesia.

2. Materials and Methods

2.1 Study Area

This research was conducted in two districts on Sumbawa Island, namely Sumbawa Regency and West Sumbawa Regency (Figure 1). In Sumbawa Regency, the observation locations were all watersheds (Watershed Areas) and included villages with rivers, estuaries, dams, and irrigation flows. The observed villages also represent villages in the highlands to villages in the lowlands. The villages observed in West Sumbawa Regency are Sekongkang Village, Brang Rea Village and

Taliwang Village.

2.2 Data Collections

This research uses a survey method. Data were collected through in-depth interviews with respondents. Respondents are people who do fishing in inland waters or fresh waters (e.g., dams, reservoirs, rivers, irrigation canals to estuaries). Determination of respondents using the snowball sampling method by visiting villages where the community often catches eel fish.

The number of respondents in this study was 166 people who came from several villages in Sumbawa Regency and West Sumbawa Regency. Each respondent was interviewed for approximately 45 minutes. Interview refers to the questionnaire that has been made previously. Interviews were conducted to obtain information and knowledge from local communities about the species of eel caught, the location where the eel was found, fishing gear, fishing time, fishing season, motivation to catch eels, utilization of eel, and community knowledge regarding the protection status of eel in Indonesia.

2.3 Analysis Data

Data on the distribution of eels that have been identified and verified are presented in the table. The data were then analyzed descriptively. Catching data such as a month, season, and time of fishing, as well as types of fishing gear, were analyzed descriptively. Data is presented in a dendrogram. Meanwhile, the respondent's knowledge related to the motivation for catching eel, the utilization of the caught eel, and their knowledge of the protection of the eel species were also analyzed descriptively and displayed in a pie chart.

3. Results and Discussion

3.1 Distributions of Eel

This study is the first study to associate distribution, fishing of eel, and utizations of eels on Sumbawa Island. The results of interviews and direct verification showed that the adult eels found by the respondents were widely distributed in dams/reservoirs, rivers, and estuary (Table 1). In addition, eels are also often found by farmers in the fields. Based on the latitude, the eels are found up to the river in Batu Rotok Village which is a highland area in Sumbawa Regency. This area is an upstream area, whilst the distance of the river from Batu Rotok Village is 76.90 km. This migration distance is further than the migration distance of eels in several other regions in Indonesia. It was reported that eels were found 10 km from the estuary of Pelabuhan Ratu Bay. In Sulawesi, eels are found upstream up to 60 km from the estuary. This migration distance is influenced by the species and the place of migration destination, but this study did not examine in detail the effect of species on the migration distance. Consequently, the information regarding eel migration distances in the tropics is still lacking. In the meantime, several studies figured out that eels in the subtropics, namely *A. anguilla* and *A. rostrata* migrate more than 2000–8000 km (Schmidt, 1923; Miller *et al*., 2019). Eels in the tropics have a shorter migration distance than eels in the subtropics. In detail, eels in the tropics, *A. celebesensis* and *A. borneensis*, are scattered in migration at a distance of 100 km from their continental habitat.

This study also signified that eels were found in the dams in Sumbawa Regency and West Sumbawa Regency. Specifically, eels were found in four dams, namely in Batu Bulan Dam, Pernek Dam, Mama Dam, Gapit Dam, Pemasar Dam and Bintang Bano Dam. The presence of eels in the dam indicated that the eels pass through the dam to migrate from upstream to downstream or vice versa. Equally important, Batu Bulan Dam, which is one of the locations where eels were found, has a distance of 23.8 km from the estuary. In short, the discovery of eels in several dams in Sumbawa and West Sumbawa depicts that the dam is a pathway for migration so the degradation of the dam will affect the migration path of the eel. Several studies have declared that the presence of dams is feared to interfere with the immigration of juvenile eels moving upstream and adult eels migrating to the sea.

The presence of eels in estuaries, dams, and up to upstream rivers denotes that eels are spread in various waters. Most importantly, several previous studies have revealed that eels are distributed in almost all freshwater, brackish, coastal, and marine environments. This is presumably because eels have a tolerance to a diverse environment. Despite of having wide environmental tolerances, however, eels also exhibit certain preferences and requirements for micro-habitats. The results of several studies depict that habitat factors include water depth, temperature, salinity, substrate, water velocity, oxygen concentration, vegetation cover, prey availability, the threat of predation, and the presence of other eels. Knowledge about habitat use by tropical eels is more limited than temperate eels. Furthermore, habitat loss, habitat modification, and habitat fragmentation are the main threats for eels. Meanwhile, according to Arai and Kadir (2017), habitat use by tropical eels (Anguilla) may be more influenced by environmental factors, such as salinity, temperature, altitude, river size, and carrying capacity, rather than ecological competition, such as interspecific competition. In addition, their tolerance will increase in line with body growth.

Table 1. The types of waters and the location of the waters where the eels are found

Type/Name of Waters	Village/Districts/ Name	Species of eel			
		Am	*Ab*	*Ac*	*Ai*
Damps					
Batu Bulan	Batu Bulan/Moyo Hulu/Sumbawa	+	+	+	+
Pernek	Pernek/Moyo Hulu/Sumbawa	+	-	-	-
Mama'	Simu/Maronge/Sumbawa	+	-	-	-
Gapit	Gapit/Empang/Sumbawa	+	-	-	-
Pemasar	Pemasar/Marange/Sumbawa	+	-	-	-
Bintang Bano	Brang Rea/Sumbawa Barat	+	-	-	-
Rivers			-	-	-
Lunyuk	Lunyuk/ Sumbawa	+	-	-	-
Selang	Selang/Unter Iwes/Sumbawa	+	-	-	-
Karang Cemes	Sumbawa/Sumbawa	+	-	-	-
Pelat	Pelat/Unter Iwes/Sumbawa	+	-	-	-
Berare	Berare/Moyo Hilir/Sumbawa	+	-	-	-
Tuang Amung	Sempe/Moyo Hulu/Sumbawa	+	+	-	-
Kalimango	Kalimango/Alas/Sumbawa	+	-	-	-
Aliran Irigasi	Jorok/Unter Iwes/Sumbawa	+	-	-	-
Leseng	Leseng/Moyo Hulu/Sumbawa	+	-	+	-
Brang Be	Leseng/Moyo Hulu/Sumbawa	+	-	+	-
Batu Rotok	Batu Rotok/Batu Lanteh/Sumbawa	+	-	-	-
Ai Jiran	Batu Rotok/Batu Rotok/Sumbawa	+	-	-	-
Brang Bara	Brang Biji/Sumbawa Besar/Sumbawa	+	+	-	-
Batu Alang	Batu Alang/Moyo Hulu/Sumbawa	+	-	-	-
Kukin	Kukin/Moyo Utara/Sumbawa	+	-	-	-
Samapuin	Samapuin/Sumbawa/ Sumbawa	+	-	-	-
Tiu Lapis	Batualang/Moyo Hulu/Sumbawa	+	-	-	-
Tiu Jukung	Batualang/Moyo Hulu/Sumbawa	+	-	-	-
Tiu Nisung	Batu Rotok/Batu Lanteh/Sumbawa	+	+	-	-
Manti	Batu Rotok/Batu lanteh/Sumbawa	+	+	-	-
Samongkat	Batu Dulang/Batu Lanteh/Sumbawa	+	-	-	-
Empang	Empang/Empang/Sumbawa	+	+	-	-
Sekongkang	Sekongkang/Sekongkang,/Sumbawa Barat	+		-	-
Pemasar	Pemasar/Maronge/Sumbawa	+	+	-	-
Pungka	Pungka/Unter Iwes/Sumbawa	+	+	+	-
Rarak Ronges	Rarak Ronges/Brang Rea/Sumbawa Barat	+	-	-	-
Estuary		+	-	-	-
Brang Biji	Brang Biji/Sumbawa Besar/Sumbawa	+	-	-	-

Description: (+) Found, (-) not found, Am = *Anguilla marmorata*, Ab = *Anguilla bicolor*, Ac = *Anguilla celebensis*, Ai = *Anguila interioris*

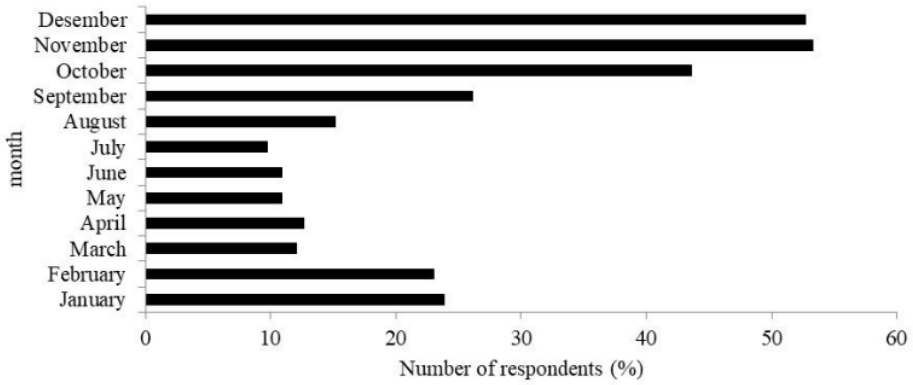

Figure 2. Dendrogram Percentage Number of respondents who make arrests in each month of the year

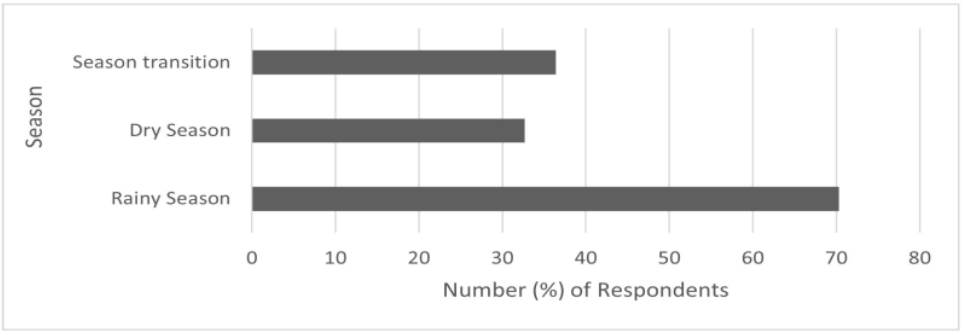

Figure 3. Dendrogram percentage number of respondents who catch eel in each fishing season

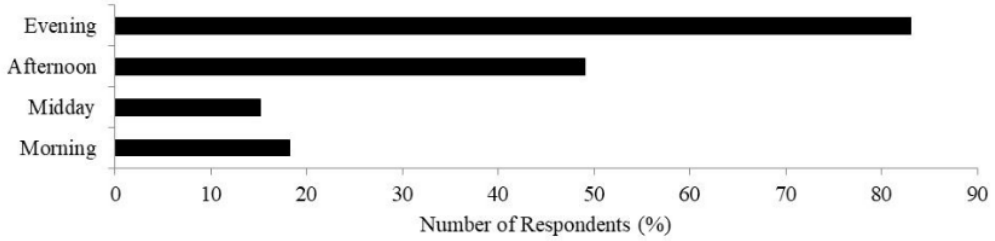

Figure 4. Dendrogram percentage of respondents who make arrests based on the daily time of the arrest

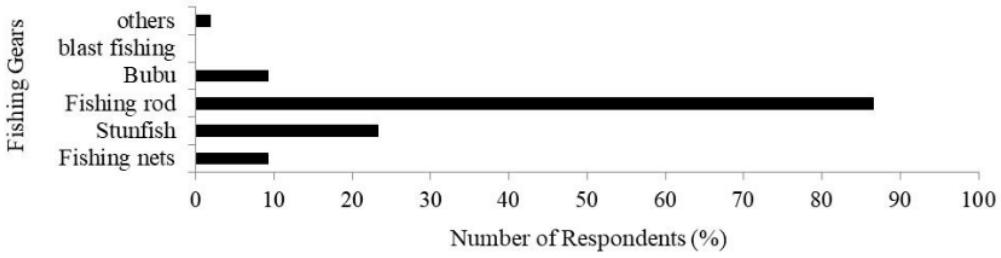

Figure 5. Dendrogram percentage of respondents who use fishing gear to catch eels (Anguilla)

Moreover, the presence of eels in various waters in Indonesia has been previously reported by several researchers, including in Dumago river and Poigor river, North Sulawesi (Sugeha *et al*., 2008, 2001; Arai *et al*., 1999), Pelabuhan Ratu estuary (Hakim *et al*., 2015); Halmahera Island (Ahmad, 2016); North Lombok (Setyono *et al*., 2018), Brayeun river (Fachrurrazi *et al*., 2019); Palu River and Poso Lake (Jamaluddin *et al*., 2018); Cikaso River (Sugianti *et al*., 2020). Arai *et al*. (1999) and Sugeha *et al*. (2001) found an abundance of glass eels at Poigar River, North Sulawesi. Not only found in Indonesia, but eels are also found in other Asian countries, including in Malaysian waters. *Anguilla marmorata* was also found in Peninsular and Borneo Island, Malaysia (Kadir *et al*., 2015; Arai and Kadir, 2017; Arai and Wong, 2016; Zan *et al*., 2020). According to Arai and Kadir (2017), habitat use by tropical eels (Anguilla) may be more influenced by environmental factors, such as salinity, temperature, altitude, river size, and carrying capacity, rather than ecological competition, such as interspecific competition. Arai *et al*. (2013) reported that *Anguilla marmorata* can live optimally in a wide range of salinity and temperature. In addition, their tolerance will increase in line with body growth (Edeline *et al*., 2006).

3.2 Pattern of Fishing

Informations of fishing aspects needs to be known because it is related to eel management. In this study, the fishing aspect that has been observed is the fishing gear used to catch eel, month, season, and time of catching. The results of interviews with respondents indicate that eel fishing is carried out throughout the year, from January to December. Most of the respondents stated that the highest number of eels was found from September to December, and the lowest was from March to August (Figure 2). Only a few of the respondents have ever found or caught eel from March to August. Based on the season, most of the respondents stated that eels were mostly found in the rainy season (Figure 3).

The peak of eel fishing based on information from local people occurs in the rainy season from September to December (Figure 2 and Figure 3). Similar results were also reported in several eel catching areas including the southern coast of Java (Haryono and Wahyudewantoro, 2016), Kupang city (Nubatonis *et al*., 2020), and the Poso river (Krismono and Putri, 2012). The increase in the number of catches during the rainy season is thought to be influenced by the increase in water mass and river discharge which can help the migration process of adult eels. However, the increase in freshwater input will affect the salinity and temperature of river and estuary. This causes physiological stress on the body of the eel so that only the eel that is able to adapt to these conditions is dominantly found, including *Anguilla marmorata*.

The time spent by respondents on one fishing trip ranged from 1 to 12 hours. The results of interviews with respondents showed that the highest intensity of eel fishing activity was carried out at night, starting at 20.00 – 24.00 WITA (Middle Indonesian Time). The high percentage of respondents who catch at night is thought to be due to eels that are generally more active at night (nocturnal) (Figure 4). Haryani and Hehanussa (2000) reported that the highest catch of eel (Anguilla) is at night with an average of 30 individuals each night, each weighing 2.5-17 kg per eel. Haryani and Hehanussa (2000) reported that the highest catch of eel (Anguilla) is at night with an average of one night catching 30 individuals, each weighing 2.5-17 kg. The high fishing activity and catches are obtained at night because the eel is nocturnal. Sugeha *et al*. (2008) reported that *Anguilla bicolor* pacifica appeared in the estuary shortly after sunset (19.00-20.00), *Anguilla marmorata* appeared throughout the night (19.00 - 05.00) during low tide, *Anguilla celebensis* and *A. interioris* arrived at the estuary in the middle night (22.00 - 03.00) when the water recedes gradually increases (high tide). The results of this study indicate that the migration mechanism in the Dumoga estuary is influenced by circadian rhythms which are regulated by environmental conditions such as the new moon period and tidal cycles that usually occur in Indonesian waters.

The fishing gear used by respondents to catch eel is quite diverse. Four types of fishing gear were identified that were used by the Sumbawa people to catch freshwater fish, including eels. Most of the respondents caught eel using fishing rods. After fishing rod, the fishing gear that is still widely used by respondents is stun. The results of the interview also showed that there were several respondents who used machetes, shovels, and yellow flower grass. This yellow flower grass is used to anesthetize eels. The machete, rake, and yellow flower grass are categorized as other fishing gear.

Fishing rods are the dominant fishing gear used by respondents to catch eels (Figure 5). The same phenomenon was also reportedby Krismono and Kartamihardja (2012), fishing rod is the dominant fishing gear used by the community to catch eel (Anguilla) in the Poso watershed, Central Sulawesi, and can catch various sizes of eel. According to Latuconsina (2020), one of the causes of the degradation of the stock of biological fish resources in the wild is the use of fishing gear that is destructive, not selective, and not environmen-

tally friendly nor friendly to the biological resources of fish that are the target of catching. According to Affandi (2005), one of the efforts that need to be considered in increasing the utilization of the eel sub-sector is the need to introduce simple and environmentally friendly eel fishing techniques. This effort is made to avoid fishing activities that are destructive and can threaten the sustainability of eel fish.

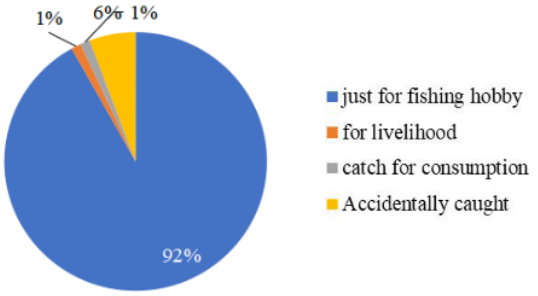

Figure 6. Diagram of the percentage of the number of respondents based on the purpose of catching eel (Anguilla)

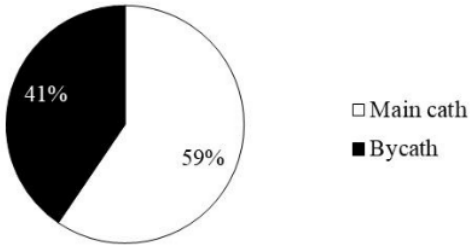

Figure 7. Diagram of the percentage of respondents based on the status of the catch of eel (Anguilla)

Information on fishing activities (age, month, time, and fishing gear) of eel (Anguilla) by the community on the island of Sumbawa becomes the basis for information on fishing patterns that must be adjusted to the biological activities of eels, for example, the activity of spawning and recruiting highway towards estuary. Thus, research information related to the biological aspects and patterns of eels on Sumbawa Island in the future must be carried out comprehensively in order to obtain a map of distribution and distribution patterns as well as the spawning season and recruitment of eels to support their management on Sumbawa Island.

3.3 Utilization and Economic Value of Eel

The results of the interviews showed that most of the respondents caught eel with the aim of channeling their hobby of fishing. Only 1.20% of respondents make eel fishing a livelihood. Others, caught eel because the eel was caught accidentally (bycatch) (Figure 6). Further information indicated that eel was not the main catch of the respondents. Of the total respondents who do fishing as a livelihood, only 40.51% of respondents use eel as their main catch (Figure 7), and 62% of respondents stated that the catches of eel they get are not marketed, but for their own consumption needs (Figure 8).

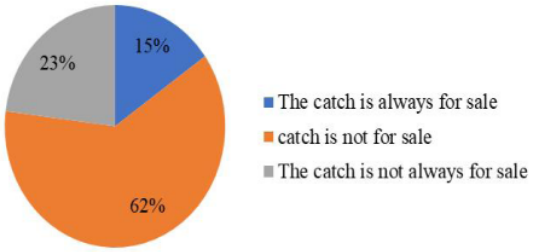

Figure 8. Diagram Number of respondents based on the use of eel (Anguilla)

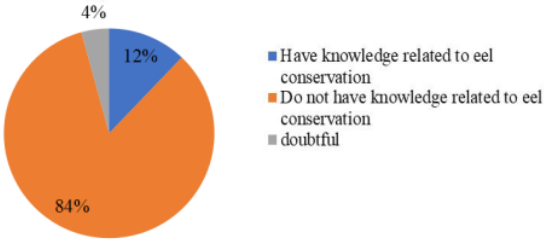

Figure 9. Diagram of the percentage of respondents based on knowledge of the protection status of eel (Anguilla) in Indonesia

In this study, three types of eel were recorded, namely (1) used for consumption with the family, (2) accidentally caught an eel, distributed to family and neighbors, and (3) sold and marketed. The results showed that only 15.20% of respondents always sold eel. Most respondents (61.80%) do not sell the eel. Based on the selling price, it is known that the selling price of eel varies between respondents. The results of the interview show that the selling price at the level of fishermen (eel catchers) is 10,000 IDR (0.71 USD) – 300,000 IDR (21.45 USD) with an average price of 150,000 IDR per individual.

The lack of utilization of eels by the people of Sumbawa Island shows that public knowledge regarding the high nutritional value of eels is still low. Nafsiyah *et al.* (2018) reported that *Anguilla bicolor* contains

16.78% protein, 13.26% fat, and 1213 g/100 g vitamins. *A. marmorata* contains nutrients, namely 17.30% protein, 21.35% fat, and 1.839 g/100 g vitamins. The two types of eel also found essential amino acids, namely leucine and glutamic acid. Leucine is the only amino acid that can slow down the degradation of muscle tissue by increasing muscle protein synthesis, optimizing growth and immune deficiency, and preventing and treating injuries. Thus, the high amino acid content in eel can be used as a source of animal protein food and nutritional fulfillment for local communities.

To introduce eel as an important fishery commodity, and can be accepted as fish for consumption by the wider community, according to Affandi (2005) there must be an effort to spread eel in the wild, especially outside the highway groove where eels are expected to grow and develop well. Through this effort, people will gradually recognize and even accept eel as fish for consumption. This strategy also needs to be supported by the introduction of various processed fish products to the public (for example jerky eel, *pepes*, soup, *kabayaki*, smoked eel, and others), both through electronic mass media and print mass media and exhibitions, and this activity takes 3-5 years optimally.

Only 15% of respondents market their caught eel (Figure 8). As many as 22% of respondents stated that the caught eel is only sometimes marketed (not always marketed), even if it is sold in fresh form, the price is relatively high, namely 150,000 IDR (10.71 USD) per individual. This high price is thought to have influenced the people's low purchasing power of eel fish resources. According to Affandi (2005), in order to increase the purchasing power of eel and to make it acceptable to the public, it is necessary to add value to eel in processed form. It is one of the strategies to optimize the utilization of eel resources.

3.4 Local Community Knowledge of Eel Conservation

The results of in-depth interviews on the knowledge of local communities about the conservation status of eel based on the Regulation of the Minister of Marine Affairs and Fisheries of the Republic of Indonesia No. 80/the year 2020 show that most of the respondents (83.64%) did not know that some eels are protected fisheries resources. In this study, it was found that only 12.12% of respondents knew that eel was included in protected fish resources (Figure 9). Others stated that the "doubtful" had knowledge related to eel protection. This indicates that respondents are not sure that they have obtained information or knowledge related to eel protection.

It is feared that this phenomenon will threaten the existence of the eel population in the wild because it is considered not a special fish, especially since people's knowledge of the bio-ecological aspects is still low. Even though the eel from the genus Anguilla according to Arai (2022) is considered an important fishery and aquaculture resource from a biological and ecological perspective, in recent decades its population has declined worldwide, due to overexploitation.

According to Latuconsina (2020), the threat to fish biological resources in Indonesia is caused by the lack of knowledge and understanding of the community about the importance of the existence of endemic and protected fish which should be a symbol of fish biodiversity in Indonesia, hence an active role from the government and other stakeholders, including universities, is needed. To massively introduce the potential of fish biological resources owned by Indonesia, including those that are endemic and protected and those in the wild, this socialization is not only on various social media but can also be considered to be developed in the school.

The results of this preliminary research are the basis for very useful scientific information to conduct a comprehensive and in-depth bioecological study of eel on the island of Sumbawa. Considering that naturally each species and sub-species of eel scattered in Indonesia may have different patterns for recruitment and spawning, as Sugeha *et al.* (2008) found that the mechanism of recruitment of eel migration in tropical estuaries in Indonesian waters differs between regions. This difference will certainly be an important information material for developing eel management strategies in different regions.

4. Conclusion

Eels are caught throughout the year with a peak from October to December, during the rainy season, and most often caught at night. However, the eel (Anguilla) has not become a special fish for the people in Sumbawa, and this condition makes eel catches categorized as by-catch. The purpose of catching eel is just a hobby. Most people do not sell their catch. This condition is also exacerbated by the low level of public knowledge about the conservation status of Eel (Anguilla).

In-depth and comprehensive bioecological research is needed on eel in the waters of the island of Sumbawa as an information base for the management of eel, and the importance of introducing eel as a food source with high nutritional content and the development of derivative products from eel to increase public

interest about eel. Intensive and massive socialization is needed regarding the conservation status of eels at all levels of society so that the existence of eels and their habitats can be well maintained so that they can be used in a measured and sustainable manner.

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Authors' Contributions

All authors contributed to the final manuscript. The contribution of each author as follow, N.K.; de-vised the main conceptual ideas, collected the data and drafted the manu-script. H.L; formulated the critical discussion and provided critical revision of the articles. I.Z; drafted the of discussion part and helped to compile information related to the research. All authors discussed the results and contributed to the final manuscript.

Conflict of Interest

The authors declare that they have no compet-ing interests.

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