Submission Files:

Fish Species Richness on the Seagrass is Suitable Evidence Considered for Conservation in Length of the South Coast Lombok Island, Indonesia

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Abstract

The concept of seagrass conservation at a global scale tends to be less suitable with environmental conditions at regional and local scales. Therefore, scientific studies at the regional and local scales are relevant as a basis for conservation action. This research aims to describe the importance of seagrass conservation based on the richness of fish species. The study collected data on the seven seagrass locations through surveys and observations. Collecting fish data uses small fishermen's tools to catch fish in the seagrass area and its surroundings. Data analysis used descriptive statistical analysis. Besides, data were analyzed using the Shannon-Wiener index (H '), Evenness Index (E) and Richness Index (D), and Cluster analysis. All statistics were assisted using IBM SPSS Statistics 25. The results of this study found 106 fish species consisting of 37 families. The ecological index value of fish species proves the environmental contribution of seagrass and fish functionality associated with seagrass habitat (food acquisition, locomotion, space). Therefore, scientific evidence of the richness of fish species at each seagrass bed in the study location can be a source of information in increasing local scale seagrass conservation efforts.

Keywords: Fish Species, Seagrass, Ecological Index, Seagrass Conservation, Local Scale.

I. Introduction

Seagrass is a higher plant that thrives in oligotrophic environments (Anton et al. 2020), and plays a vital role in human wellbeing (Rappe. 2010; Nordlund et al. 2010; Cullen-Unsworth et al. 2014), especially from fishery production on a global scale, regional and local (de la Torre-Castro et al. 2014; Nordlund et al. 2018; Unsworth et al. 2019). On the other hand, essential service provides hábitat and food to diverse marine life (Du et al. 2019; Moussa et al. 2020). However, seagrass status is under the spotlight in protection compared to other ecosystems in coastal areas, such as mangrove ecosystems and coral reefs (Waycott et al. 2009; Larkum et al. 2018). Meanwhile, ecological evidence indicates that 20% of commercial fish species are dependent on seagrass in their life cycle (Ambo-Rappe et al. 2013), and have permanent characteristics, temporal, regular, and irregular. Furthermore, seagrass cover and canopy structure positively correlate with fish species abundance (Susilo et al. 2018). Meanwhile, areas vegetated by seagrass can increase fish biomass, and the economic value per hectare is higher with areas with mangrove vegetation and tidal swamps (Jänes et al. 2020).

Seagrass is currently under threat of destruction in many places, and seagrass beds in Indonesia are under widespread threat. The implications could significantly impact local food supply and global fishery production, carbon cycling, and biodiversity conservation (Unsworth et al. 2018). Specifically, the regular source of threats is anthropogenic activity (Syukur et al. 2017), and the danger of damage is a significant challenge in conservation efforts. Obstacles in seagrass conservation efforts are (1) affirmation so that the community realizes or recognizes the importance of seagrass, (2) data and information on the current status and condition of seagrass are not yet regular, (3) management actions at the local scale have not targeted appropriate steps, (4)) efforts are needed to balance human needs and survival, (5) limited scientific research output to support conservation actions, and (6) conservation efforts are increasingly difficult in the era of climate change (Unsworth et al. 2019). Nevertheless, seagrass conservation efforts at a local scale can be achieved through affirmation and optimizing fishing communities (Jayabaskaran et al. 2018; Syukur et al. 2018). However, the information related to seagrass damage on a local scale is minimal and inadequate.

Besides, seagrass, which has a vital function in supporting food security, is still underappreciated. This condition is a factor in the difficulty of preventing seagrass degradation. Another factor is the incomplete understanding of seagrass habitats' ecosystem services, particularly those related to management in the fisheries sector. Meanwhile, seagrass ecosystems rule tends to indicate a more general coastal management (Griffiths et al., 2020). In this case, a management strategy that relies on a global scale paradigm tends not to withstand seagrass degradation from the pressure complexity.

However, scientific evidence has been used as an indicator of conservation. Therefore, local specifics are needed to be integrated into the seagrass conservation or restoration plan (de la Torre-Castro. 2006; Newmaster et al. 2011).

The local specific relevance in seagrass management is derived from seagrass ecosystem services' dominant resources, such as fish resources. The indicators of fish species diversity that are considered can include fish abundance, population, fish size, and the number and diversity of fish species in seagrass areas, such as marine protected areas (Pregiwati et al., 2015; Yuliana et al., 2019). Scientific facts support it, seagrass beds are very important for fishery production and play an essential role in the productivity and biodiversity of coral reefs and other ecosystems in coastal waters (Unsworth, & Cullen, (2010). In this case, scientific research efforts to inform policy and practice are still minimal. From 1122 articles about seagrass from 1973 to 2016 in the Asian region (including China), only 77% are about management, and only 23% are about science (Fortes, 2018). However, research related to seagrass potential, especially fish resources that can be indicators of conservation, has not been carried out. Therefore, this research is conducted to obtain scientific information about the diversity of fish species associated with seagrass. The aim is to get scientific details in seagrass conservation efforts at a scale. This research's benefit is that it can be a source. Information for seagrass conservation policies in the study location is not only for the fisheries sector, but its utilization has developed into a natural tourism object.

II. Material and Method

2.1 Site Location

The study was conducted from April to August 2020 at 7 locations (Figure 1). The research locations include East Lombok Regency (Gili Kere, Tanjung Luar, Lungkak and Poton Bakau, and Central Lombok Regency (Kute, Gerupuk, and Awang). The potential of seagrass in the study location is in Kute Bay 11 species, Grupuk Bay 10 species (Kiswara . & Winardi. 1994), and Teluk Awang 7 species (Sari et al. 2020). Furthermore, the number of seagrass species at four sampling locations in East Lombok's coastal waters is nine species (Syukur et al., 2017). Meanwhile, The environmental conditions around the seagrass area, such as Lungkak, Poton Bakau, and Awang, are close to the mangrove ecosystem, and the mangrove vegetation that grows and develops along the coast around the research location is the result of revegetation around the beginning of 1990 (Idrus et al. 2019). The area of the seagrass, such as Tanjung Luar, is adjacent to the Fish Landing Site. While the seagrass sites in Gili Kere, Gerupuk, and Kute are adjacent to coral reef ecosystems, these three seagrass locations have become a natural tourist destination on the southern coast of Lombok Island (Syukur et al. 2020).

2.2. Data collection and analysis

Data sources are primary and collected through surveys and observations—retrieval of fish data at seven predetermined locations. The fish of data is taken using fishers' fishing gear who catch fish in the seagrass area. The fishing gear used is mini-trawlers. The specifications are 80 m of net length, 1.25 inch, 1 inch, 0.75 inches, and 0.625-inch mesh, with 0.5-inch mesh pockets. The nets are pulled by fishing boats with an average speed of 5m / minute, and the length of time for each data collection is ± two hours. Every month, data collection, namely on the full moon, between 14-16 / Hijri month from April to August 2019. The fish caught are placed in the container that has been provided.

Furthermore, the fish are grouped and separated according to family and species. Identification of fish species using identification standards (Tsukamoto et al., 1997). Meanwhile, the first collected data were analyzed by descriptive statistics. Furthermore, analysis of fish diversity index (H ') using the Shannon-Waiver Index (Ludwig and Reynolds, 1988), Evenness Index (E) using the formula from Simpson and Species Richness Index (D) Morisita Distribution Index. Furthermore, a cluster analysis is performed based on the ecological index value (H ', E, and D). All statistical analyzes were assisted using IBM SPSS Statistics 25.

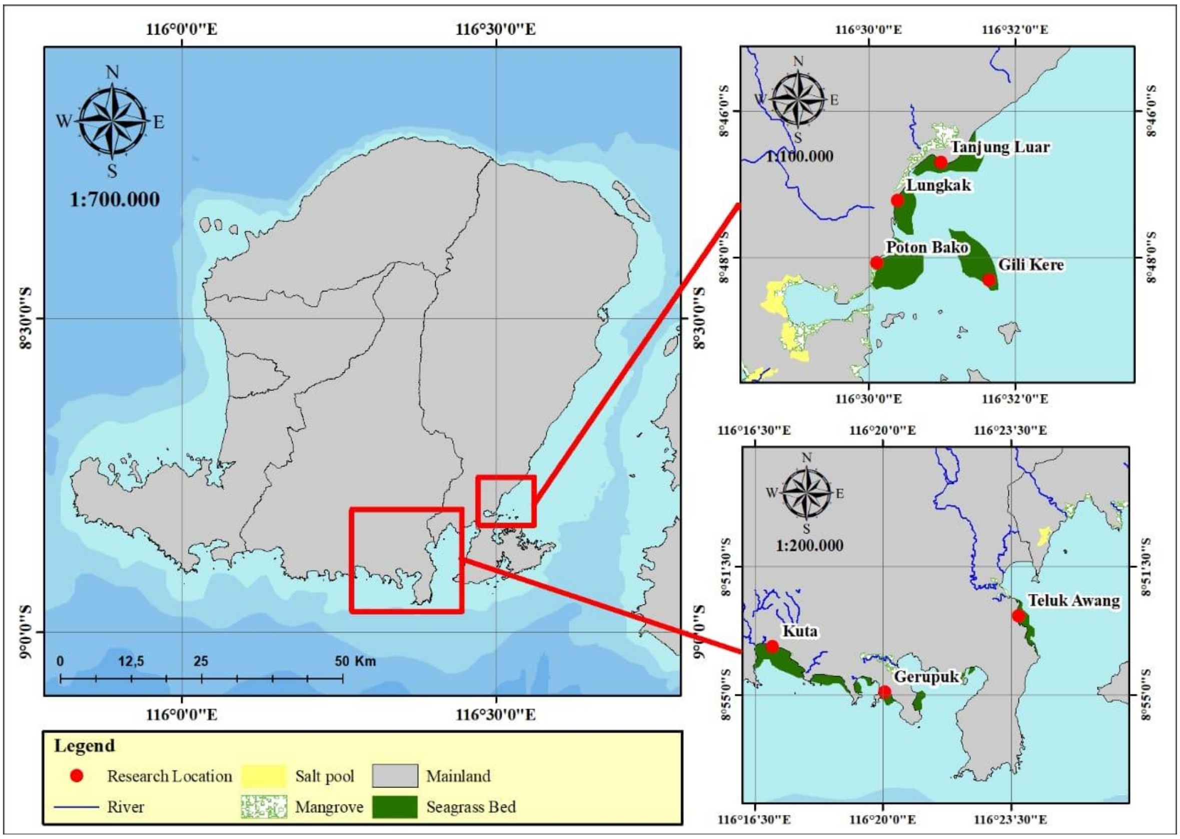

Figure 1. Research Location

III. Results and Discussion

3.1 Composition of Fish in The Study Area

The results showed that on 37 fish families covering 106 species and 20352 individuals (Table 1). The composition of the fish family (Figure 2) indicates that Leiognathidae has 10.377% species, 7.547% Carangidae and Tetraodontidae, 6. 604% Pomacentrydae, and 5,660% Apogonidae. Meanwhile, in this study, twenty fish species were found, with the number of individuals above the average number of individuals of 162.52 (Figure 3). *Archamia goni* is the species with the highest number of individuals 19.04%, *Leiognathus equulus* 11.10%, *Leiognahus bindus* 8.66%, and *Sardinella gibbosa* 6.76%. The most abundant species' composition was species with individual numbers of 0.05% - 0.147%, including 46 species (Table 1).

Table 1. Fish species associated with seagrass in the study location

Name of Species	Number of Individu/ species	Number of Individu/ Species (%)	Name of Species	Number of Individu/ species	Number of Individu/ Species (%)
Apogonichthys ocellatus	414	2.034	*Gazza minuta*	92	0.452
Archamia goni	3876	19.045	*Gazza rhombea*	269	1.322
Archamia zosteropthora	14	0.069	*Leiognahus bindus*	1762	8.658
Foa bracygramma	3	0.015	*Leiognathus daura*	229	1.125
Cheilodipterus macrodon	9	0.044	*Leiognathus equulus*	2259	11.100
Cheilodipterus macrodon	42	0.206	*Leiognathus rapsoni*	56	0.275
Atherinomirus lacunosus	30	0.147	*Secutor interpuptus*	127	0.624
Atherinomirus duodecimalis	2	0.010	*Ambassis urotaenia*	27	0.133
Alticus saliens	72	0.354	*Gazza achlamys*	15	0.074
Andarnia tetradactylus	5	0.025	*Leiognathus splendens*	456	2.241
Petroscirtes variabilis	89	0.437	*Leiognathus oblongus*	345	1.695
Bothus pantherinus	30	0.147	*Lethrinus variegates*	24	0.118
Atule mate	153	0.752	*Gymnocranius elongates*	64	0.314
Caranx ignobilis	226	1.110	*Lutjanus lutjanus*	91	0.447
Scomberoides tala	40	0.197	*Lutjanus erythropterus*	64	0.314

Scomberinemus lysan	500	2.457	*Lutjanus argentimaculatus*	108	0.531
Caranx melampygus	108	0.531	*Lutjanus boutton*	103	0.506
Caranx sexfasciatus	393	1.931	*Acreichthys tomentosus*	409	2.010
Selar crumenophthalmus	142	0.698	*Acreichthys sp*	68	0.334
Trachinotus blochii	73	0.359	*Moolgarda delicates*	109	0.536
Ambassis buruensis	968	4.756	*Empheris oualensis*	22	0.108
Sardinella gibbosa	1376	6.761	*Upeneus sulphureus*	84	0.413
Sardinella lemuru	987	4.850	*Upeneus tragula*	24	0.118
Paraplagusia bilineata	28	0.138	*Upeneus vittatus*	476	2.339
Cyanoglosus puntisep	18	0.088	*Plotosus lineatus*	3	0.015
Cyanoglosus lungua	22	0.108	*Polynemus pelbeius*	9	0.044
Paraplagusia blochi	29	0.142	*Filimanus xanthonema*	162	0.796
Diodon litorosus	6	0.029	*Abudefduf notatus*	16	0.079
Platax boersi	20	0.098	*Amphiprion frenathus*	11	0.054
Stolephorus indicus	93	0.457	*Neopomacentris azysron*	55	0.270
Thryssa setirostris	9	0.044	*Pomacentrus lepidogenys*	5	0.025
Stolepholus commersonnii	54	0.265	*Abudefduf vaigiensis*	11	0.054
Stolephorus indicus	175	0.860	*Abudefduf sexfasciatus*	1	0.005
Fistularia commersonii	38	0.187	*Abudefduf septemfasciatus*	6	0.029
Gerres abbreviatus	53	0.260	*Leptoscarus vaigiensis*	33	0.162
Gerres erythrourus	1	0.005	*Colotomus spinidens*	24	0.118
Gerres filamentosus	370	1.818	*Epinephelus bontoides*	66	0.324
Gerrres oyena	44	0.216	*Siganus canaliculatus*	62	0.305
Hemiramphus far	144	0.708	*Siganus guttatus*	42	0.206
Plectorhinchus flavomaculatus	211	1.037	*Siganus argentheus*	12	0.059
Plectorhinchus celebicus	54	0.265	*Sphyraena flavicauda*	46	0.226
Thallassoma hardwickii	3	0.015	*Sphyraena barracuda*	25	0.123
Helichoeres papilionaceus	2	0.010	*Sillago macrolepis*	421	2.069
Sillago chondropus	121	0.595	*Canthigaster compressa*	51	0.251
Sillago sihama	389	1.911	*Chelonodon patoca*	51	0.251
Johnius amblycephalus	7	0.034	*Lagocephalus lunaris*	3	0.015
Johnius borneensis	2	0.010	*Lagocephalus ivheeleri*	12	0.059
Johnius macropterus	6	0.029	*Langocephalus gloveri*	8	0.039
Ablabys taenianotus	4	0.020	*Takifugu radiates*	2	0.010
Syngnathoides biaculeatus	2	0.010	*Arothron immaculatus*	179	0.880
Saurida nebulosa	47	0.231	*Arothron manilensis*	118	0.580
Saurida gracilis	2	0.010	*Triacanthus nieuhofi*	36	0.177
Synodus dermatogenys	4	0.020	*Trichiurus lepturus*	89	0.437
Total number of Individu	11510		Total number of Individu	8842	

Another study on the richness of fish species in seagrass is on the Jordanian coast, 35 families of fish (Khalaf et al. 2012). Furthermore, in Ban Pak Klong, Thailand 35 fish families (Phinrub et al .. 2014), Gazi Bay Kenya 41 fish families (Musembi et al .. 2019), Karang Congkak Island Kepulauan Seribu National Park Indonesia 26 fish families (Simanjuntak et al. 2020), and at Jervis Bay Marine Park New South Wales Australia fish families of 24 families (Kiggins et al .. 2019). Besides, in the Quirimba Archipelago Northern Mozambique, the dominant fish species is *Siganus sutor*, *Leptoscarus vaigiensis*, *Lethrinus variegatus*, *Lethrinus lentjan* and *Gerres oyena* (Gell. & Whittington. 2002), Thailand's Pak Klong Ban are *Sillago sihama*, *Leiognathus jonesi* and *Gerres erythrourus* (Phinrub et al. 2014).

Muara Binuangeun Lebak Banten, the dominant species, is *Moolgarda sp* and *Istiblennius edentulus* (Kholis et al. 2017). Next, *Spratelloides gracilis*, *Stenatherina panatela*, *Siganus canaliculatu*, *Gerresoyena sp*, and Siganusspinus sp are the dominant seagrass species beds of Karang Congkak Island, Kepulauan Seribu National Park Indonesia (Simanjuntak et al .. 2020). In Youtefa Bay, Jayapura, Papua, the dominant species are *Scolopsis lineata*, *Apogon ceramensis*, *Parupeneus barberinus*, *Aeliscus strigatus*, *Siganus fuscescens*, and *Siganus canaliculatus* (Tebaiy et al. 2017). The richness of different fish species between seagrass beds, incredibly dominant species, is the primary value of seagrass as a fish habitat (Nordlund et al. 2018). Furthermore, this information can become a scientific basis for seagrass conservation efforts at each seagrass area scale, such as at the study site.

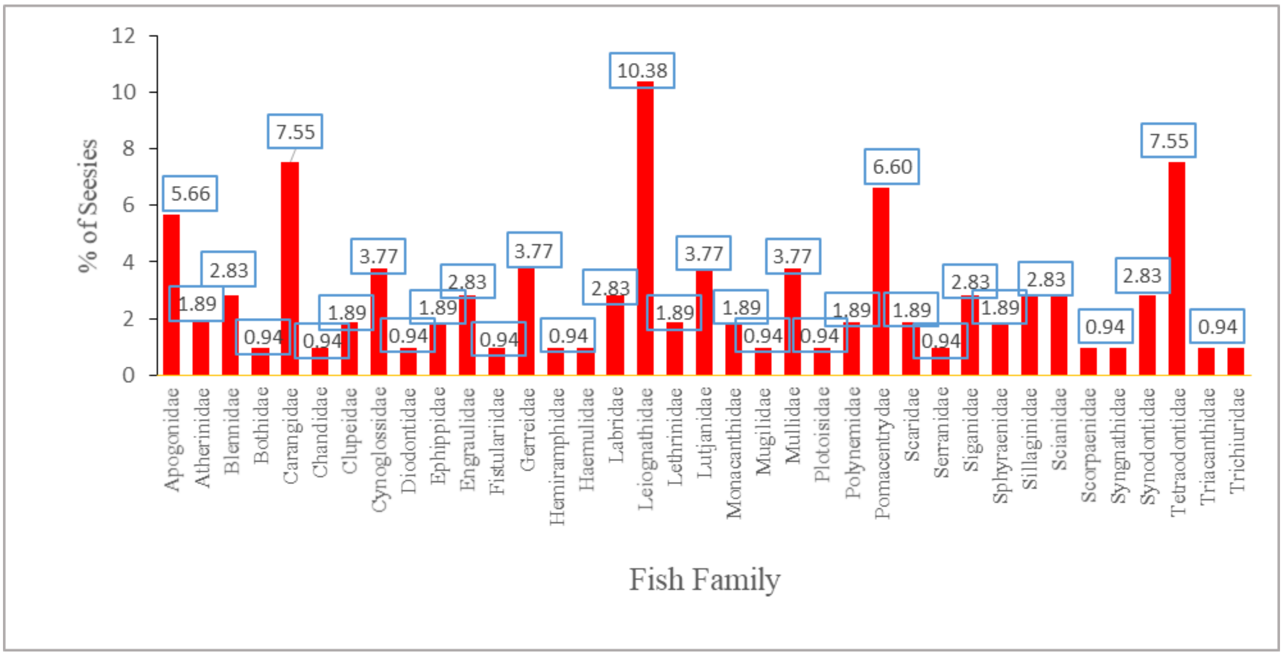

Figure 2. Composition of fish families based on the number of species in the study location

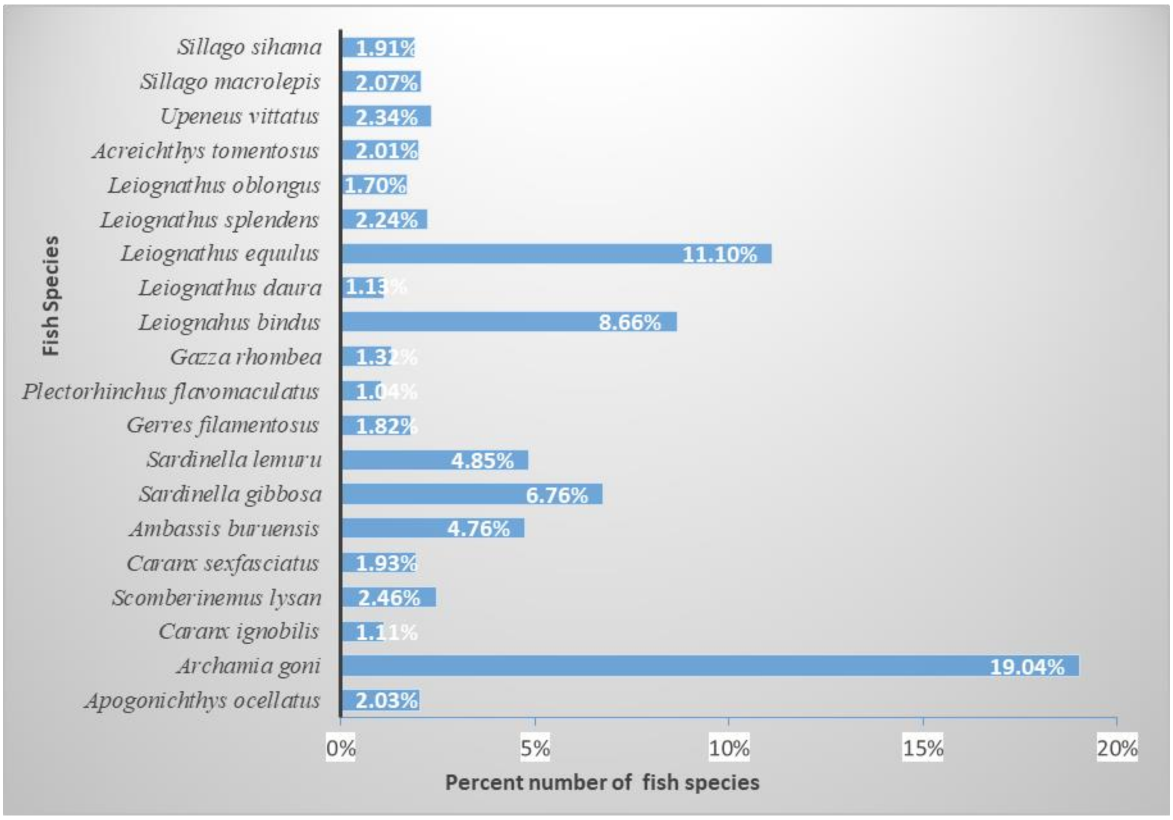

Figure 3. Fish species with an above-average number of individuals

3.2. Ecological Index of Fish Species Associated with Seagrass in the Study Site

The existence of fish species in seagrass (Figures 2, 3, and Table 1) describes the composition of fish species found during the study period. The results of the analysis of the ecological index of fish species by location (Figure 4). The distribution of the diversity index value at all seagrass locations is from 2.40 to 2.80, with an average value of 2.61. Meanwhile, the index of species richness value distribution is between 2.14 - 8.47, with an average value of 7.74.

Furthermore, the distribution of ecological index values for fish species by month (Table 2). In this case, the three indicators of fish species' environmental index are sufficient as evidence of seagrass's ecological services for fish communities' existence. Like, the diversity index value can correlate with community stability. Meanwhile, the evenness index value correlates with the concentration of the distribution of species. Furthermore, the richness index value correlates with the number of species found at each study location.

Variations in the ecological index value of fish species, such as in the study location, are implications derived from the condition of seagrass vegetation and its environment. For example, the seagrass environment on the Lungkak, Poton Bakau, and Awang beaches are the seagrass beds' location adjacent to the mangrove environment. Meanwhile, Gili Kere, Tanjung Luar, Gerupuk, and Kute are close to the coral reef environment. Even so, the ecological index value of fish species found in the study location can provide environmental evidence that the presence of seagrass is needed by marine organisms to survive, such as fish. In this case, the function is very vital in providing food, rearing, and protection from predators, especially fish biodiversity (Jackson et al., 2001; Heck et al., 2003; Bertelli & Unsworth, 2014; Prasetya & Purwanti, 2017; Hidayati & Suparmoko, 2018).

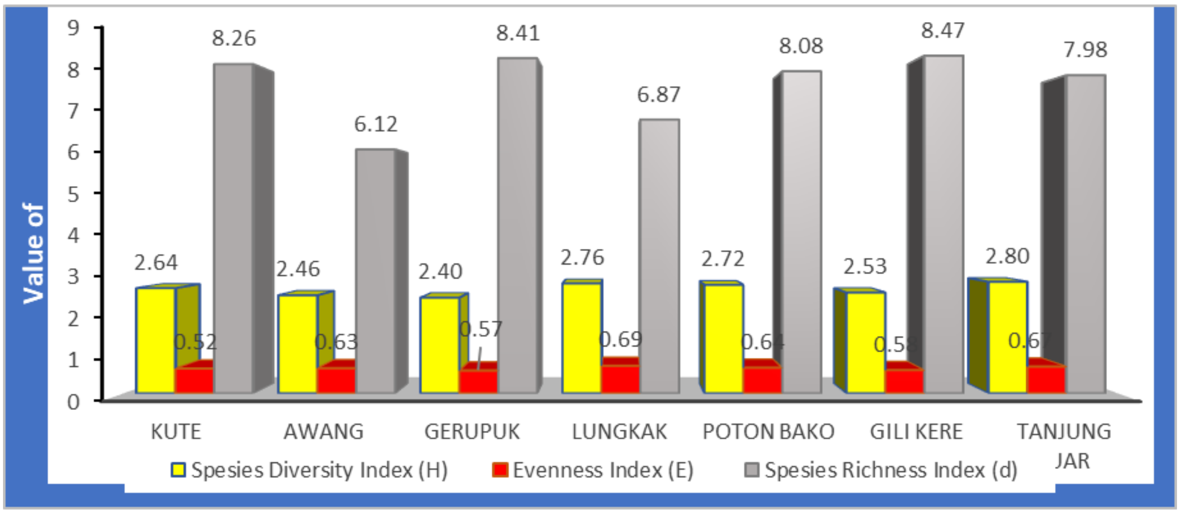

Figure 4. Diversity Index, Evenness Index, and Richness Index in the Study Area

In connection with fish in seagrass in the study location, maintaining fish habitat, such as preventing or restraining the damage rate, is crucial. The implication is not only a positive impact on the preservation of fish and other marine biota resources. Still, it can be an indicator in efforts to conserve and manage ecosystem-based coastal resources. Also, seagrass protection efforts can prevent the degradation or loss of seagrass ecosystem services in coastal waters' ecological systems, especially for protecting marine biodiversity. Still, on the other hand, the damage to seagrass can have negative implications for decreasing the productivity of marine resources, disrupting trophic interactions, and reducing stability. Natural ecological systems in the marine environment (Duffy, 2006; Best & Stachowicz, 2012; Duffy et al., 2015). Besides, there is no doubt that the loss of seagrass populations will hurt fish habitats and carbon storage (Patro et al., 2017; Mishra et al., 2019).

Meanwhile, the value of Standard Deviation, such as the highest diversity index, is Tanjung Luar. The lowest is Gerupuk, and in full, the Standard Deviation score for all ecological index (Table 3). The value of Standard Deviation of the ecological fish index (Diversity, evenness, and richness) can explain the number of individuals of each species against the average value. Meanwhile, the Standard Deviation value of the evenness index at all sampling locations has a relatively similar value. It shows that no individual's concentration is too dominant. Furthermore, the Standard Deviation value of the lowest species richness is Awang Bay. It is possible due to the complexity of the Awang Bay waters' habitat, which is only supported by mangroves' presence around the seagrass beds. It is different from other locations; apart from being supported by mangroves' existence, the seagrass area has coral reefs.

Table 2. The distribution of ecological index values for fish species by month

Location	Index	Month				
		April	May	June	July	August
Kute	Species Diversity Index (H)	2.31	2.52	2.99	2.64	2.76
	Evenness Index (E)	0.57	0.65	0.88	0.82	0.84
	Species Richness Index (d)	8.04	8.21	8.80	8.72	8.76
Awang	Species Diversity Index (H)	2.11	2.32	2.71	2.46	2.68
	Evenness Index (E)	0.6	0.62	0.76	0.73	0.74
	Species Richness Index (d)	6.04	6.26	6.48	6.31	6.41
Gerupuk	Species Diversity Index (H)	2.09	2.18	2.64	2.28	2.56
	Evenness Index (E)	0.61	0.63	0.79	0.71	0.74
	Species Richness Index (d)	7.93	8.21	8.88	8.49	8.67
Lungkak	Species Diversity Index (H)	2.46	2.65	2.99	2.73	2.97
	Evenness Index (E)	0.69	0.72	0.86	0.78	0.84
	Species Richness Index (d)	6.42	6.62	7.09	6.78	6.88
Poton Bako	Species Diversity Index (H)	2.38	2.43	2.97	2.87	2.93
	Evenness Index (E)	0.69	0.73	0.82	0.79	0.81
	Species Richness Index (d)	7.56	7.79	8.2	8.04	8.11
Gili Kere	Species Diversity Index (H)	2.12	2.21	3.01	2.59	2.73
	Evenness Index (E)	0.71	0.75	0.98	0.89	0.92
	Species Richness Index (d)	8.14	8.23	8.91	8.41	8.76
Tanjung Luar	Species Diversity Index (H)	2.51	2.71	2.98	2.93	2.87
	Evenness Index (E)	0.65	0.71	0.89	0.81	0.82
	Species Richness Index (d)	7.21	7.41	8.11	7.76	7.89

Table 3. Value of Standard Deviation of Seagrass Ecological Index at the Study Site

Indeks	Lokasi						
	Kute	Awang	Gerupuk	Lungkak	Poton Bako	Gili Kere	Tanjung Luar
Spesies Diversity Index (H)	2.64±0.26	2.46±0.25	2.35±0.24	2.76±0.22	2.72±0.29	2.53±0.37	2.80±0.19
Evenness Index (E)	0.75±0.13	0.69±0.07	0.70±0.08	0.78±0.07	0.77±0.06	0.85±0.12	0.78±0.10
Spesies Richness Index (D)	8.51±0.35	6.30±0.17	8.44±0.37	6.76±0.25	7.94±0.26	8.49±0.33	7.68±0.36

The results of the Cluster Analysis (Figure 5) show that Poton Bakau and Gili Kere have a degree of similarity of 0.029. Meanwhile, Awang and Lungkak are 0.040, and Awang and Kute are 0.055. Furthermore, Tanjung Luar has a similarity level with Poton Bakau and Gili Kere of 0.154. However, Gerupuk is a location that has a group of difference from all sampling locations. The clustering results can explain the differences in the composition of fish species in each area of the seagrass beds in the study location. In this case, the seagrass habitat influences both spatially and or temporally, such as the different ocean currents patterns between areas. However, the variation in the size of the mosaic plots in the seagrass beds showed a positive relationship with fish biomass (Staveley et al., 2020). Other factors that have significant influence are seagrass habitat architecture and can affect the total biomass of fish, and specialist species seagrass such as syngnathids (Scapin et al., 2018). Therefore, although this study did not explore the seagrass habitat structure, the specific environmental conditions influenced the collected fish's species composition. For example, in Awang and Lungkak, which have the closest similarity, the two locations' environment is very close to the mangrove environment. Besides, it can describe the ecological Connectivity of seagrass presence with other habitats, such as mangroves and coral reefs.

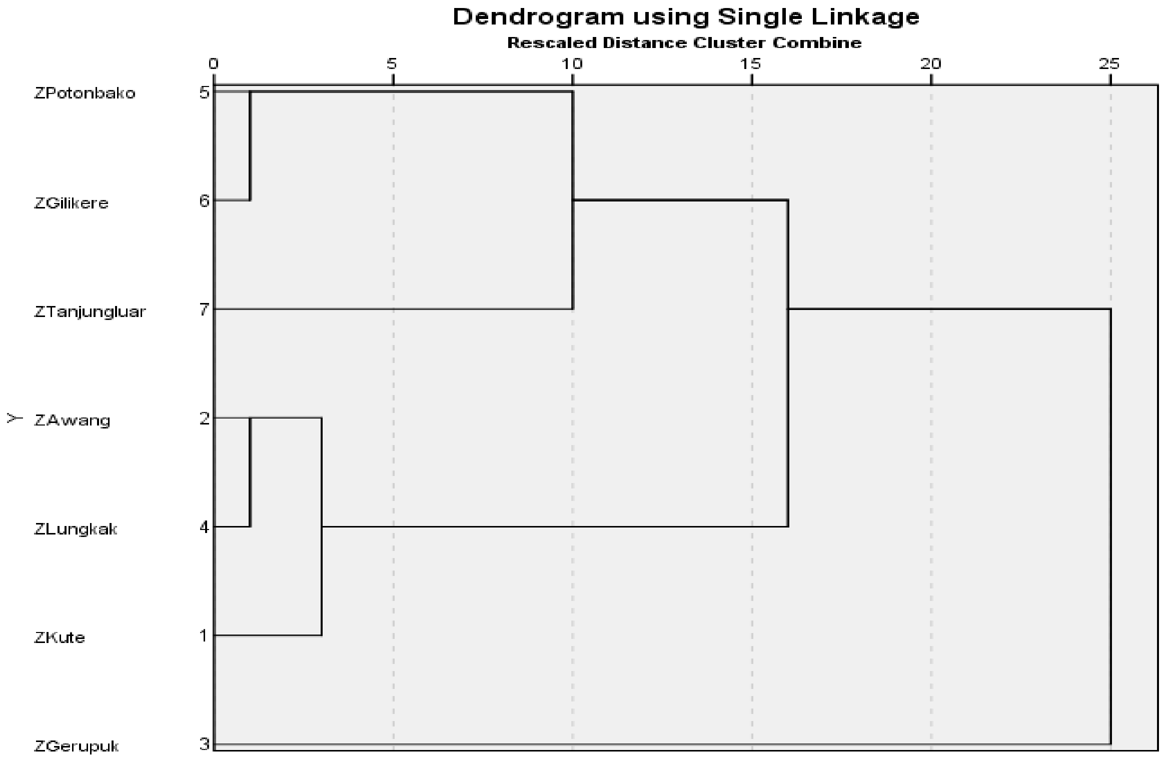

Figure 5. Cluster analysis of euclidean distance

3.3. Seagrass Conservation

The study of seagrass provisioning services, particularly for fish resources, emphasizes seagrass conservation at regional and local scales, such as in the study sites. It is evident that many seagrass areas are experiencing degradation, which has a vital role, is experiencing a threat of damage. The danger for seagrass in Lombok Island's coastal waters is from anthropogenic activities (Syukur et al., 2017). Also, the right seagrass conditions' status is the primary source or determinant of small-scale fishers (Cullen-Unsworth et al., 2014; de la Torre-Castro et al., 2014). Meanwhile, seagrass restoration in southern Australia has increased 15 commercial fish species (Blandon, & Zu Ermgassen, 2014). Eight commercial fish species are associated with seagrass and production, with an average monetary value of 95.75 €/ha/year. When linked to market price standards, the matter can be 67 030.30 €/year in one area found long ago (Tuya et al., 2014). In this respect, the richness of fish species in the study area, which includes 106 species and is dominated by commercial fish species (Table 1), is scientific evidence that can the considered for local scale seagrass conservation.

This study can prove that the presence of fish species at each location of the seagrass beds can not only be explained as an implication of seagrass's ecological function. However, the species abundance that has been shown by the environmental index values at all study locations is the functional form of fish species or the operational characteristics of fish associated with seagrass habitats. In this case, the associated functions are food acquisition, locomotion, space, and matrix (Villéger et al., 2010; Mouillot et al., 2013). Meanwhile, although fish species' composition can be different, the functional status is the same, as in the study location (Figure 6). This has to do with the nature of fish mobility or its attachment to habitat characteristics. This study proves that not all fish species are in one location (Table 4). However, there were 26.41% found in all areas and 7.54% at one location. Therefore, this study's results are sufficient as scientific information on conservation efforts or integrated management of seagrass in a sustainable management system. This evidence is also quite relevant to the spatial distribution of fish ecological functions in changing management priorities to improve conservation performance in seagrass ecosystems (Unsworth, & Cullen, 2010; Henderson et al., 2019). (Unsworth & Cullen, 2010; Henderson et al., 2019).

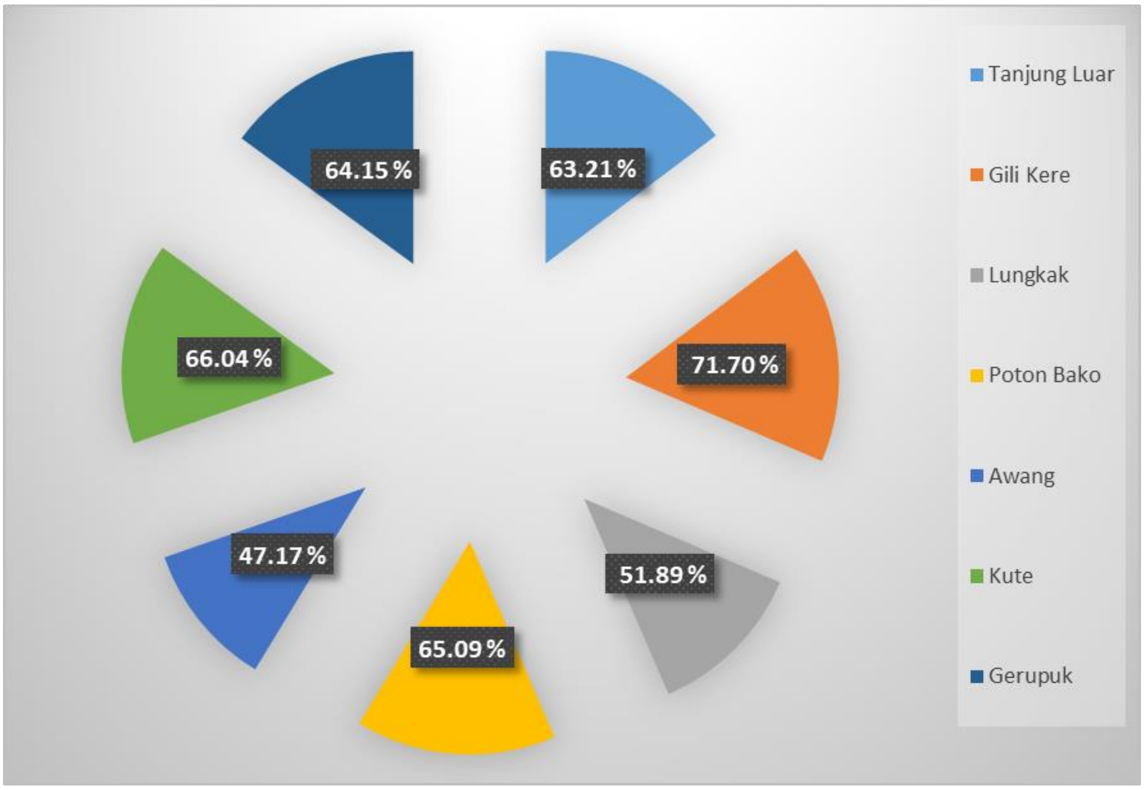

Figure 6.% number of fish species at each seagrass bed in the study location

Table 4. Spatial distribution of fish species in the study location

Frequency of Species	Composition of Species	Number of Species
All Location	*Acreichthys tomentosus, Ambassis buruensis, Archamia goni, Canthigaster compressa, Caranx ignobilis, Caranx melampygus, Caranx sexfasciatus,, Chelonodon patoca, Colotomus spinidens, Epinephelus bontoides, Fistularia commersonii, Gazza minuta, Gazza rhombea, Leiognathus bindus, Leiognathus daura, Leiognathus equulus, Leiognathus rapsoni, Lutjanus argentimaculatus, Lutjanus boutton, Lutjanus erythropterus, Moolgarda delicates, Sardinella gibbosa, Saurida nebulosi, Secutor interpuptus, Siganus canaliculatus, Sillago sihama, Stolephorus indicus, Upeneus vittatus.*	28
Six location	*Abudefduf vaigiensis, Ambassis urotaenia, Gerres filamentosus, Paraplagusia blochi, Scomberinemus lysan, Sillago macrolepis, Stolepholus commersonnii, Bothus pantherinus, Sardinella lemuru*	9
Five location	*Alticus saliens, Arothron immaculatus, Arothron manilensis, Atule mate, Gazza achlamys, Leiognathus oblongus, Platax boersi, Plectorhinchus celebicus, Plectorhinchus flavomaculatus, Selar crumenophthalmus, Sillago macrolepis*	11
Four location	*Abudefduf notatus, Cheilodipterus macrodon, Hemiramphus far, Leiognathus splendens, Siganus guttatus, Sphyraena barracuda, Sphyraena flavicauda, Triacanthus nieuhofi, Upeneus sulphureus*	9
Three Location	*Abudefduf septemfasciatus, Acreichthys sp, Apogonichthys ocellatus, Archamia zosteropthora, Atherinomirus lacunosus, Cyanoglosus lungua, Cyanoglosus puntisep, Filimanus xanthonema, Gymnocranius elongates, Johnius amblycephalus, Johnius macropterus, Lagocephalus ivheeleri* *Lagocephalus lunaris, Leptoscarus vaigiensis , Lethrinus variegates, Plotosus lineatus , Polynemus pelbeius, Pomacentrus lepidogenys, Sillago chondropus, Thallassoma hardwickii,*	23

	Trachinotus blochii, Trichiurus lepturus, Upeneus tragula	
Two Location	*Amphiprion frenathus, Atherinomirus duodecimalis, Cheilodipterus quenquelinatus, Diodon litorosus, Empheris oualensis, Foa bracygramma, Gerres abbreviates, Gerrres oyena, Helichoeres papilionaceus, Johnius borneensis, Langocephalus gloveri, Lutjanus lutjanus, Paraplagusia bilineata, Petroscirtes variabilis, Saurida gracilis, Scomberoides tala, Siganus argentheus, Synodus dermatogenys*	18
One Location	*Abudefduf sexfasciatus, Andarnia tetradactylus, Gerres erythrourus, Neopomacentris azysron, Syngnathoides biaculeatus, Takifugu radiates, Thryssa setirostris, Ablabys taenianotus*	8
Total Number of Species		106

.IV. Conclusions

The diversity of fish species found in the seagrass area in the study location is ecological evidence of seagrass's contribution to the sustainability of fish species. Furthermore, fish species' ecological indexes, such as diversity index, Evenness Index, and meat species Richness, are indicators for seagrass conservation in the study location. Therefore, this study's results can become a scientific basis for seagrass conservation at local and regional scales. Seagrass conservation efforts at various scales, especially outside protected areas, such as in study locations and other locations, are urgently needed to protect and preserve marine biodiversity and residents' economic sustainability.

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Author's Contributions

Agil Al Idrus. Abdul Syukur and Lalu Zulkifli: Conducted all experiments. Observation data analysis and preparation of the paper manuscript.

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Reviewer's Attachments

~~F~~fish species richness ~~on the seagrass~~ providesis ~~suitable~~ evidence ~~considered for~~ to support conservation ~~in length o~~alongf the South Coast of Lombok Island, Indonesia

Abstract. [H1]The concept of seagrass conservation at a global scale tends to be less ~~suitable~~ appropriate with regard to ~~with~~ environmental conditions at regional and local scales. Therefore, scientific studies at the regional and local scales are relevant and needed as a basis for conservation action. This research ~~aims~~ aimed to describe the importance of seagrass conservation based on the species richness of seagrass-associated fishes ~~species~~. ~~The study~~We collected data[H2] ~~on~~ from~~the~~ seven seagrass locations ~~through~~ using surveys and observation methodss. Data on the fish species present were c~~C~~ollected ~~ing fish data us~~with gear used by small-scale ~~es small~~ fishermen~~'s tools~~ to catch fish in the seagrass area and ~~its~~ the surrounding waterss. Data analysis was descriptive; statistical analyses performed included calculation of the Shannon-Wiener ~~indices~~ Index of Diversity (H '), the Simpson ~~and~~ Evenness Index (E), and ~~and~~ the Morisita Species~~????~~ Richness Index (D), as well as Cluster analysis. All statistical analyses were performed in IBM SPSS Statistics 25. ~~The results of this study~~We found 106 fish species ~~consisting of~~belonging to 37 families. The values of the ecological ~~index~~ indices ~~value of fish species proves~~strongly support the environmental contribution of seagrass ecosystems and fish functionality associated with seagrass habitat (food acquisition, locomotion, space). Therefore, scientific evidence of the species richness of fish ~~species~~ at each seagrass bed in the study location can be used as a source of information ~~in~~ for increasing and improving local scale seagrass conservation efforts.

Keywords: Fish ~~Species~~diversity[H3], ~~Seagrass~~[H4], Ecological Index, Seagrass Conservation, Local Scale

INTRODUCTION

Seagrass is a higher plant that thrives in oligotrophic environments (Anton et al. 2020), and plays a vital role in human wellbeing (Ambo-Rappe. 2010; Nordlund et al. 2010; Cullen-Unsworth et al. 2014), especially from fishery production on ~~a~~ global ~~scale~~, regional and local scales (de la Torre-Castro et al. 2014; Nordlund et al. 2018; Unsworth et al. 2019). On the other hand, essential services provide~~s~~ ~~hábitat~~habitat and food to diverse marine life (Du et al. 2019; Moussa et al. 2020). However, seagrass status and -protection ~~is~~ rarely come under the spotlight in ~~protection~~ ~~compared~~ comparison to other ecosystems in coastal areas, such as mangrove ecosystems and coral reefs (Waycott et al. 2009; Larkum et al. 2018). Meanwhile, ecological evidence indicates that 20% of commercial fish species are dependent on seagrass in their life cycle (Ambo-Rappe et al. 2013), ~~and have~~ as permanent ~~characteristics~~, temporary~~l~~, regular, ~~and~~ or irregular residents. Furthermore, seagrass cover and canopy structure positively correlate with fish species abundance (Susilo et al. 2018). Meanwhile, areas vegetated by seagrass can increase fish biomass, and the economic value per hectare ~~is~~ has been estimated to be higher compared to ~~with~~ areas with mangrove vegetation and tidal swamps (Jänes et al. 2020).

Seagrass is currently under threat of destruction in many places, and seagrass beds in Indonesia are under widespread threat. The implications could significantly impact local food supply and global fishery production, carbon cycling, and biodiversity conservation (Unsworth et al. 2018). Specifically, the regular source of threats is anthropogenic activity (Syukur et al. 2017), and the danger of damage is a significant challenge in conservation efforts. Obstacles in seagrass conservation efforts are (1) affirmation so that the community realizes or recognizes the importance of seagrass, (2) data and information on the current status and condition of seagrass are not yet regular, (3) management actions at the local scale have not targeted appropriate steps, (4)) efforts are needed to balance human needs and survival, (5) limited scientific research output to support conservation actions, and (6) conservation efforts are increasingly difficult in the era of climate change (Unsworth et al. 2019). Nevertheless, seagrass conservation efforts at a local scale can be achieved through affirmation and optimizing fishing ~~communities~~ community participation (Jayabaskaran et al. 2018; Syukur et al. 2018). However, the information related to seagrass damage on a local scale is minimal and inadequate.

~~Besides, s~~Seagrass~~es~~, which ~~has~~ have a vital function in supporting food security, ~~is~~ are still widely underappreciated. This ~~condition~~ situation is a factor in the difficulty of preventing seagrass degradation. Another factor is the incomplete understanding of the ecosystem services provided by seagrass habitats~~' ecosystem services~~, particularly those related to management in the fisheries sector. Meanwhile, seagrass ecosystems rule tends to indicate a more general coastal management[H5] (Griffiths et al., 2020). In this case, a management strategy that relies on a global scale paradigm tends not to withstand seagrass degradation from the pressure complexity. However, scientific evidence has been used as an indicator of conservation[H6]. Therefore, local specifics ~~are~~ need~~ed~~ to be integrated into the seagrass conservation or restoration plan (de la Torre-Castro. 2006; Newmaster et al. 2011).

The local specific relevance in seagrass management is derived from seagrass ecosystem services' dominant resources, such as fish resources.[H7] The indicators of fish species diversity that are considered can include fish abundance, population, fish size, and the number and diversity of fish species in seagrass areas, such as marine protected areas (Pregiwati et al., 2015; Yuliana et al., 2019). Scientific facts support ~~it~~the contention that ~~,~~ seagrass beds are very important for fishery production and play an essential role in the productivity and biodiversity of coral reefs and other ecosystems in coastal waters (Unsworth, & Cullen, (2010). However, ~~In this case,~~ scientific research efforts to inform policy and practice in this regard are still minimal. From 1122 articles ~~about~~ on seagrass published from 1973 to 2016 in the Asian region (including China), ~~only~~ 77%[H8] are about management, and only 23% are about science (Fortes, 2018). However, there has been little research related to seagrass potential[H9], especially on fish resources[H10] that can be indicators of conservation[H11]~~, has not been carried out~~. Therefore, this research ~~is~~ was conducted to obtain scientific information ~~about~~ on the diversity of fish species associated with seagrass. The aim ~~is to get~~was to provide detailed scientific knowledge as a basis for ~~details in~~ seagrass conservation efforts at a local scale. Th~~is~~e output from this ~~rese~~research can serve as a source of ~~arch's benefit is that it can be a source. I~~information for seagrass conservation policies in the study location, ~~is~~ not only for the fisheries sector, but also for ~~its utilization has developed into a~~development of seagrass beds as natural tourism objects.

MATERIAL AND METHOD

Site location

The study was conducted from April to August 2020 at 7 locations (Figure 1)~~. The research locations include~~ in East Lombok Regency (Gili Kere, Tanjung Luar, Lungkak and Poton Bakau)~~,~~ and Central Lombok Regency (Kute, Gerupuk, and Awang). The ~~potential of~~ seagrass species ~~in~~ reported from the Central Lombok study locations are: ~~is in~~ Kute Bay 11 species, Grupuk Bay 10 species (Kiswara . & Winardi. 1994), and Teluk Awang 7 species (Sari et al. 2020), while nine ~~. Furthermore, the number of~~ seagrass species ~~at~~ have been reported from four sampling locations in East Lombok~~'s coastal waters is nine species~~ (Syukur et al., 2017). ~~Meanwhile, The~~In terms of the environmental conditions around the seagrass areas, some sites such as Lungkak, Poton Bakau, and Awang were~~, are~~ close to the mangrove ecosystem. Most of the mangrove vegetation along the coast around the research locations is the result of replanting efforts in the early 1990's (Idrus et al. 2019).~~, and the mangrove vegetation that grows and develops along the coast around the research location is the result of revegetation around the beginning of 1990 (Idrus et al. 2019).~~ While t~~T~~he seagrass area ~~of the seagrass, such as~~ at Tanjung Luar~~,~~ is adjacent to the Fish Landing Site, ~~. While~~ the seagrass sites in Gili Kere, Gerupuk, and Kute are adjacent to coral reef ecosystems, and the~~se~~ latter three seagrass locations have become ~~a natural~~ nature ~~tourist~~ tourism destinations on the southern coast of Lombok Island (Syukur et al. 2020).

Data collection and analysis

~~Data sources are p~~Primary ~~and~~ data were collected through survey~~s~~ and observation methods~~s — retrieval of fish data~~ at the seven predetermined locations. The data on fish species at each location were collected ~~of data is taken~~ using ~~fishers'~~ fishing gear belonging to fishers[H12] who generally catch fish in the seagrass area. The fishing gear used is a kind of mini-trawl~~ers~~. The specifications ~~a~~ were: net length 80 m ~~of net length~~ with ~~,~~ 1.25 ~~inch~~", 1 ~~inch~~", 0.75 ~~inche~~"~~s~~, and 0.625~~'~~" ~~inch~~ mesh-size, and ~~with~~ 0.5 ~~inch~~" mesh in the ~~pockets~~cod end. The nets we~~a~~re ~~pulled~~ towed by fishing boats ~~with~~ at an average speed of 5m-/-minute, ~~and the length of time for each data collection is~~ with each tow lasting ~~±~~ around two hours. Data were collected ~~E~~every month, ~~data collection, namely on~~during -the full moon phase (~~, between~~ days 14-16 of the lunar phase) ~~/ Hijri month~~ from April to August 2019. The fish caught ~~are~~ were placed in ~~the~~ a container that ~~has~~ had been provided.

~~Furthermore, t~~The fish caught in each sampling tow we~~a~~re grouped and separated according to family and species. Identification of fish species ~~using~~ used a standard identification reference [H13]~~standards~~ (Tsukamoto et al., 1997). ~~Meanwhile, t~~The ~~first~~ data collected ~~data~~ were tabulated and -analyzed ~~by~~ using descriptive statistics. ~~Furthermore, analysis of f~~Fish community diversity and composition were evaluated using three indices: ~~index (H ') using~~ the Shannon-Waiver Diversity Index (H ')~~Index~~ (Ludwig and Reynolds, 1988), the Simpson Evenness Index (E) ~~using the formula from Simpson~~ and the Morisita Distribution Index of Species Richness ~~Index~~ (D)~~- Morisita Distribution Index~~. Furthermore, a cluster analysis ~~is~~ was performed based on the ecological index values (H ', E, and D). All statistical ~~analyzes~~ analyses were ~~assisted using~~performed in IBM SPSS Statistics 25.

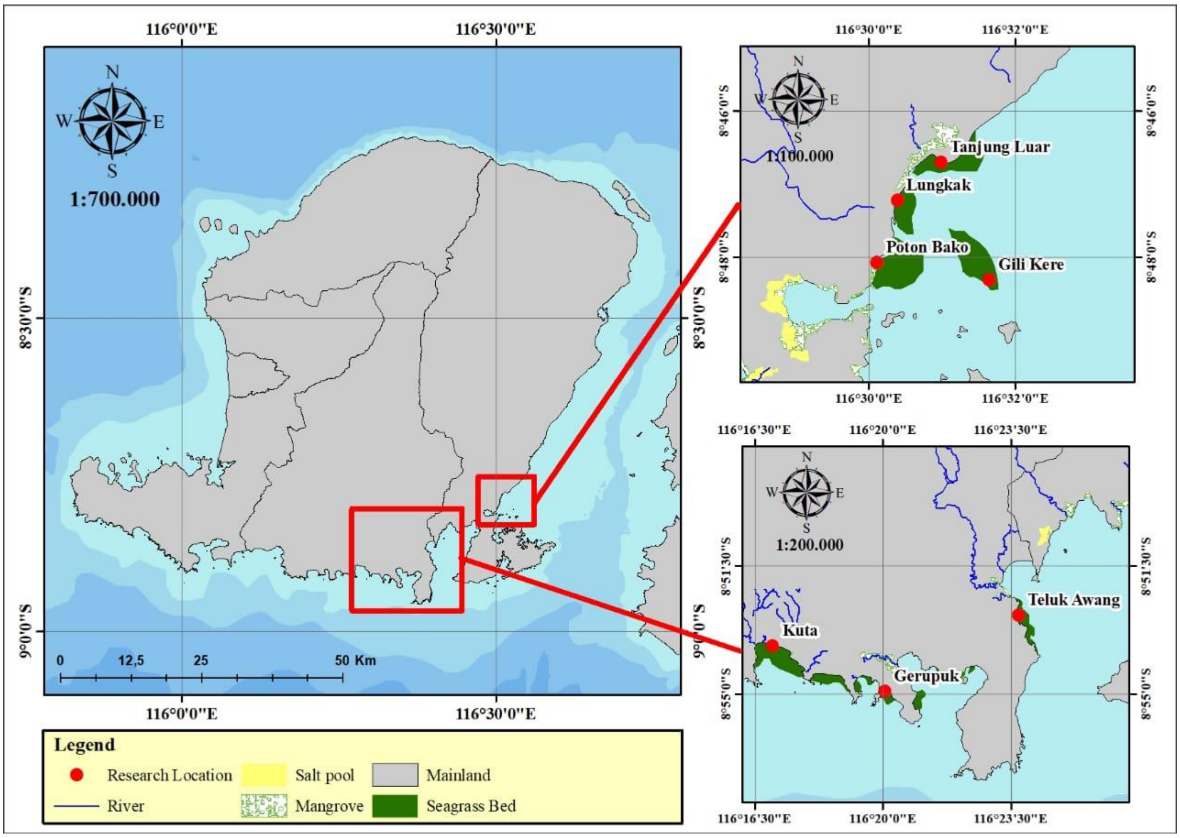


Figure 1. Map of Lombok Island, Indonesia showing the seven ~~R~~research ~~lL~~ocations

RESULTS AND DISCUSSION

Composition of fish in the study area

The results show~~ed~~ that 20352 individual fish (specimens) were identified as belonging to ~~on~~ 37 fish families ~~covering~~ and 106 species ~~and~~ ~~20352 individuals~~ (Table 1). The species composition by ~~of the~~ fish family ~~(~~Figure 2) ~~indicates~~ shows that Leiognathidae ~~has~~ was the most speciose family with 10.377% of species, followed by the Carangidae and Tetraodontidae, both contributing 7.547% of species, ~~Carangidae and Tetraodontidae~~, the Pomacentridae with 6. 604% ~~Pomacentrydae~~, and the Apogonidae with 5,660% ~~Apogonidae~~. Meanwhile, in this study, twenty fish species ~~were found, with the number of individuals~~ contributed an above ~~the~~ average number of individuals ~~s of~~ (more than 162.5~~2~~ specimens) to the total sample (Figure 3). *Archamia goni* ~~is~~ was the species with the highest number of individuals (19.04%), followed by *Leiognathus equulus* (11.10%), *Leiognahus bindus* (8.66%), and *Sardinella gibbosa* (6.76%). The [H14]most abundant species' composition was species with individual numbers of 0.05% - 0.147%, including 46 species (Table 1).

Table 1[H15]. ~~Fish~~ Total number and species composition of sampled fish ~~species~~ associated with seagrass ~~in~~ at the seven study locations

Species Name ~~Name of Species~~	Number of ~~Individu~~specimens/ species	~~Number of Individu~~Specimens/ Species (%)	Species Name ~~of Species~~	Number of specimens/ species ~~Number of Individu/ species~~	Specimens/ Species (%) ~~Number of Individu/ Species (%)~~
Apogonidae					
Apogonichthys ocellatus	414	2.034	*Gazza minuta*	92	0.452
Archamia goni	3876	19.045	*Gazza rhombea*	269	1.322
			Leiognathidae		
Archamia zosteropthora	14	0.069	*Leiognahus bindus*	1762	8.658
Foa bracygramma	3	0.015	*Leiognathus daura*	229	1.125
Cheilodipterus macrodon	9	0.044	*Leiognathus equulus*	2259	11.100
Cheilodipterus macrodon	42	0.206	*Leiognathus rapsoni*	56	0.275
Atherinomirus lacunosus	30	0.147	*Secutor interpuptus*	127	0.624

Atherinomirus duodecimalis	2	0.010	*Ambassis urotaenia*	27	0.133
Alticus saliens	72	0.354	*Gazza achlamys*	15	0.074
Andarnia tetradactylus	5	0.025	*Leiognathus splendens*	456	2.241
Petroscirtes variabilis	89	0.437	*Leiognathus oblongus*	345	1.695
Bothus pantherinus	30	0.147	*Lethrinus variegates*	24	0.118
Atule mate	153	0.752	*Gymnocranius elongates*	64	0.314
Caranx ignobilis	226	1.110	*Lutjanus lutjanus*	91	0.447
Scomberoides tala	40	0.197	*Lutjanus erythropterus*	64	0.314
Scomberinemus lysan	500	2.457	*Lutjanus argentimaculatus*	108	0.531
Caranx melampygus	108	0.531	*Lutjanus boutton*	103	0.506
Caranx sexfasciatus	393	1.931	*Acreichthys tomentosus*	409	2.010
Selar crumenophthalmus	142	0.698	*Acreichthys sp*	68	0.334
Trachinotus blochii	73	0.359	*Moolgarda delicates*	109	0.536
Ambassis buruensis	968	4.756	*Empheris oualensis*	22	0.108
Sardinella gibbosa	1376	6.761	*Upeneus sulphureus*	84	0.413
Sardinella lemuru	987	4.850	*Upeneus tragula*	24	0.118
Paraplagusia bilineata	28	0.138	*Upeneus vittatus*	476	2.339
Cyanoglosus puntisep	18	0.088	*Plotosus lineatus*	3	0.015
Cyanoglosus lungua	22	0.108	*Polynemus pelbeius*	9	0.044
Paraplagusia blochi	29	0.142	*Filimanus xanthonema*	162	0.796
Diodon litorosus	6	0.029	*Abudefduf notatus*	16	0.079
Platax boersi	20	0.098	*Amphiprion frenathus*	11	0.054
Stolephorus indicus	93	0.457	*Neopomacentris azysron*	55	0.270
Thryssa setirostris	9	0.044	*Pomacentrus lepidogenys*	5	0.025
Stolepholus commersonnii	54	0.265	*Abudefduf vaigiensis*	11	0.054
Stolephorus indicus	175	0.860	*Abudefduf sexfasciatus*	1	0.005
Fistularia commersonii	38	0.187	*Abudefduf septemfasciatus*	6	0.029
Gerres abbreviatus	53	0.260	*Leptoscarus vaigiensis*	33	0.162
Gerres erythrourus	1	0.005	*Colotomus spinidens*	24	0.118
Gerres filamentosus	370	1.818	*Epinephelus bontoides*	66	0.324
Gerrres oyena	44	0.216	*Siganus canaliculatus*	62	0.305
Hemiramphus far	144	0.708	*Siganus guttatus*	42	0.206
Plectorhinchus flavomaculatus	211	1.037	*Siganus argentheus*	12	0.059
Plectorhinchus celebicus	54	0.265	*Sphyraena flavicauda*	46	0.226
Thallassoma hardwickii	3	0.015	*Sphyraena barracuda*	25	0.123
Helichoeres papilionaceus	2	0.010	*Sillago macrolepis*	421	2.069
Sillago chondropus	121	0.595	*Canthigaster compressa*	51	0.251
Sillago sihama	389	1.911	*Chelonodon patoca*	51	0.251
Johnius amblycephalus	7	0.034	*Lagocephalus lunaris*	3	0.015
Johnius borneensis	2	0.010	*Lagocephalus ivheeleri*	12	0.059
Johnius macropterus	6	0.029	*Langocephalus gloveri*	8	0.039
Ablabys taenianotus	4	0.020	*Takifugu radiates*	2	0.010
Syngnathoides biaculeatus	2	0.010	*Arothron immaculatus*	179	0.880
Saurida nebulosa	47	0.231	*Arothron manilensis*	118	0.580
Saurida gracilis	2	0.010	*Triacanthus nieuhofi*	36	0.177
Synodus dermatogenys	4	0.020	*Trichiurus lepturus*	89	0.437
Total number of ~~Individu~~ specimens	11510		Total number of ~~Individu~~ specimens	8842[H16]	

~~Another study on the richness of fish species in seagrass is on the Jordanian coast, 35 families of fish (Khalaf et al. 2012). Furthermore, in Ban Pak Klong, Thailand 35 fish families (Phinrub et al .. 2014), Gazi Bay Kenya 41 fish families (Musembi et al .. 2019), Karang Congkak Island Kepulauan Seribu National Park Indonesia 26 fish families (Simanjuntak et al. 2020), and at Jervis Bay Marine Park New South Wales Australia fish families of 24 families (Kiggins et al .. 2019). Besides, in the Quirimba Archipelago Northern Mozambique, the dominant fish species is *Siganus sutor*, *Leptoscarus vaigiensis*, *Lethrinus variegatus*, *Lethrinus lentjan* and *Gerres oyena* (Gell. & Whittington. 2002), Thailand's Pak Klong Ban are *Sillago sihama*, *Leiognathus jonesi* and *Gerres erythrourus* (Phinrub et al. 2014).~~

~~Muara Binuangeun Lebak Banten, the dominant species, is *Moolgarda sp* and *Istiblennius edentulus* (Kholis et al. 2017). Next, *Spratelloides gracilis*, *Stenatherina panatela*, *Siganus canaliculatu*, *Gerresoyena sp*, and Siganusspinus sp are the dominant seagrass species beds of Karang Congkak Island, Kepulauan Seribu National Park Indonesia (Simanjuntak et al .. 2020). In Youtefa Bay, Jayapura, Papua, the dominant species are *Scolopsis lineata*, *Apogon ceramensis*, *Parupeneus barberinus*, *Aeliscus strigatus*, *Siganus fuscescens*, and *Siganus canaliculatus* (Tebaiy et al. 2017). The richness of different fish species between seagrass beds, incredibly dominant species, is the primary value of~~

~~seagrass as a fish habitat (Nordlund et al. 2018). Furthermore, this information can become a scientific basis for seagrass conservation efforts at each seagrass area scale, such as at the study site.~~

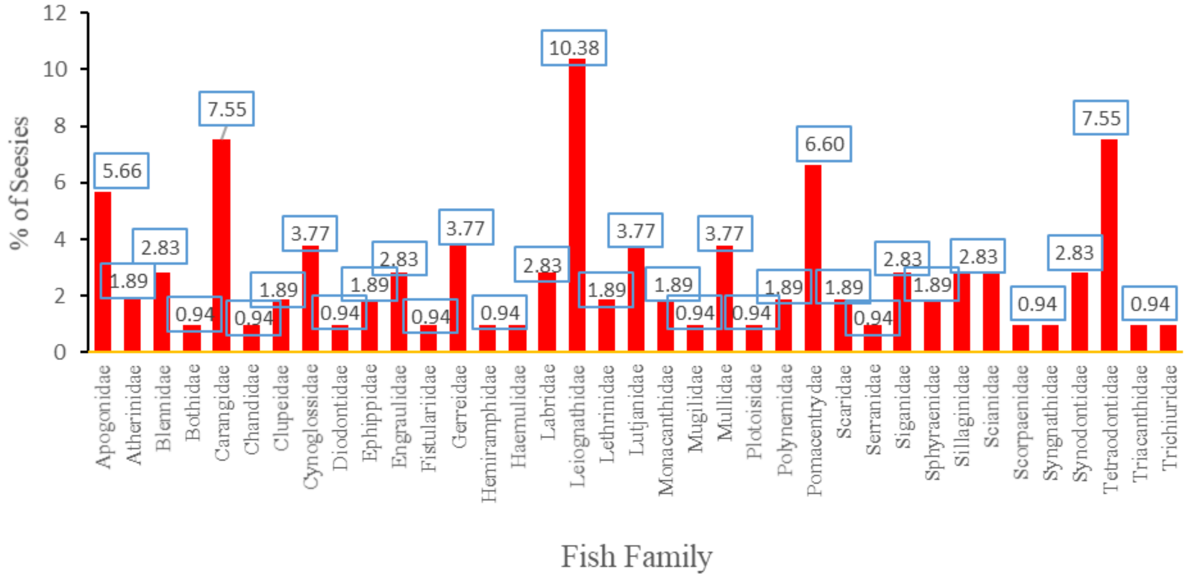


Figure 2.[H17] Fish community composition by ~~Composition of fish~~ ~~families~~ family based on the number of species present in the seven study locations.

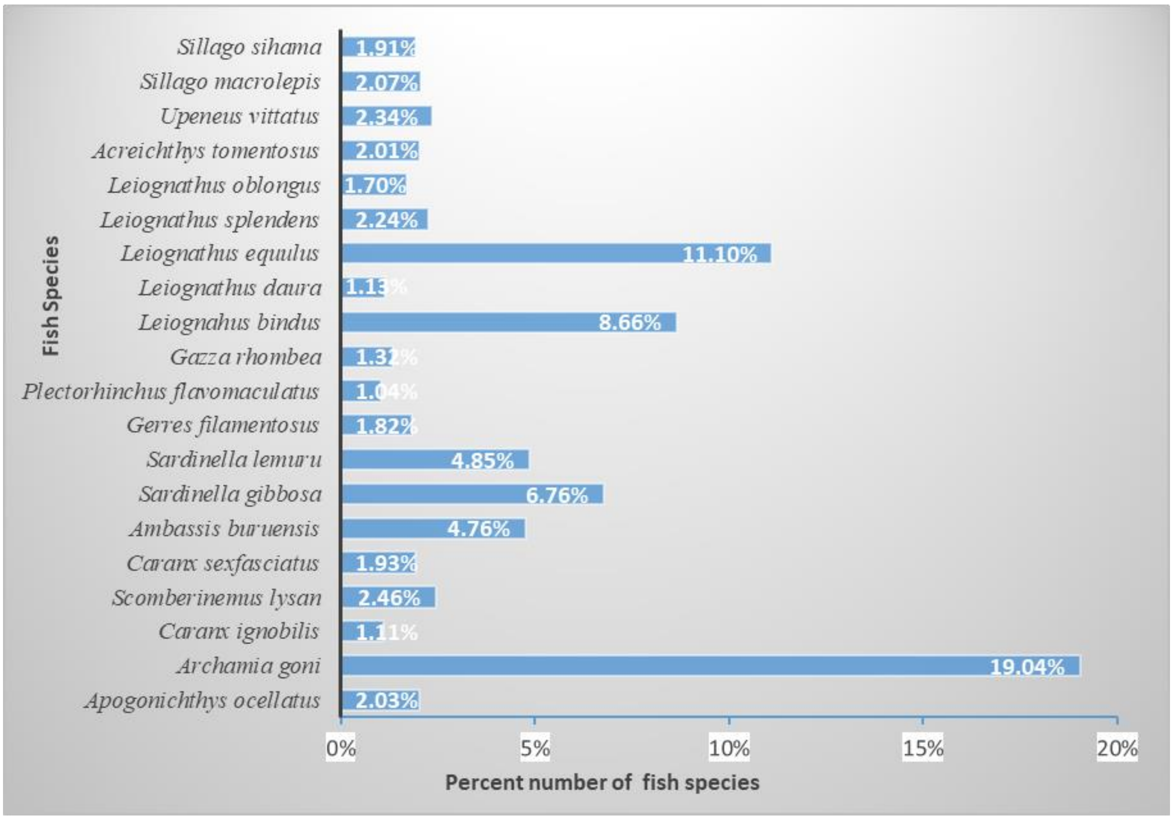


Figure 3.[H18] Fish species with an above-average number of individuals

Other studies[H19] on the richness of fish species in seagrass found similar numbers of families. For example 35 families on the Jordanian coast, (Khalaf et al. 2012) and Ban Pak Klong, Thailand (Phinrub et al. 2014), with 41 fish families in Gazi Bay, Kenya (Musembi et al. 2019), 26 fish families at Karang Congkak Island, Kepulauan Seribu National Park, Indonesia (Simanjuntak et al. 2020), and 24 fish families at Jervis Bay Marine Park, New South Wales, Australia (Kiggins et al. 2019).

The dominant seagrass-associated fish species reported vary considerable between sites For example, in the Quirimba Archipelago, Northern Mozambique, the dominant fish species were *Siganus sutor*, Leptoscarus *vaigiensis*, *Lethrinus variegatus*, *Lethrinus lentjan* and *Gerres oyena* (Gell. & Whittington. 2002), while in Pak Klong Ban, Thailand's they were *Sillago sihama*, *Leiognathus jonesi* and *Gerres erythrourus* (Phinrub et al. 2014). With respect to some other sites within Indonesia, at Muara Binuangeun, Lebak Banten the dominant species were *Moolgarda sp* and *Istiblennius edentulus* (Kholis et al. 2017), while *Spratelloides gracilis*, *Stenatherina panatela*, *Siganus canaliculatus*, *Gerresoyena sp*, and *Siganus spinus* were the dominant species in the seagrass beds of Karang Congkak Island, Kepulauan Seribu National Park Indonesia (Simanjuntak et al .. 2020). In Youtefa Bay, Jayapura, Papua, the dominant species were *Scolopsis lineata*, *Apogon ceramensis*, *Parupeneus barberinus*, *Aeliscus strigatus*, *Siganus fuscescens*, and *Siganus canaliculatus* (Tebaiy et al. 2017). The richness of different fish species between seagrass beds, incredibly dominant species, is the primary value of seagrass as a fish habita[H20]t (Nordlund et al. 2018). Furthermore, this[H21] information can become a scientific basis for seagrass conservation efforts at each seagrass area scale, such as at the study site.

Ecological index of fish species associated with seagrass in the study site

~~The existence of fish species in seagrass (Figures 2, 3, and Table 1) describes the composition of fish species found during the study period.~~ [H22]The ~~results of the analysis of the~~ ecological ~~index~~ indices based on the~~of~~ fish species present at each ~~by~~ location are shown in ~~(~~Figure 4~~)~~. The ~~distribution of the~~ Diversity Index value at all seagrass locations ~~is from~~was between 2.40 ~~to~~ and 2.80, with an average value of 2.61. Meanwhile, the Species Richness Index ~~of species richness~~ value ~~distribution is~~was between 2.14 ~~–~~and 8.47, with an average value of 7.74 and the Evenness Index ranged from xx to yy[H23].

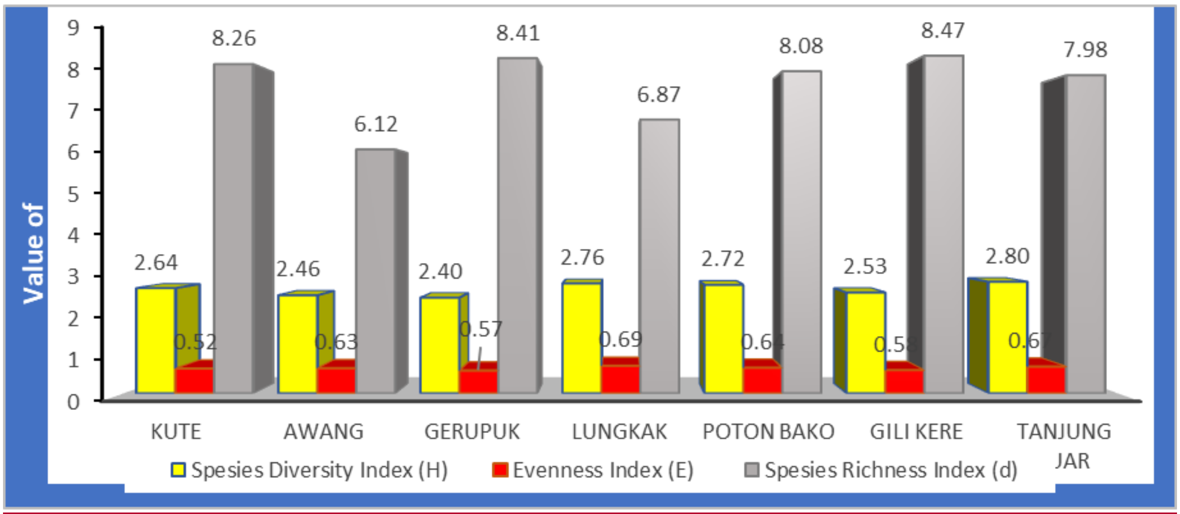
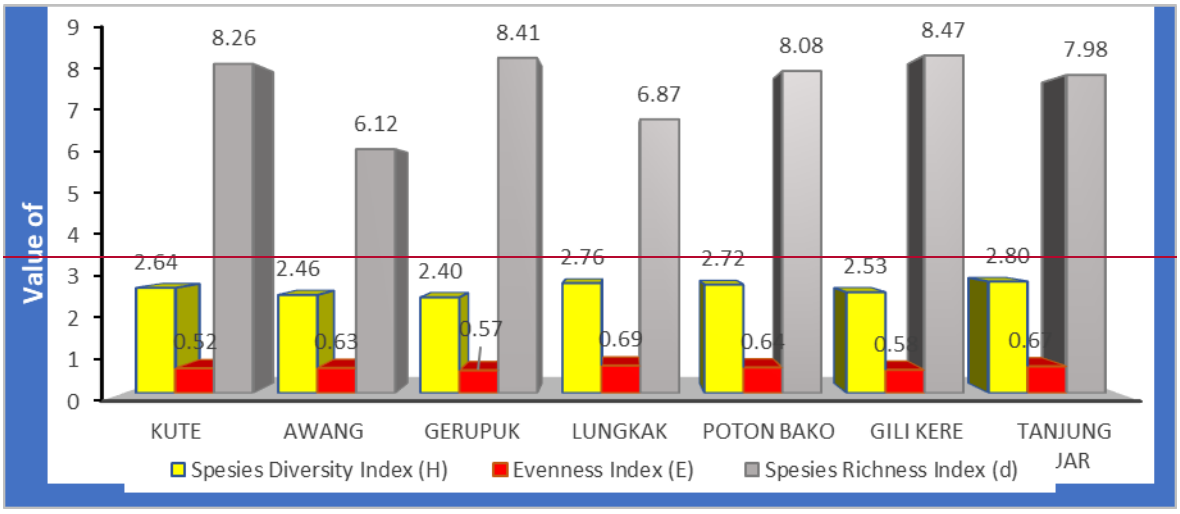


Figure 4. Diversity Index, Evenness Index, and Species Richness Index at the seven survey locations within the study area

Furthermore, the ~~distribution of~~ ecological index values for fish species varied by month (Table 2). In this case, the three indicators of fish species' environmental index are sufficient as evidence of seagrass's ecological services for fish communities' existence.[H24] ~~Like,~~ For example, the Diversity Index value can correlate with community stability. Meanwhile, the evenness index value correlates with the concentration of the distribution [H25]of species. Furthermore, the richness index value correlates with the number of species found at each study location.

Table 2 should go here. I have not done any detailed editing below this point. Yellow highlight shows the sentences which are especially problematical, though many others also need attention.

Variations in the ecological index value of fish species, such as in the study location, are implications derived from the condition of seagrass vegetation and its environment. For example, the seagrass environment on the Lungkak, Poton Bakau, and Awang beaches are the seagrass beds' location adjacent to the mangrove environment. Meanwhile, Gili Kere, Tanjung Luar, Gerupuk, and Kute are close to the coral reef environment. Even so, the ecological index value of fish species found in the study location can provide environmental evidence that the presence of seagrass is needed by marine organisms to survive, such as fish. In this case, the function is very vital in providing food, rearing, and protection from predators, especially fish biodiversity (Jackson et al., 2001; Heck et al., 2003; Bertelli & Unsworth, 2014; Prasetya & Purwanti, 2017; Hidayati & Suparmoko, 2018).



~~**Figure 4.** Diversity Index, Evenness Index, and Richness Index in the Study Area~~

In connection with fish in seagrass in the study location, maintaining fish habitat, such as preventing or restraining the damage rate, is crucial. The implication is not only a positive impact on the preservation of fish and other marine biota resources. Still, it can be an indicator in efforts to conserve and manage ecosystem-based coastal resources. Also, seagrass protection efforts can prevent the degradation or loss of seagrass ecosystem services in coastal waters' ecological systems, especially for protecting marine biodiversity. Still, on the other hand, the damage to seagrass can have negative implications for decreasing the productivity of marine resources, disrupting trophic interactions, and reducing stability. Natural ecological systems in the marine environment (Duffy, 2006; Best & Stachowicz, 2012; Duffy et al., 2015). Besides, there is no doubt that the loss of seagrass populations will hurt fish habitats and carbon storage (Patro et al., 2017; Mishra et al., 2019).

Meanwhile, the value of Standard Deviation, such as the highest diversity index, is Tanjung Luar. The lowest is Gerupuk, and in full, the Standard Deviation score for all ecological index (Table 3). The value of Standard Deviation of the ecological fish index (Diversity, evenness, and richness) can explain the number of individuals of each species against the average value. Meanwhile, the Standard Deviation value of the evenness index at all sampling locations has a relatively similar value. It shows that no individual's concentration is too dominant. Furthermore, the Standard Deviation value of the lowest species richness is Awang Bay. It is possible due to the complexity of the Awang Bay waters' habitat, which is only supported by mangroves' presence around the seagrass beds. It is different from other locations; apart from being supported by mangroves' existence, the seagrass area has coral reefs.

Table 2. ~~The distribution of e~~Ecological index values for seagrass-associated fish species by month at the 7 study locations

Location	Index	Month				
		April	May	June	July	August
Kute	Species Diversity Index (~~H~~H')	2.31	2.52	2.99	2.64	2.76
	Evenness Index (E)	0.57	0.65	0.88	0.82	0.84
	Species ~~Richness~~Richness Index (d)	8.04	8.21	8.80	8.72	8.76
Awang	Species Diversity Index (~~H~~H')	2.11	2.32	2.71	2.46	2.68
	Evenness Index (E)	0.6	0.62	0.76	0.73	0.74
	Species ~~Richness~~Richness Index (d)	6.04	6.26	6.48	6.31	6.41
Gerupuk	Species Diversity Index (~~H~~H')	2.09	2.18	2.64	2.28	2.56
	Evenness Index (E)	0.61	0.63	0.79	0.71	0.74
	Species ~~Richness~~Richness Index (d)	7.93	8.21	8.88	8.49	8.67
Lungkak	Species Diversity Index (~~H~~H')	2.46	2.65	2.99	2.73	2.97
	Evenness Index (E)	0.69	0.72	0.86	0.78	0.84
	Species ~~Richness~~Richness Index (d)	6.42	6.62	7.09	6.78	6.88
Poton Bako	Species Diversity Index (~~H~~H')	2.38	2.43	2.97	2.87	2.93
	Evenness Index (E)	0.69	0.73	0.82	0.79	0.81
	Species ~~Richness~~Richness Index (d)	7.56	7.79	8.2	8.04	8.11
Gili Kere	Species Diversity Index (~~H~~H')	2.12	2.21	3.01	2.59	2.73
	Evenness Index (E)	0.71	0.75	0.98	0.89	0.92
	Species ~~Richness~~Richness Index (d)	8.14	8.23	8.91	8.41	8.76
Tanjung Luar	Species Diversity Index (~~H~~H')	2.51	2.71	2.98	2.93	2.87
	Evenness Index (E)	0.65	0.71	0.89	0.81	0.82

Species RichnessRichness Index (d)	7.21	7.41	8.11	7.76	7.89

Table 3. Value of Mean and Sstandard dDeviation of Seagrass ecological Index indices for seagrass-associated fish at the seven sStudy locationsSite

IndeksIndex	LokasiLocation						
	Kute	Awang	Gerupuk	Lungkak	Poton Bako	Gili Kere	Tanjung Luar
SpesiesSpecies Diversity Index (H')	2.64±0.26	2.46±0.25	2.35±0.24	2.76±0.22	2.72±0.29	2.53±0.37	2.80±0.19
Evenness Index (E)	0.75±0.13	0.69±0.07	0.70±0.08	0.78±0.07	0.77±0.06	0.85±0.12	0.78±0.10
SpesiesSpecies Richness Index (D)	8.51±0.35	6.30±0.17	8.44±0.37	6.76±0.25	7.94±0.26	8.49±0.33	7.68±0.36

The results of the Cluster Analysis (Figure 5) show that Poton Bakau and Gili Kere have a degree of similarity of 0.029of 0.029. Meanwhile, Awang and Lungkak are 0.040, and Awang and Kute are 0.055. Furthermore, Tanjung Luar has a similarity level with Poton Bakau and Gili Kere of 0.154. However, Gerupuk is a location that has a group of difference from all sampling locations. The clustering results can explain the differences in the composition of fish species in each area of the seagrass beds in the study location. In this case, the seagrass habitat influences both spatially and or temporally, such as the different ocean currents patterns between areas. However, the variation in the size of the mosaic plots in the seagrass beds showed a positive relationship with fish biomass (Staveley et al., 2020). Other factors that have significant influence are seagrass habitat architecture and can affect the total biomass of fish, and, and specialist species seagrass such as syngnathids (Scapin et al., 2018). Therefore, although this study did not explore the seagrass habitat structure, the specific environmental conditions influenced the collected fish's species composition. For example, in Awang and Lungkak, which have the closest similarity, the two locations' environment is very close to the mangrove environment. Besides, it can describe the ecological Connectivity connectivity of seagrass presence with other habitats, such as mangroves and coral reefs.

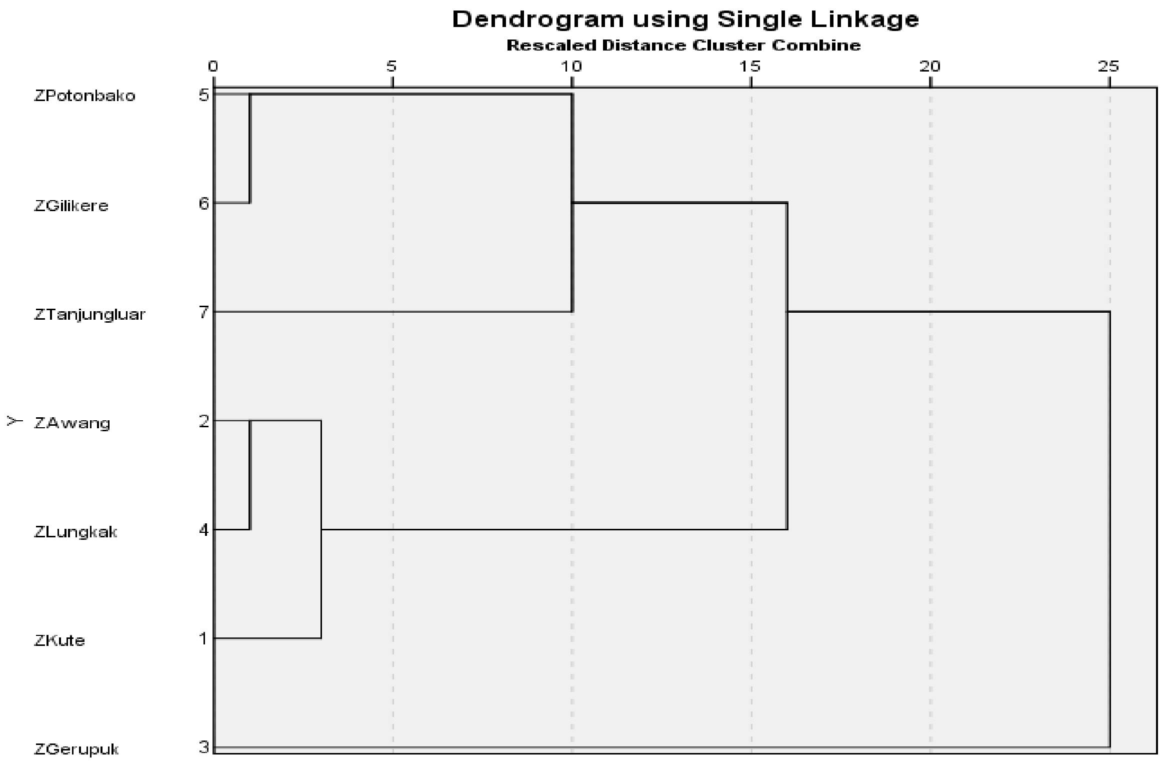


Figure 5. Cluster analysis of Eeuclidean distance between seagrass-associated fish communities at the seven study sites.

Seagrass conservation

The study of seagrass provisioning services, particularly for fish resources, emphasizes seagrass conservation at regional and local scales, such as in the study sites. It is evident that many seagrass areas are experiencing degradation, which has a vital role, is experiencing a threat of damage. The danger for seagrass in Lombok Island's coastal waters is from anthropogenic activities (Syukur et al., 2017). Also, the right seagrass conditions' status is the primary source or determinant of small-scale fishers (Cullen-Unsworth et al., 2014; de la Torre-Castro et al., 2014). Meanwhile, seagrass restoration in southern Australia has increased 15 commercial fish species (Blandon, & Zu Ermgassen, 2014). Eight commercial fish species are associated with seagrass and production, with an average monetary value of 95.75 €/ha/year. When linked to market price standards, the matter can be 67 030.30 €/year in one area found long ago (Tuya et al., 2014).

In this respect, the richness of fish species in the study area, which includes 106 species and is dominated by commercial fish species (Table 1), is scientific evidence that can the considered for local scale seagrass conservation.

This study can prove[H26] that the presence of fish species at each location of the seagrass beds can not only be explained as an implication of seagrass~~'s~~ ecological functions. However, the species abundance that has been shown by the environmental index values at all study locations is the functional form of fish species or the operational characteristics of fish associated with seagrass habitats. In this case, the associated functions are food acquisition, locomotion, space, and matrix (Villéger et al., 2010; Mouillot et al., 2013). Meanwhile, although fish species' composition can be different, the functional status is the same, as in the study location (Figure 6). This has to do with the nature of fish mobility or its attachment to habitat characteristics. This study proves that not all fish species are in one location (Table 4). However, there were 26.41% found in all areas and 7.54~~% at~~% at one location. Therefore, this study's results are sufficient as scientific information on conservation efforts or integrated management of seagrass in a sustainable management system.[H27] This evidence is also quite relevant to the spatial distribution of fish ecological functions in changing management priorities to improve conservation performance in seagrass ecosystems[H28] (Unsworth, & Cullen, 2010; Henderson et al., 2019). (Unsworth & Cullen, 2010; Henderson et al., 2019).

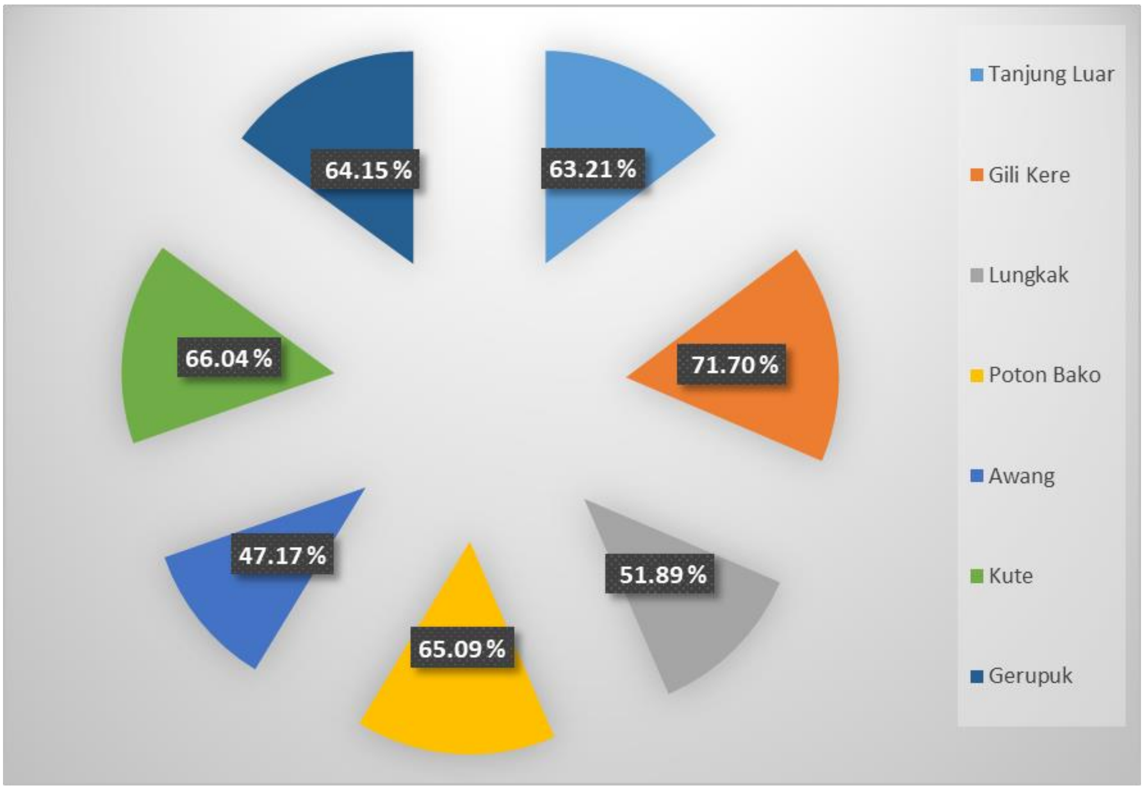


Figure 6. ~~% number~~Percentage of all ~~of~~ seagrass-associated fish species identified in this study ~~found~~ at each of the seven locations ~~seagrass bed in the study location~~

Table 4. Spatial distribution of seagrass-associated fish species identified in this study~~fish species in the study location~~

~~**Frequency of Species**~~**Spatial distribution**	~~**Composition of**~~ **Species present**	**Number of Species**
All Locations	*Acreichthys tomentosus, Ambassis buruensis, Archamia goni, Canthigaster compressa, Caranx ignobilis, Caranx melampygus, Caranx sexfasciatus,, Chelonodon patoca, Colotomus spinidens, Epinephelus bontoides, Fistularia commersonii, Gazza minuta, Gazza rhombea, Leiognathus bindus, Leiognathus daura, Leiognathus equulus, Leiognathus rapsoni, Lutjanus argentimaculatus, Lutjanus boutton, Lutjanus erythropterus, Moolgarda delicates, Sardinella gibbosa, Saurida nebulosi, Secutor interpuptus, Siganus canaliculatus, Sillago sihama, Stolephorus indicus, Upeneus vittatus.*	28
Six locations	*Abudefduf vaigiensis, Ambassis urotaenia, Gerres filamentosus, Paraplagusia blochi, Scomberinemus lysan, Sillago macrolepis, Stolepholus commersonnii, Bothus pantherinus, Sardinella lemuru*	9
Five locations	*Alticus saliens, Arothron immaculatus, Arothron manilensis, Atule mate, Gazza achlamys, Leiognathus oblongus, Platax boersi, Plectorhinchus celebicus, Plectorhinchus flavomaculatus, Selar crumenophthalmus, Sillago macrolepis*	11

Four locations	*Abudefduf notatus, Cheilodipterus macrodon, Hemiramphus far, Leiognathus splendens, Siganus guttatus, Sphyraena barracuda, Sphyraena flavicauda, Triacanthus nieuhofi, Upeneus sulphureus*	9
Three Locations	*Abudefduf septemfasciatus, Acreichthys sp, Apogonichthys ocellatus, Archamia zosteropthora, Atherinomirus lacunosus, Cyanoglosus lungua, Cyanoglosus puntisep, Filimanus xanthonema, Gymnocranius elongates, Johnius amblycephalus, Johnius macropterus, Lagocephalus ivheeleri Lagocephalus lunaris, Leptoscarus vaigiensis , Lethrinus variegates, Plotosus lineatus , Polynemus pelbeius, Pomacentrus lepidogenys, Sillago chondropus, Thallassoma hardwickii, Trachinotus blochii, Trichiurus lepturus, Upeneus tragula*	23
Two Locations	*Amphiprion frenathus, Atherinomirus duodecimalis, Cheilodipterus quiienquelinatus, Diodon litorosus, Empheris oualensis, Foa bracygramma, Gerres abbreviates, Gerrres oyena, Helichoeres papilionaceus, Johnius borneensis, Langocephalus gloveri, Lutjanus lutjanus, Paraplagusia bilineata, Petroscirtes variabilis, Saurida gracilis, Scomberoides tala, Siganus argentheus, Synodus dermatogenys*	18
One Location	*Abudefduf sexfasciatus, Andarnia tetradactylus, Gerres erythrourus, Neopomacentris azysron, Syngnathoides biaculeatus, Takifugu radiates, Thryssa setirostris, Ablabys taenianotus*	8
Total Number of Species		106

In conclusion, the diversity of fish species found in the seagrass area in the study location is ecological evidence of the contribution of ~~seagrass's~~ seagrasses ~~contribution~~ to the sustainability of fish species[H29]. Furthermore, fish species' ecological indexes, such as diversity index, Evenness Index, and ~~meat~~ species Richness, are indicators for seagrass conservation in the study location. Therefore, this study's results can become a scientific basis for seagrass conservation at local and regional scales. Seagrass conservation efforts at various scales, especially outside protected areas, such as in study locations and other locations, are urgently needed to protect and preserve marine biodiversity and ~~residents'~~ economic sustainability for local human communities.

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~~.~~AUTHOR'S CONTRIBUTIONS

Agil Al Idrus. Abdul Syukur and Lalu Zulkifli: Conducted all experiments~~. Observation~~, participated in data analysis and preparation of the ~~paper~~ manuscript.

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Notifications

[biodiv] Editor Decision

2020-11-29 02:10 PM

Abdul Syukur Syukur, Agil, Lalu Zulkifli Lalu:

We have reached a decision regarding your submission to Biodiversitas Journal of Biological Diversity, "Fish species richness on the seagrass is suitable evidence considered for conservation in length of the South Coast Lombok Island, Indonesia".

Our decision is to: Decline Submission

Note: We have received comments from reviewers but not in positive words. So, please make your "own-review" by sending your paper to at least two reviewers and one professional language editor; then sending us your revised paper along with comments from the two reviewers (incl. name & email address) and language editing certificate.

The following comments also need to be incorporated in your revised paper.

Smujo Editors

editors@smujo.id

Reviewer A:

1. General notes

The data are interesting and worth publishing. However, the paper has many weaknesses.

The English language is well below acceptable standards, with many sentences either not making sense at all or so ambiguous as to be meaningless. This is a shame because I think many readers would want to understand the concepts expressed by the authors.

I have provided editing suggestions to improve the English in much of the manuscript, but not the final pages. I hope these are useful. Once the manuscript has been revised to clarify several points, in my opinion it will need to be proof-read/edited again by a native speaker with knowledge of the subject matter. With reards to the species names, I noticed a few errors and I suggest double-checking that all scientific names are correct.

1. Notes by section

- Title: the title is not meaningful and is very confusing in English. I have made one suggestion for improvement.
- Abstract: poor English. Also, the ecological indices E and D need to be better defined, I have added suggestions based on the Method section. Week on results, a brief mention of key results would improve this section.
- Keywords: I have made suggestions for clarity, but would suggest improving these with terms not figuring prominently in the title to maximise their effectiveness
- Introduction: One reference was miss-quoted (I have corrected this). Several sentences cannot be understood and need clarification.
- Material and Method: I have suggested an improvement for the Figure 1 legend.
- Results: the results are poorly presented.
    - The table and figures need to show the data in ways that have some logical order or divisions. For example based on family, abundance, alphabetical order, etc. The authors could choose which, but the current haphazard ordering is confusing for the reader. I would suggest by Family, with Family names given, as in the suggestion shown for two Families in the attached manuscript.
    - Much of the text is incomprehensible, and the text and figures/tables are not always in a correct/logical order.
    - I gave up on editing the final part of the manuscript as I really do not have more time now. But I think what I have done should help the authors to rewrite/improve the manuscript.
    - The discussion paragraphs are mostly not well linked to the data. All the comparisons to other places need to be related to the data from the study.
    - The discussion on the meaning and usefulness of the data needs to be improved, making it sharper and more readily understood by the reader. At the moment most of it is confusing. It looks as though part of this is due to language difficulties. However, the logical thread also needs to be improved or made more evident.
- Conclusion: not relevant as no such section
- References: as noted above, one has been corrected. Overall, the references used appear to be relevant and representative. In general, I have not checked the formatting.

Recommendation: Resubmit for Review

Consultation
Close Panel

Participants Edit

- Smujo Editors (editors)
- Abdul Syukur (abdul)

Messages

Note	From
Thank you for the recommendation to get back to the sub mid, after making improvements according to the reviewer 's suggestion. However, may I ask the editor recommended by Smujo Editors. Author Abdul Syukur	abdul 2020-11-30 01:33 AM
No suggestions	editors 2020-11-30 07:33 AM

Reviewer B:

Dr. H. Mahrus <mahrus@unram.ac.id>
To:Syukur Unram
Sun, 6 Dec 2020 at 8:34 am
Dear Abdul Syukur,

I have now commented on your paper. You can find the reviewers' comments in the appendix.

Yours sincerely

Mahrus

Manuscript Review Form

Reviewer's Information

E-Mail:	mahrus@unram.ac.id
Date/Month	13/12/2020
Title:	Dr. Drs. M.Si
First Name:	Mahrus
Last Name:	Mahrus
Affiliation:	Division of Biology Education, Department of Sciences Education, Faculty of Teacher Training and Education, Mataram University
Country:	Indonesia
Specialization:	Ekologi Laut dan Bioteknology

Manuscript Information

Journal Name:	Biodiversitas
Manuscript Number:	
Manuscript Title:	**Seagrass-associated fish species' richness: Evidence to support conservation along the South Coast of Lombok Island, Indonesia**
Date Received from Journal:	
Date to Send Review Report:	

Reviewer's Blind Review Comments to Author

Kindly enter your comments based on the following sections. Also please include text excerpt or row / page no. from the manuscript for ease of reference by the author.

1.	Originality:	This paper is interesting to be published, because there are still few publications especially on seagrass. It's just that the grammar and sentences need to be improved to make it more informative. Therefore, this is a good job.
2.	Scientific Quality:	This paper is well written, because its description sufficiently comprehensive and the logical reasoning perfectly sound.
3.	General Comment:	The thread between the problem, method,objectives, results, and conclusions is clear. Manuscript should be checked thoroughly by a native speaker for usage of English language, and grammar (it is poor at present).

4.	Abstract:	The abstract may be too long, so it is better to make it more presice. The authors must follow the author guidelines strictly.
5.	Introduction:	1. The problem is not focused, and the aim of this study is not mentioned clearly. There might be some mistakes in the grammar. 2. P1 L 21 Seagrass is …….should be change to be good sentence 3. P1 L 32-43, not informated, P1 L35-39 should be deleted. Rewrite a gain the paragraph.
6.	Methodology:	1. The authors have used a good methodology, but it is less clear the difference of the survey and the observation. 2. Besides, It is less clear the difference between the data obtained by the survey and the observation. Is it enough a survey only?. Next, the survey steps are not shown in this paper.
7.	Results:	Data on P3 L 100-101 is 38 fish families and 104 species different with data in Table 1 (37families, 100 species). Figure 2 different with data in Figure 2
8.	Discussions:	1. In part of this session, the discussion is not focused on the research objective (to describe the importance of seagrass conservation based on the species richness of seagrass-associated fish). Data obtained should be compared with related to similar preliminary research. 2. P5 L120-125: the cites are combined into one 3. P7 L180-183, It will be better to add some references to the last sentence of this paragraph, because it's a very important part of this research
9.	Conclusions:	Good conclusions
10.	References / Bibliography:	1. The literature used is quite up-to-date (more than 70% use the last 10 years literature). 2. All sources used in text body must be included here
11.	Figures:	Some caption and marks need to be provided clearly
12.	Tables:	Please complete the table with the unit

13.	Reviewer's Decision Comment:	This manuscript is need to be improved by the author

Reviewer's Confidential Comments to Editor

<<define any section if needed>>	**1. <<please enter your comment here>>**

Recommandation
Kindly mark with an √

Accept As Is:	
Requires Minor Corrections:	
Requires Moderate Revision:	√
Requires Major Revision:	
Submit To Another Publication Such As:	
Rejection (Please provide reasons)	

Note	**From**
To Smujo Editors I have sent revisions from paper with topics "Seagrass-associated fish species' richness:Evidence to support conservation along the South Coast of Lombok Island, Indonesia" and paper revisions as in the attachment. Author Abdul Syukur abdul, PDUPT- Paper Revisi.doc	Abdul Syukur 2021-01-14 03:29 AM

PAPERTRUE

Certificate of Editing

Date: 07th January 2021

To whomsoever it may concern,

Title: "**Seagrass-associated fish species' richness provides evidence to support conservation along the South Coast of Lombok Island, Indonesia**"

Author: Abdul Syukur

This is to certify that PaperTrue Editing and Proofreading Services (www.papertrue.com), has edited and proofread the following document for **Abdul Syukur** and duly delivered the edited document on **15th December 2020.** The document was edited by our native English-speaking editor based in the US.

Amy Parker

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Seagrass-associated fish species' richness: Evidence to support conservation along the South Coast of Lombok Island, Indonesia

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Abstract. The concept of seagrass conservation at a global scale tends to be less appropriate with regard to the environmental conditions at the regional and local scales, and thus, there is a need for scientific studies at the regional and local scales to support conservation measures. This research aimed to describe the importance of seagrass conservation based on the species richness of seagrass-associated fish. Data was collected from seven seagrass locations using surveys and observation. Data on the fish species present were collected with the gear used by small-scale fishermen to catch fish in the seagrass area and the surrounding waters. Data analysis was descriptive; the statistical analyses performed included calculation of the Shannon-Wiener index of diversity (H '), the Simpson evenness index (E), and the Morisita species richness index (D) as well as a cluster analysis. All statistical analyses were performed in IBM SPSS Statistics 25. We found 104 fish species belonging to 38 families. Leiognathidae, Apogonidae, Clupeidae, Carangidae, Channidae, Sillaginidae, and Mullidae are families with high abundance, and 16 fish species have an abundance of individuals above the average value (192 individuals) of the total number of individuals (20,352). Meanwhile, 94.37% of the fish families are the target catch of small-scale fishermen (commercial fish). The diversity of fish species associated with seagrass in the study location is evidence of the survival of seagrass provision services at the local scale for fish. Therefore, scientific evidence of the species richness of fish, dominant of species, and its importance for small-scale fisheries at each seagrass bed in the study location can be used as a source of information for increasing and improving seagrass conservation efforts at the local scale.

Keywords: Species Richness, Ecological Index, Seagrass Conservation, Local Scale

INTRODUCTION

Seagrass is a higher plant that thrives in oligotrophic environments (Anton et al., 2020) and plays a vital role in human wellbeing (Ambo-Rappe, 2010; Cullen-Unsworth et al., 2014; Nordlund et al., 2010), especially in fishery production at the global, regional, and local scales (de la Torre-Castro et al., 2014; Nordlund et al., 2018; Unsworth et al., 2019). Conversely, essential services provide habitats and food to diverse marine life (Du et al., 2019; Moussa et al., 2020). However, seagrass status and protection rarely come under the spotlight as compared to other ecosystems in coastal areas, such as mangrove ecosystems and coral reefs (Larkum et al., 2018; Waycott et al., 2009). Meanwhile, ecological evidence indicates that 20% of commercial fish species are dependent on seagrass during their life cycle (Ambo-Rappe et al., 2013), as permanent, temporary, regular, or irregular residents. Furthermore, seagrass cover and canopy structure positively correlate with fish species' abundance (Susilo et al., 2018). Meanwhile, areas vegetated by seagrass can increase fish biomass, and the economic value per hectare has been estimated to be higher compared to areas with mangrove vegetation and tidal swamps (Jänes et al., 2020).

Seagrass is currently threatened with destruction in many places, and seagrass beds in Indonesia are under widespread threat. The implications of this can significantly impact local food supply as well as global fishery production, carbon cycling, and biodiversity conservation (Unsworth et al., 2018). The usual source of the threats is anthropogenic activity (Syukur et al., 2017), and the danger of damage is a significant challenge in conservation efforts. Obstacles in seagrass conservation efforts are as follows: (1) affirmation must be provided so that the community realizes or recognizes the importance of seagrass; (2) data and information on the current status and condition of seagrass are not yet regular; (3) management actions at the local scale have not taken the appropriate steps; (4) efforts are needed to balance human needs and survival; (5) there is limited scientific research output to support conservation actions; (6) conservation efforts are increasingly difficult in the era of climate change (Unsworth et al., 2019). Nevertheless, seagrass conservation efforts at a local scale can be achieved through affirmation and optimizing the participation of the fishing community (Jayabaskaran et al., 2018; Syukur et al., 2018). However, the available information related to seagrass damage on a local scale is minimal and inadequate.

Seagrasses, which have a vital function in supporting food security, are still widely underappreciated. This is a factor in the difficulty of preventing seagrass degradation. Another factor is the incomplete understanding of the ecosystem services provided by seagrass habitats, particularly those related to management in the fisheries sector. Meanwhile, the integration of bad planning on the part of the jurisdiction and sectoral management often causes the continued degradation of biodiversity and ecosystem values due to anthropogenic activities and climate change (Griffiths et al., 2020) Therefore, policies that are oriented toward the protection of fish resources and their ecosystems are urgently needed. The alternative is to provide scientific information, especially relating to local specifics (ecology, economy, and culture). In this regard, local specific components are the primary factors for success in integrated management for seagrass conservation and restoration purposes (de la Torre-Castro, 2006; Newmaster et al., 2011).

Furthermore, the objective of seagrass conservation or management is the preservation of fish resources and their ecosystems. In this case, the indicators of fish species diversity that are considered can include fish abundance, population, fish size, and the number and diversity of fish species in seagrass areas, such as marine protected areas (Pregiwati et al., 2015; Yuliana et al., 2019). Scientific facts support the contention that seagrass beds are very important for fishery production and play an essential role in the productivity and biodiversity of coral reefs and other ecosystems in coastal waters (Unsworth & Cullen, 2010). However, research efforts to inform policy and practice in this regard are still minimal. From 1,122 articles on seagrass published from 1973 to 2016 in the Asian region (including China), 77% is high and thus inappropriate, and only 23% are about science (Fortes, 2018). However, there has been little research related to seagrass fisheries resources, fish stocks, or fish communities, particularly to support conservation or management policies at the local and regional scales, such as at the study site. Therefore, this research was conducted to obtain scientific information on the diversity of fish species associated with seagrass. The aim was to provide detailed scientific knowledge as a basis for seagrass conservation efforts at the local scale. The results of this research can serve as a source of information for seagrass conservation policies in the study location, not only for the fisheries sector but also for the development of seagrass beds as natural tourism spots.

MATERIALS AND METHODS

Site location

The study was conducted from April to August 2020 at seven locations (Figure 1) in East Lombok Regency (Gili Kere, Tanjung Luar, Lungkak, and Poton Bakau) and Central Lombok Regency (Kute, Gerupuk, and Awang). The seagrass species reported at the locations in Central Lombok are as follows: Kute Bay (11 species), Grupuk Bay (10 species) (Kiswara & Winardi, 1994), and Teluk Awang (seven species) (Sari et al., 2020). Meanwhile, nine seagrass species have been reported from the four sampling locations in East Lombok (Syukur et al., 2017). In terms of the environmental conditions around the seagrass areas, some sites—such as Lungkak, Poton Bakau, and Awang—were close to the mangrove ecosystem. Most of the mangrove vegetation along the coast around the research locations is the result of replanting efforts in the early 1990's (Idrus et al., 2019). While the seagrass area at Tanjung Luar is adjacent to the Fish Landing Site, the seagrass sites in Gili Kere, Gerupuk, and Kute are adjacent to coral reef ecosystems, and the latter three seagrass locations have become nature tourism destinations on the southern coast of Lombok Island (Syukur et al., 2020).

Data collection and analysis

Primary data was collected through surveys and observation at the seven predetermined locations. The data on fish species at each location was collected using fishing gear belonging to the fishers who generally catch fish in the seagrass area. Furthermore, data collection was carried out by the research team, assisted by the fishermen. The fishing gear used was a kind of mini-trawl. The specifications were as follows: net length 80 m with 1.25", 1", 0.75", and 0.625" mesh-size, and 0.5" mesh at the cod end. The nets were towed by fishing boats at an average speed of 5m/minute, with each tow lasting around two hours. Data was collected every month, during the full moon phase (days 14–16 of the lunar phase) from April to August 2019. The fish caught were placed in a container that had been provided.

The fish caught in each sampling tow were grouped and separated according to family and species. The identification of the fish species employed a standard identification reference (Tsukamoto et al., 1997). The data collected was tabulated and analyzed using descriptive statistics. The diversity and composition of the fish community were evaluated using three indices: the Shannon-Waiver diversity index (H ') (Ludwig & Reynolds, 1988), the Simpson evenness index (E), and the Morisita distribution index of species richness (D). Furthermore, a cluster analysis was performed based on the ecological index values (H ', E, and D). All statistical analyses were performed in IBM SPSS Statistics 25.

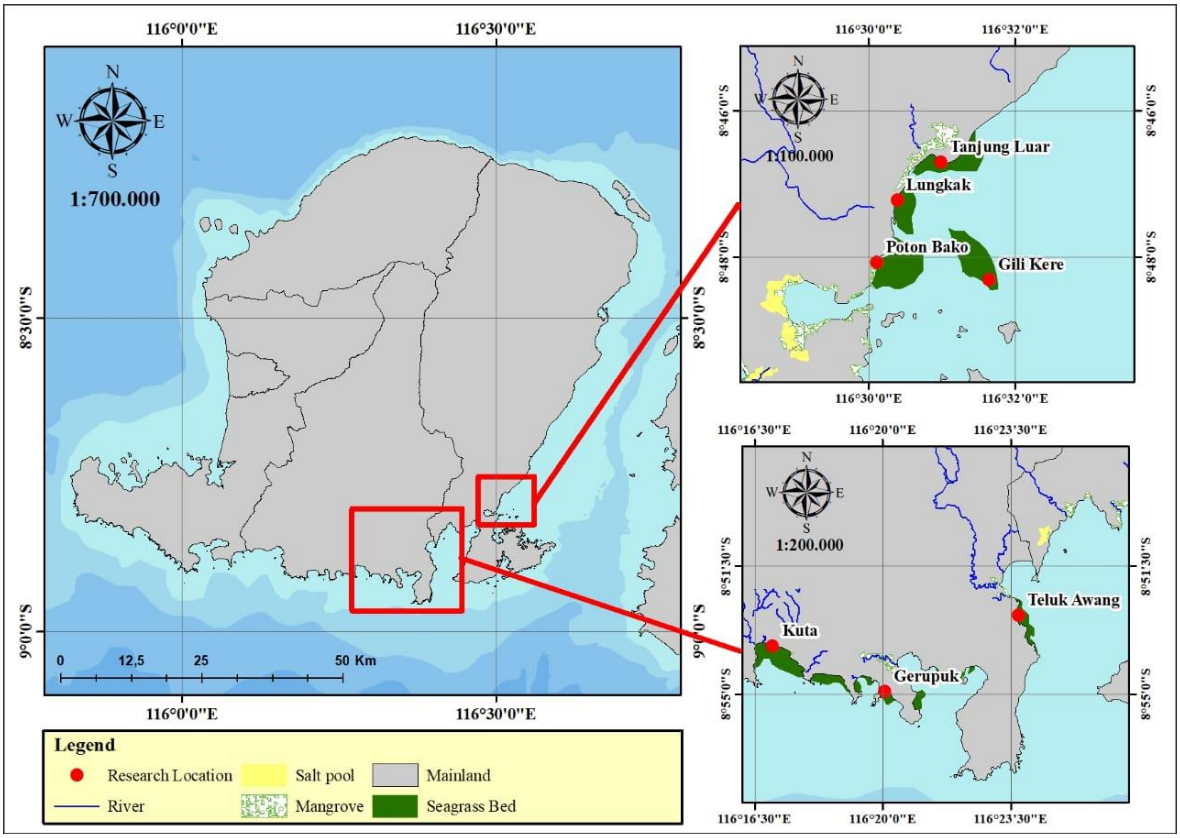

Figure 1. A map of Lombok Island, Indonesia, showing the seven research locations.

RESULTS AND DISCUSSION

Composition of fish in the study area

The results reveal that 20,352 individual fish (specimens) were identified as belonging to 38 fish families and 104 species (Table 1). Meanwhile, in this study, 16 fish species contributed an above average number of individuals (more than 192 specimens) to the total sample; they include *Archamia goni* (19.045%), *Leiognathus equulus* (11.100%), *Leiognahus bindus* (8.658%), *Sardinella gibbosa* (6.761%), *Ambassis buruensis* (4.756%), *Scomberinemus lysan* (2.457%), *Leiognathus splendens* (2.241%), *Sillago macrolepis* (2.069%), *Apogonichthys ocellatus* (2.034%), *Acreichthys tomentosus* (2.010%), *Sillago sihama* (1.911%), *Leiognathus oblongus* (1.695%), *Gazza rhombea* (1.322%), *Leiognathus daura* (1.125%), *Caranx ignobilis* (1.110%), and *Plectorhinchus flavomaculatus* (1.037%). However, 84% of the species had below average values. Furthermore, in the category of species with the number of individuals below the average, 20 species had number of individuals between one and 10, and the fish species with the lowest number of individuals were *Gerres erythrourus* from the family Gerreidae and *Abudefduf sexfasciatus* from the family Pomacentridae. Meanwhile, it was found that seven of the 38 families' contribution was above the average of the total number of individuals/families (more than 536): Leiognathidae (27.78%), Apogonidae (21.41%), Clupeidae (11.61%), Carangidae (8.03%), Channidae (4.75%), Sillaginidae (4.57%), and Mullidae (2.97%). Meanwhile, the species composition by fish family (Figure 2) showed that Leiognathidae was the most speciose family, with 10.377% of species, followed by Carangidae and Tetraodontidae (both contributing 7.547%), Pomacentridae (6. 604%), and Apogonidae (5.660%). Therefore, the existence of these seven families is very important in the structure of the fish community in the study location. However, the presence of other families contributes to the species' richness value of the fish communities associated with seagrass in the study location.

Table 1. The total number and species composition of the sampled fish associated with seagrass at the seven study locations.

No	Family	Species	Number of specimens/species	Specimens/Species (%)
1	Apogonidae	*Apogonichthys ocellatus*	414	2.03
		Archamia goni	3876	19.04
		Archamia zosterophorum	14	0.07
		Cheilodipterus macrodon	51	0.25

		Foa bracygramma	3	0.01
2	Atherinidae	*Atherinomorus duodecimalis*	2	0.01
		Atherinomorus lacunosus	30	0.15
3	Blenniidae	*Alticus saliens*	72	0.35
		Andamia tetradactylus	5	0.02
		Petroscirtes variabilis	89	0.44
4	Bothidae	*Bothus pantherinus*	30	0.15
5	Channidae	*Ambassis buruensis*	968	4.76
6	Carangidae	*Atule mate*	153	0.75
		Caranx ignobilis	226	1.11
		Caranx melampygus	108	0.53
		Caranx sexfasciatus	393	1.93
		Scomberoides tala	40	0.20
		Selar crumenophthalmus	142	0.70
		Scomberinemus lysan	500	2.46
		Trachinotus blochii	73	0.36
7	Clupeidae	*Sardinella gibbosa*	1376	6.76
		Sardinella lemuru	987	4.85
8	Cynoglossidae	*Paraplagusia bilineata*	28	0.14
		Paraplagusia blochi	29	0.14
9	Diodontidae	*Diodon liturosus*	6	0.03
10	Engraulidae	*Stolephorus commersonii*	54	0.27
		Stolephorus indicus	268	1.32
		Thryssa setirostris	9	0.04
11	Ephippidae	*Platax boersii*	20	0.10
12	Fistulariidae	*Fistularia commersonii*	38	0.19
13	Gerreidae	*Gerres abbreviatus*	53	0.26
		Gerres erythrourus	1	0.00
		Gerres filamentosus	370	1.82
		Gerres oyena	44	0.22
14	Haemulidae	*Plectorhinchus celebicus*	54	0.27
		Plectorhinchus flavomaculatus	211	1.04
15	Hemiramphidae	*Hemiramphus far*	144	0.71
16	Labridae	*Halichoeres papilionaceus*	2	0.01
		Thalassoma hardwicke	3	0.01
17	Leiognathidae	*Ambassis urotaenia*	27	0.13
		Gazza achlamys	15	0.07
		Gazza minuta	92	0.45
		Cynoglossus puntisep	18	0.09
		Gazza rhombea	269	1.32
		Leiognathus daura	229	1.13
		Leiognathus equulus	2259	11.10
		Leiognathus bindus	1762	8.66
		Leiognathus rapsoni	56	0.28
		Leiognathus splendens	456	2.24

		Leiognathus oblongus	345	1.70
		Secutor interruptus	127	0.62
18	Lethrinidae	*Gymnocranius elongatus*	64	0.31
		Lethrinus variegatus	24	0.12
19	Lutjanidae	*Lutjanus argentimaculatus*	108	0.53
		Lutjanus boutton	103	0.51
		Lutjanus erythropterus	64	0.31
		Lutjanus	91	0.45
20	Mugilidae	*Moolgarda delicates*	109	0.54
21	Mullidae	*Pempheris oualensis*	22	0.11
		Upeneus sulphureus	84	0.41
		Upeneus tragula	24	0.12
		Upeneus vittatus	476	2.34
22	Monacanthidae	*Acreichthys tomentosus*	409	2.01
		Acreichthys sp	68	0.33
23	Plotosidae	*Plotosus lineatus*	3	0.01
24	Polynemidae	*Filimanus xanthone*	162	0.80
		Polynemus pelbecius	9	0.04
25	Pomacentridae	*Abudefduf notatus*	16	0.08
		Abudefduf vaigiensis	11	0.05
		Abudefduf sexfasciatus	1	0.00
		Abudefduf septemfasciatus	6	0.03
		Amphiprion frenatus	11	0.05
		Neopomacentrus azysron	55	0.27
		Pomacentrus lepidogenys	5	0.02
26	Scaridae	*Calotomus spinidens*	24	0.12
		Leptoscarus vaigiensis	33	0.16
27	Scianidae	*Johnius amblycephalus*	7	0.03
		Johnius borneensis	2	0.01
		Johnius macropterus	6	0.03
28	Scorpaenidae	*Ablabys taenianotus*	4	0.02
29	Serranidae	*Epinephelus bontoides*	66	0.32
30	Siganidae	*Siganus argenteus*	12	0.06
		Siganus canaliculatus	62	0.30
		Siganus guttatus	42	0.21
31	Sillaginidae	*Sillago chondropus*	121	0.59
		Sillago sihama	389	1.91
		Sillago macrolepis	421	2.07
32	Soleidae	*Cynoglossus lingua*	22	0.11
33	Sphyraenidae	*Sphyraena barracuda*	25	0.12
34	Syngnathidae	*Syngnathoides biaculeatus*	2	0.01
		Synodus dermatogenys	4	0.02
35	Synodontidae	*Saurida gracilis*	2	0.01
		Saurida nebulosa	47	0.23
		Sphyraena flavicauda	46	0.23

36	Tetraodontidae	*Arothron immaculatus*	179	0.88
		Arothron manilensis	118	0.58
		Canthigaster compressa	51	0.25
		Chelonodon patoca	51	0.25
		Lagocephalus gloveri	8	0.04
		Lagocephalus ivheeleri	12	0.06
		Lagocephalus lunaris	3	0.01
		Takifugu radiatus	2	0.01
37	Triacanthidae	*Triacanthus nieuhofi*	36	0.18
38	Trichiuridae	*Trichiurus lepturus*	89	0.44
Total			20352	100

Other studies on the number of fish families found in seagrass beds recorded 35 families in the Jordanian coast (Khalaf et al., 2012), 35 families in Ban Pak Klong, Thailand (Phinrub et al., 2014), 41 families in Gazi Bay, Kenya (Musembi et al., 2019), 26 families in Karang Congkak Island, Kepulauan Seribu National Park, Indonesia (Simanjuntak et al., 2020), 24 families in Jervis Bay Marine Park, New South Wales, Australia (Kiggins et al., 2019), 44 families in the seagrass ecosystem of Minicoy Atoll, Lakshadweep, India (Prabhakaran et al., 2013), and 38 families in the inner Ambon Bay, eastern Indonesia (Ambo-Rappe et al., 2013). Furthermore, at twenty-two seagrass beds, there were differences in the number of fish families (Ambo-Rappe, 2020). Thus, different locations of seagrass beds, including the study locations, possess different attractions for the fish. This can be influenced by habitat characteristics or habitat structure variability (Bijoy et al., 2013; Vieira et al., 2020), whether the habitat's adjacent to seagrass (mangroves, coral reefs, and other habitats), fragmentation of the seagrass habitat (Hyndes et al., 2018), and the diversity of the seagrass species' morphology (Ambo-Rappe et al., 2013). Furthermore, the existence of fish species in seagrass is useful for assessing the level of species diversity (Short et al., 2007).

The presence of a dominant fish species is another parameter that explains the difference in the composition of fish communities between locations. For instance, in the Quirimba Archipelago, Northern Mozambique, the dominant fish species were *Siganus sutor*, *Leptoscarus vaigiensis*, *Lethrinus variegatus*, *Lethrinus lentjan*, and *Gerres oyena* (Gell & Whittington, 2002), while in Pak Klong Ban, Thailand, they were *Sillago sihama*, *Leiognathus jonesi*, and *Gerres erythrourus* (Phinrub et al., 2014). With respect to some other sites in Indonesia, at Muara Binuangeun, Lebak Banten, the dominant species were *Moolgarda sp* and *Istiblennius edentulus* (Kholis et al., 2017), while *Spratelloides gracilis*, *Stenatherina panatela*, *Siganus canaliculatus*, *Gerresoyena sp*, and *Siganus spinus* were the dominant species in the seagrass beds of Karang Congkak Island, Kepulauan Seribu National Park, Indonesia (Simanjuntak et al., 2020). In Youtefa Bay, Jayapura, Papua, the dominant species were *Scolopsis lineata*, *Apogon ceramensis*, *Parupeneus barberinus*, *Aeliscus strigatus*, *Siganus fuscescens*, and *Siganus canaliculatus* (Tebaiy et al., 2017). Fish species that gather on seagrass with dominant indicators of species richness and species constitute the main value of seagrass as a fish habitat (Nordlund et al., 2018). Therefore, in this study, the species richness and dominant fish species are important information that provides a scientific basis for protecting or conserving seagrass.

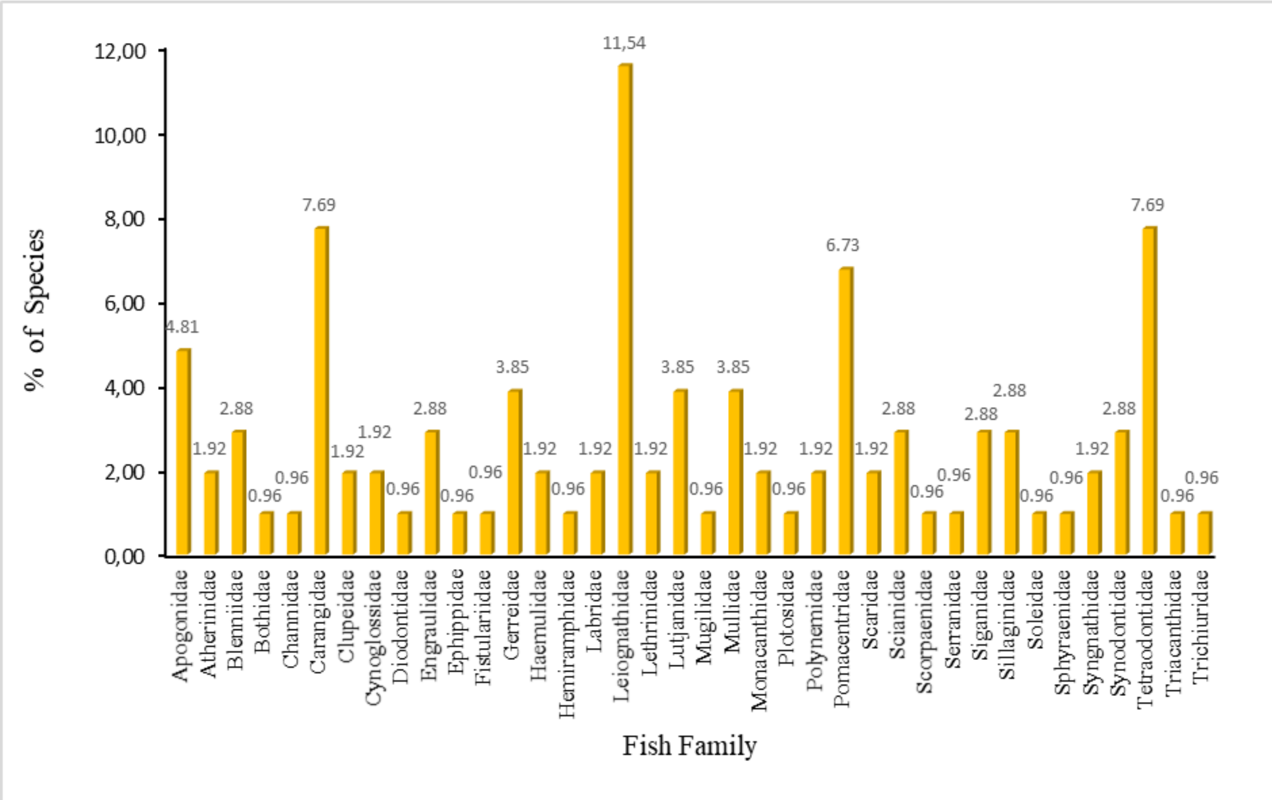

Figure 2. Fish community composition by family based on the number of species present in the seven study locations.

Ecological index of fish species associated with seagrass in the seven study sites

The results of the analysis of the diversity index (H '), evenness index (E), and species richness index (D) at the seven sampling locations are shown in Figure 3. The results of this study indicate that Tanjung Luar is the location with the highest H ', E, and D values, and Gerupak is the location with the lowest ecological index values for H ', E, and D. Meanwhile, the diversity index value at all seagrass locations was between 2.40 and 2.80, with an average value of 2.61. Meanwhile, the species richness index values were between 2.14 and 8.47, with an average of 7.74, and the evenness index ranged from 0.57–0.69, with an average value of 0.62. In this case, the value of H ' can describe the structure of the fish community at the seven sampling locations. In addition, it can explain the distribution of species based on the number of individuals. However, the value of E, which is below one, indicates that no fish species is very dominant at the seven sampling locations. Ecological indices, in addition to those described above. The next assessment was based on month (Table 2). The results of the analysis show that the average H 'value at the seven sampling locations was 2.35 ± 0.24–2.80 ± 0.19, the average E value was 0.59 ± 0.08–0.78 ± 0.10, and the average D value was 6.30 ± 0.17–8.51 ± 0.35. Meanwhile, the highest H 'value was 2.99 in June in Kute, and the lowest was 2.21 in April in Gili Kere. The highest E value was 0.89 in June, and the lowest was 0.49 in April in Gili Kere. Finally, the highest D value was 8.80 in June in Tanjung Luar, and the lowest was 6.04 in April in Gerupk. Because of this, the ecological index value of fish species found in the study location can provide environmental evidence that the presence of seagrass is needed by marine organisms to survive, but that fish density in seagrass is often dominated by juvenile fish groups (Dorenbosch et al., 2005; Hylkema et al., 2015). Moreover, it can explain the vital role of seagrass to fish, which includes providing food, rearing, and protection from predators, and especially fish biodiversity (Bertelli & Unsworth, 2014; Heck et al., 2003; Hidayati & Suparmoko, 2018; Jackson et al., 2001; Prasetya & Purwanti, 2017).

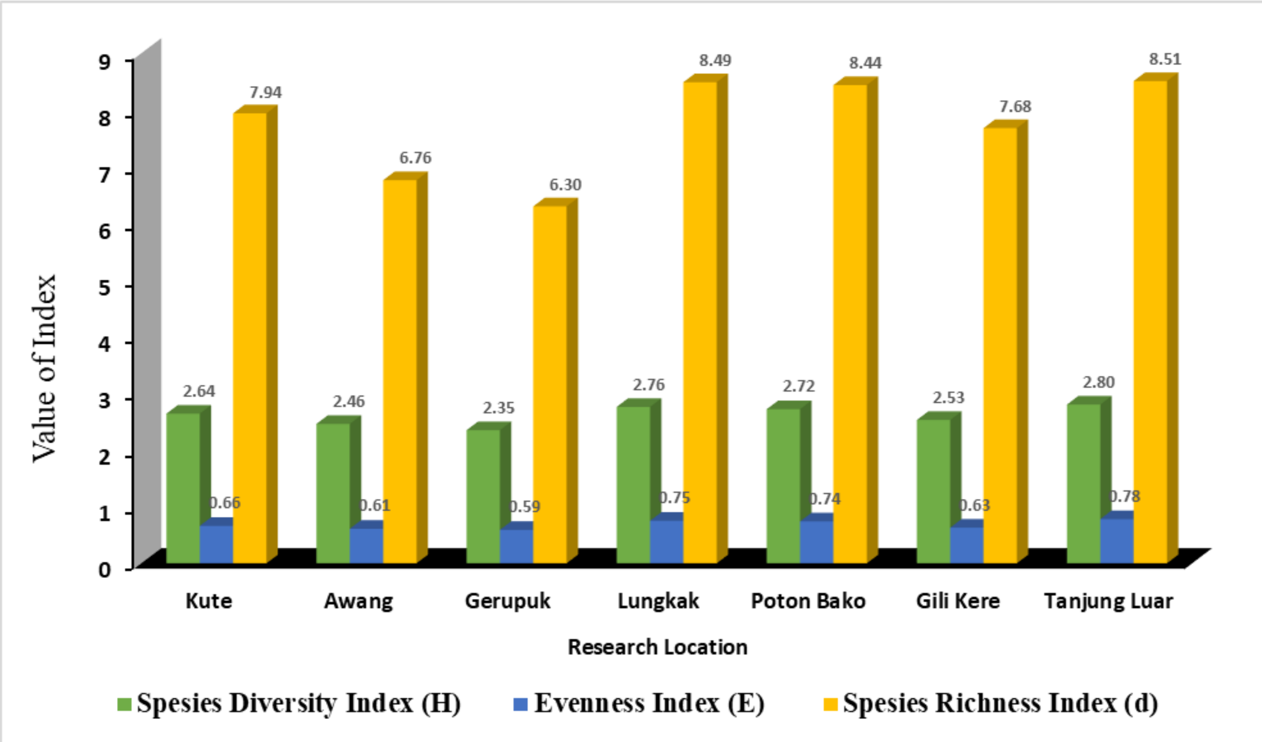

Figure 3. Diversity index, evenness index, and species richness index at the seven survey locations in the study area.

The results of the one-way ANOVA analysis of the ecological index values (H ', E, and D) are presented in Table 2. H ' and E show no significant differences, with an $F\text{-}_{count}$ value of 2.689, $F\text{-}_{table}$ 13.013, and $P\text{-}_{value}$ 2.93 for H ', and $F\text{-}_{count}$ 2.758, $F\text{-}_{table}$ 5.012, and $P\text{-}_{value}$ 0.004 for E. Meanwhile, the value of D shows that there is a significant difference, with F_{count} 2.758, F_{table} 0.582, and P-value 0.677 (Table 3). This explains that the seven seagrass beds have extremely different species and individuals that are evenly distributed or not. The significant difference in the values of D can be explained through the results of the analysis cluster (Figure 4), where Awang and Lungkak are in one group and have similar characteristics, namely that they are situated close to river estuaries and mangrove ecosystems. Furthermore, Gili Kere and Poton Bakau are in one group because they are in close proximity. Other locations, such as Tanjung Luar, have similarities with Gili Kere and Poton Bakau, Kute has similarities with Lungkak and Awang, and only Gerupk does not belong to the first and second stage grouping. Furthermore, the composition of the fish species at the seven sampling locations consisted 94.37% of the commercial fish or the target fish families caught by fishermen. In this case, more than 20% of the commercial fish species experience a shift in habitat use between ecosystems adjacent to seagrass (Honda et al., 2013). Therefore, the presence of other ecosystems and commercial fish species has contributed to the differences in fish species richness, such as in the study sites.

Table 2. Ecological index values for seagrass-associated fish species by month at the seven study locations.

Location	Index	Month					
		April	May	June	July	August	Mean ±SD
Kute	Species Diversity Index (H ')	2.31	2.52	2.99	2.64	2.76	2.64±0.26
	Evenness Index (E)	0.57	0.65	0.72	0.67	0.69	0.66±0.06
	Species Richness Index (D)	7.56	7.79	8.2	8.04	8.11	7.94±0.26
Awang	Species Diversity Index (H ')	2.11	2.32	2.71	2.46	2.68	2.46±0.25
	Evenness Index (E)	0.51	0.56	0.67	0.62	0.68	0.61±0.07
	Species Richness Index (D)	6.42	6.62	7.09	6.78	6.88	6.76±0.25
Gerupuk	Species Diversity Index (H ')	2.09	2.18	2.64	2.28	2.56	2.35±0.24
	Evenness Index (E)	0.5	0.53	0.69	0.56	0.66	0.59±0.08
	Species Richness Index (D)	6.04	6.26	6.48	6.31	6.41	6.30±0.17
Lungkak	Species Diversity Index (H ')	2.46	2.65	2.99	2.73	2.97	2.76±0.22
	Evenness Index (E)	0.69	0.71	0.82	0.74	0.81	0.75±0.06

	Species Richness Index (D)	8.14	8.23	8.91	8.41	8.76	8.44±0.37
Poton Bako	Species Diversity Index (H ')	2.38	2.43	2.97	2.87	2.93	2.72±0.29
	Evenness Index (E)	0.65	0.67	0.81	0.75	0.81	0.74±0.08
	Species Richness Index (D)	7.93	8.21	8.88	8.49	8.67	8.49±0.33
Gili Kere	Species Diversity Index (H ')	2.12	2.21	3.01	2.59	2.73	2.53±0.37
	Evenness Index (E)	0.49	0.59	0.82	0.59	0.64	0.63±0.12
	Species Richness Index (D)	7.21	7.41	8.11	7.76	7.89	7.68±0.36
Tanjung Luar	Species Diversity Index (H ')	2.51	2.71	2.98	2.93	2.87	2.80±0.19
	Evenness Index (E)	0.65	0.71	0.89	0.81	0.82	0.78±0.10
	Species Richness Index (D)	8.04	8.21	8.80	8.72	8.76	8.51±0.35

Table 3. The results of the one-way ANOVA analysis of the ecological indices for seagrass-associated fish at the seven study locations (ἀ = 0,05).

One-way ANOVA	Source of Variation	Diversity Index (H ')	Evenness Index(E)	Richness Index (D)
SS	Between Groups	1.778	0.157	2.194
	Within Groups	1.025	0.196	23.532
df	Between Groups	4	4	4
	Within Groups	30	25	25
MS	Between Groups	0.444	0.039	0.548
	Within Groups	0.034	0.007	0.941
F crit		2.689	2.758	2.758
F *table*		13.013	5.012	0.582
P-value		2.932	0.004	0.677

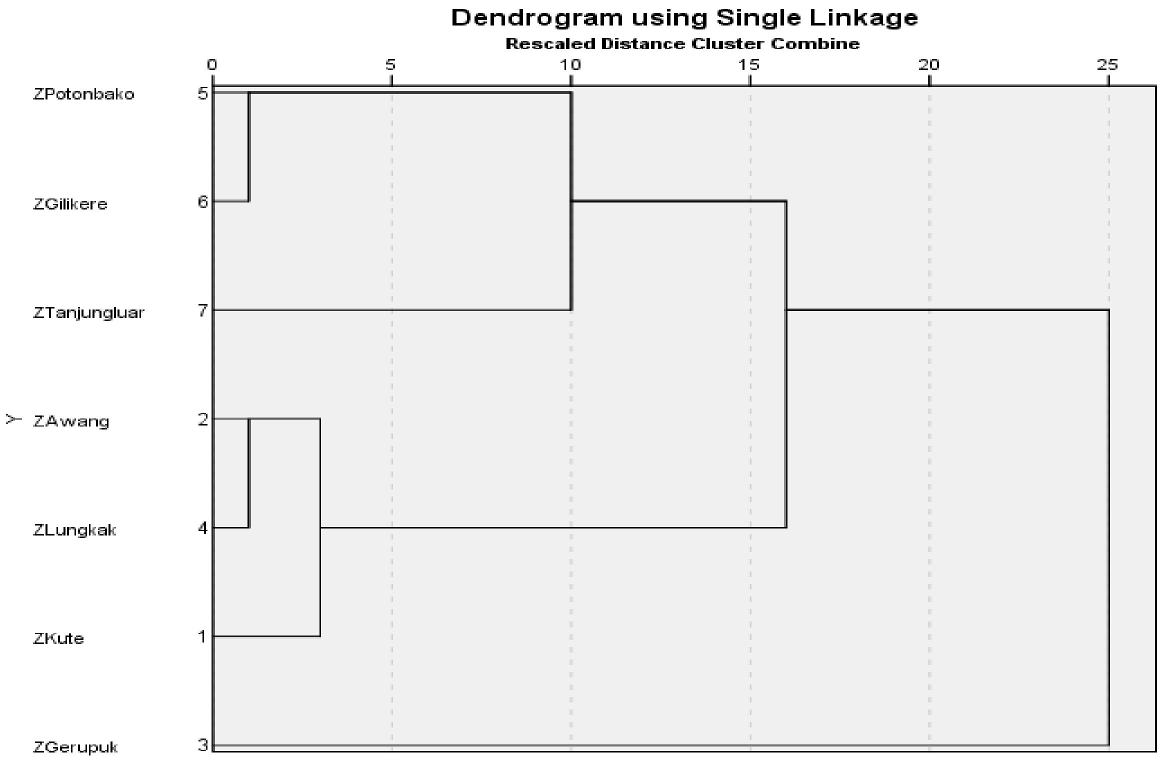

Figure 4. Cluster analysis of the Euclidean distance between seagrass-associated fish communities at the seven study sites.

Seagrass conservation

Several research results have proven the importance of inter-tidal areas, such as mangroves, seagrass beds, and coral reefs, as fish habitats (Aller et al., 2014; Honda et al., 2013; Moussa, 2018; Moussa et al., 2020; Nagelkerken et al., 2014; Unsworth et al., 2009). In particular, seagrass beds have contributed to supporting global fisheries' production and local-scale fisheries' sustainability (Ambo-Rappe, 2020; Nordlund et al., 2018; Unsworth et al., 2019a). The results of this study indicate the potential to support small-scale fisheries in the study locations. First is the level of distribution of fish species at the seven sampling locations (Table 4); second, 25.96% of fish species can be found at all locations, and only 7.69% are found at one location; third, the richness of fish species at each location is above the average value, i.e., 14.42 out of 104 species at all locations, and the highest number of species is found in Gili Kere (73.08%) and the lowest is in Awang (48.08%) (Figure 5); fourth, 94.73% of fish families are fish groups that are the target catch of small-scale fishermen, and among the families that are not, only 5. Moreover, 26% are from Apogonidae and Cynoglossidae (Table 1). Therefore, the existence of seagrass beds in the study location is very important for the economic sustainability of small-scale fishermen. Meanwhile, the richness of fish species associated with seagrass in the seven sampling locations is a source of the biodiversity of fish resources, which must be protected.

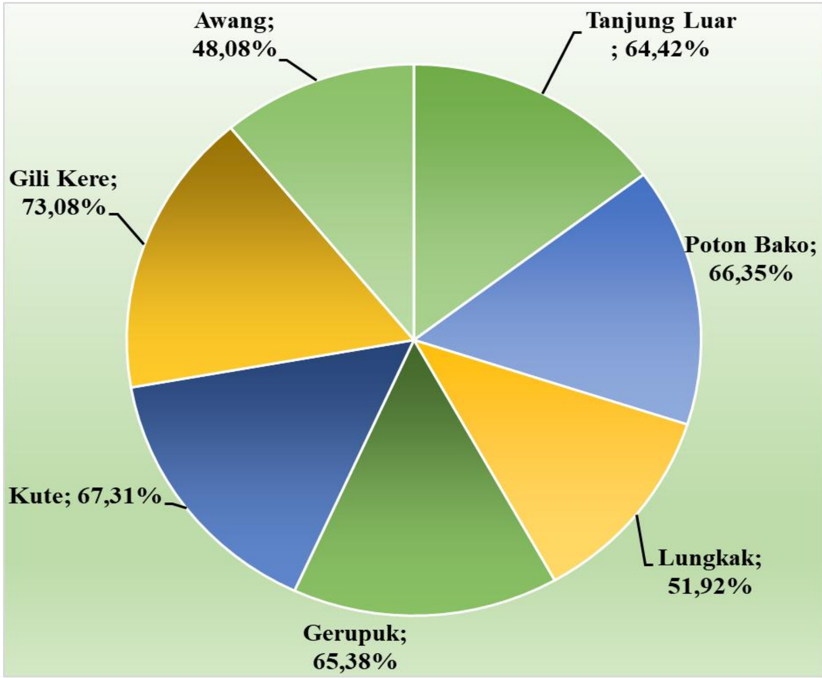

Figure 5. The percentage of all seagrass-associated fish species identified in this study found at each of the seven locations.

Furthermore, the results of this study can explain the value of the ecological indices H ', E, and D quantitatively (Figure 3 and Table 2) as indicators of the role of seagrass ecological services in providing habitat, food, and shelter from predators. Therefore, the results of this study can become a reference for the design of seagrass conservation plans or seagrass management, worked into an integrated and sustainable management system at the study site. Moreover, the results can become the basis for monitoring and evaluating the changes caused by disturbances or threats, such as species overexploitation, habitat destruction, and other anthropogenic activities as well as climate change. This is very important given the disturbance to biodiversity, especially fish resources, despite conservation efforts, where the loss of biodiversity continues at a regional or global scale in various ecosystems (Mouillot et al., 2013; Villéger et al., 2010). If environmental management is neglected, such as in the study location, it can cause a reduction in the value of biodiversity, particularly fish resources, which will affect the sustainability of ecological processes and the provision of ecosystem services.

The current problem that cannot be resolved is the degradation of seagrass habitats, which can reduce the supply of fish produced by small-scale fishermen. Furthermore, the status of seagrass conditions determines the livelihoods of small-scale fishermen (Cullen-Unsworth et al., 2014; de la Torre-Castro et al., 2014). Therefore, efforts to maintain the condition of the seagrass can be done through conservation. This is very important, as seen by how seagrass conservation through restoration in southern Australia has increased the populations of 15 commercial fish species (Blandon & Zu Ermgassen, 2014). Another study explains that the economic value of seagrass beds is dominated by the species *Cymodocea nodosa*, which greatly determines the sustainability of local fisheries in East Atlantic oceanic islands, especially for fishing and breeding (Tuya et al., 2014). According to the results of this study, 94.73% of the fishermen's target fish group contributed to supporting the sustainability of small-scale fisheries' production. Another extremely important aspect of the results is the value of the ecological indices, where at two sampling locations, the H ' values of 2.53 in Gili Kere and 2.76 in Lungak were higher than in 2017, when the values were 2.448 in Gili Kere and 2.60 in Lungkak (Syukur et al., 2017). However, in two other locations Poton Bakau and Tanjung Luar (Kampung Baru), the values of H ' were lower than in 2017. Therefore, the study of seagrass provisioning services, particularly for fish resources, is produced as scientific information for the management or conservation of local-scale seagrass at the study location.

Table 4. Spatial distribution of the seagrass-associated fish species identified in this study.

Spatial distribution	**Species present**	**Number of Species**
All Locations	*Acreichthys tomentosus, Ambassis buruensis, Archamia goni, Canthigaster compressa, Caranx ignobilis, Caranx melampygus, Caranx sexfasciatus, Chelonodon patoca, Calotomus spinidens, Epinephelus bontoides, Fistularia commersonii, Gazza minuta, Gazza rhombea, Leiognathus bindus, Leiognathus daura, Leiognathus equulus, Leiognathus rapsoni, Lutjanus argentimaculatus, Lutjanus boutton, Lutjanus erythropterus, Moolgarda delicates, Sardinella gibbosa, Saurida nebulosa, Secutor interruptus, Siganus canaliculatus, Sillago sihama, Stolephorus indicus, Upeneus vittatus*	27
Six locations	*Abudefduf vaigiensis, Ambassis urotaenia, Gerres filamentosus, Paraplagusia blochi, Scomberinemus lysan, Sillago macrolepis, Stolephorus commersonii, Bothus pantherinus, Sardinella lemuru*	9
Five locations	*Alticus saliens, Arothron immaculatus, Arothron manilensis, Atule mate, Gazza achlamys, Leiognathus oblongus, Platax boersii, Plectorhinchus celebicus, Plectorhinchus flavomaculatus, Selar crumenophthalmus*	10
Four locations	*Abudefduf notatus, Cheilodipterus macrodon, Hemiramphus far, Leiognathus splendens, Siganus guttatus, Sphyraena barracuda, Sphyraena flavicauda, Triacanthus nieuhofi, Upeneus sulphureus*	9
Three Locations	*Abudefduf septemfasciatus, Acreichthys sp, Apogonichthys ocellatus, Archamia zosteropthorum, Atherinomirus lacunosus, Cynoglossus lingua, Cynoglossus puntisep, Filimanus xanthone, Gymnocranius elongatus, Johnius amblycephalus, Johnius macropterus, Lagocephalus ivheeleri, Lagocephalus lunaris, Leptoscarus vaigiensis , Lethrinus variegatus, Plotosus lineatus , Polynemus pelbecius, Pomacentrus lepidogenys, Sillago chondropus, Thallassoma hardwicke, Trachinotus blochii, Trichiurus lepturus, Upeneus tragula*	23
Two Locations	*Amphiprion frenatus, Atherinomorus duodecimalis, Diodon liturosus, Pempheris oualensis, Foa bracygramma, Gerres abbreviatus, Gerrres oyena, Halichoeres papilionaceus, Johnius borneensis, Lagocephalus gloveri, Lutjanus, Paraplagusia bilineata, Petroscirtes variabilis, Saurida gracilis, Scomberoides tala, Siganus argentheus, Synodus dermatogenys*	18
One Location	*Abudefduf sexfasciatus, Andamia tetradactylus, Gerres erythrourus, Neopomacentrus azysron, Syngnathoides biaculeatus, Takifugu radiatus, Thryssa setirostris, Ablabys taenianotus*	8
	Total Number of Species	104

In connection with the seagrass-associated fish species in the study location, maintaining fish habitats, such as preventing or restraining the damage rate, is crucial. Furthermore, seagrass protection efforts can prevent the degradation or loss of seagrass ecosystem services in the ecosystems of coastal waters, especially for protecting marine biodiversity. Moreover, the damage to seagrass can have negative implications by decreasing the productivity of marine resources, disrupting trophic interactions, and reducing stability in the natural ecosystems in the marine environment (Best & Stachowicz, 2012; Duffy, 2006; Duffy et al., 2015). Selain itu, hilangnya vegetasi lamun dapat berpengaruh langsung terhadap ikan yang membutuhkan lamun sebagai habiat (Mishra et al., 2019; Patro et al., 2017). Therefore, practical initiatives are needed in the conceptualization of pilots to conserve exemplary seagrass beds. In this case, the conservation of seagrass beds can be realized through the participation of fishing communities, especially small-scale fishermen.

In conclusion, the fish communities associated with seagrass in the study sites have two main dimensions in relation to conservation. The first aspect of the diversity of fish species found in the seagrass area in the study location constitutes ecological evidence of the contribution of seagrasses to the sustainability of fish communities. Second, 94.73% of the fish families targeted by small-scale fishermen contribute to supporting the sustainability of small-scale fisheries' production. It is hoped that these two factors can become the primary considerations in the local-scale seagrass management and conservation plan in the study location. Consequently, seagrass conservation efforts at various scales, especially outside protected areas such as the study location and others, are urgently needed to protect and preserve marine biodiversity and economic sustainability for local human communities.

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AUTHOR'S CONTRIBUTIONS

Abdul Syukur Agil Al Idrus. and Lalu Zulkifli: Conducted all experiments, participated in data analysis and preparation of the manuscript.

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[biodiv] Editor Decision

2021-01-25 11:08 AM

ABDUL SYUKUR, AGIL AL-IDRUS, LALU ZULKIFLI:

We have reached a decision regarding your submission to Biodiversitas Journal of Biological Diversity, "Seagrass-associated fish species' richness: evidence to support conservation along the south coast of Lombok Island, Indonesia".

Our decision is to: Accept Submission

Smujo Editors
editors@smujo.id

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[biodiv] Editor Decision

2021-01-27 06:13 AM

ABDUL SYUKUR, AGIL AL-IDRUS, LALU ZULKIFLI:

The editing of your submission, "Seagrass-associated fish species' richness: evidence to support conservation along the south coast of Lombok Island, Indonesia," is complete. We are now sending it to production.

Submission URL: https://smujo.id/biodiv/authorDashboard/submission/7061

Smujo Editors
editors@smujo.id

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