

C7

by Abdul Syukur

Submission date: 26-Aug-2020 09:30AM (UTC+0700)

Submission ID: 1374166970

File name: r_bereputasi-_Q-3,American_Journal_of_Environmental_Sciences.pdf (462.16K)

Word count: 9367

Character count: 50733

Original Research Paper

Threats to Seagrass Ecology and Indicators of the Importance of Seagrass Ecological Services in the Coastal Waters of East Lombok, Indonesia

¹Abdul Syukur, ²Yusli Wardiatno, ²Ismudi Muchsin and ²Mohammad Mukhlis Kamal

¹Department of Sciences Education,
Faculty of Teacher Training and Education, Mataram University, Indonesia

²Department of Aquatic Resources Management,
Faculty of Fisheries and Marine Sciences, Bogor Agricultural University, Indonesia

Article history

Received: 09-11-2016

Revised: 05-04-2017

Accepted: 17-05-2017

Corresponding Author:

Abdul Syukur
Department of Sciences
Education, Faculty of Teacher
Training and Education,
Mataram University, Indonesia
Email: syukur_unram@gmail.com

Abstract: Seagrass ecology contributes to the preservation of fish and other biota diversity and is also an important livelihood source for fishermen and local communities. The purpose of our research was (1) to determine the source of the threats to seagrass ecology and to the ecological services it provides for the sustainability of fish resources and (2) to determine the main indicators defining the conservation needs of seagrass in the study area. Data were collected through direct observation, questionnaires, interviews and discussions. Data for fish in the seagrass bed research sites were obtained using mini-trawlers belonging to local fishermen. All data were analyzed using descriptive statistical analyses. The results showed that seagrass beds play an important role in fish ecology and that local livelihoods were highly dependent on small-scale fishing. However, fishermen and local communities also constituted the two main threats to the preservation and sustainability of fish and other biota in the area. Our results found, too, that there is a scarcity of some types of biota: some fish species, mollusks, crabs, sea-urchin and some types of sea cucumber were very difficult to find in the seagrass beds that were the focus of our study. Our conclusion is that, given the scarcity of fifteen species of fish, as well as of other biota and the lack of diversity in fish food in our study area, it is imperative that seagrass conservation becomes an important priority for conservation interventions.

Keywords: Resources Threats, Seagrass Ecology Systems, Conservation of Seagrass

Introduction

Seagrass beds are an important habitat in the tropical marine environment. The global species diversity of seagrasses is low (<60 species), but are a key component of ecological systems in the coastal environment and can form extensive meadows supporting high biodiversity (Short *et al.*, 2007). Many of the smaller fish species and invertebrates and other animals (e.g., gastropods, bivalves and polychaetes) are found in seagrass beds (Shokri *et al.*, 2009; Maheswari *et al.*, 2011; Satumanatpan *et al.*, 2011) and they support the productivity and fish biodiversity of coral reefs (Bosire *et al.*, 2012; Unsworth and Cullen, 2010). *Tripneustes gratilla*, *Leptoscarus vaigiensis*, *Chelonia midas* and *Dugong dugong* have all been found to have a

high dependence on seagrass (Mamboya *et al.*, 2009). Thirteen fish of commercial importance were identified as being recruitment enhanced in seagrass habitat, twelve of which were associated with sufficient life history on seagrass beds in southern Australia (Blandford and Ermgassen, 2014) and the artificial seagrass could play a vital role as a nutrient rich habitat for marine fishes (Shahbudin *et al.*, 2011). Seagrass beds provide feeding habitats for some life-stages of fish and contribute to stabilizing our climate and support food security (Verweij *et al.*, 2006; Unsworth *et al.*, 2015), but these impacts have brought about accelerated the decline in seagrass habitats globally (Waycott *et al.*, 2009).

Storms and prolonged rain (which affect water clarity) have had a significant impact on seagrass beds in the

30 stal areas of Indonesia. Declines were associated with storm and cyclone activity and similar to other nearby seagrass areas and natural disturbances such as water changes affect seagrass populations (Ahmad-Kamil *et al.*, 2013; Mckenna *et al.*, 2015) and productivity were expected to decrease with decreasing water clarity (van Tussenbroek *et al.*, 2014). Our research found that a combination of these factors has resulted in significant damage to hundreds of meters of seagrass beds (Orth *et al.*, 2006; Short *et al.*, 2006; Brigitta *et al.*, 2014). From the review of 45 case studies worldwide for a total loss of 21,023 ha of seagrass vegetation (Erfemeijer and Lewis, 2006) and the coastal natural of Philippine demography, development and facilities, have caused eutrophication of marine waters, which, along with habitat loss, is a major long-term threat to seagrass ecosystems (Fortes, 2011).

Eutrophication of the coastal estuaries is profoundly altering the primary producer, carbon and nitrogen storage capacity of coastal ecosystems at local and regional scales (Schmidt *et al.*, 2012). Nevertheless, the increasing human impacts associated with eutrophication and it is possible that could exacerbate seagrass loss (Coll *et al.*, 2011; Stoner *et al.*, 2014). This indicates that, the anthropogenic factors that negatively influenced the abundance and distribution of seagrass, through fluvial channels, urban and commercial development, the anchoring of motorized and non-motorized boats, diverse fishing techniques and the dumping of solid waste (Pitanga *et al.*, 2012), as though, seagrass in the Western Pacific are showing signs of stress and decline due to human impacts, despite the vastness of the ocean area and relatively low development pressure (Short *et al.*, 2014).

Indonesia, the most serious and direct threats to coastal and marine biodiversity are the conversion of the coastal habitats (e.g., mangroves, seagrass beds and estuaries) into man-made land use, such as tambak, industrial estates, settlement; and of coastal and marine resources (Hutomo and Moosa, 2005). Seagrass meadows in Indonesia have also lost their trophic balance due to overexploitation, placing their resilience to poor water quality at risk (Unsworth *et al.*, 2015). Anthropogenic activities, particularly port development, livestock grazing, land conversion and over-exploitation by fishermen and local communities have had a major impact, too. Examples of areas where extensive damage has occurred include Gerupuk and Kuta South Lombok and the coastal waters of East Lombok (Syukur *et al.*, 2012).

Conservation measures urgently need to be implemented in order to preserve and maintain the remaining seagrass beds and to protect them from these threats and the world's seagrass species under the Categories and Criteria of the International Union for the Conservation of Nature (IUCN) Red List of Threatened

Species (Short *et al.*, 2011). Seagrass conservation monitoring protocols are based on conceptual models that link: (1) light and nutrient availability on the seagrass condition (2) physicochemical stressors, (3) habitat quality resilience bioindicators and (4) environmental change (Dunton *et al.*, 2011; Di Carlo and McKenzie, 2011). Furthermore, by classifying the attributes of the species present, meadow structure and their possible drivers into a framework to assist ongoing monitoring and management decision-making (McKenzie *et al.*, 2016). Other factors indicative of the importance of seagrass bed conservation include its role in maintaining water quality, for example in interventions in Chesapeake Bay, USA and the numbers of coral reef fish that migrate to them. This has been important in the expansion of the Great Barrier Reef protection area in Australia (Larkum *et al.*, 2006).

The conservation of seagrass in the coastal waters of Indonesia is particularly important because of the vital functions seagrass plays in the life of fish, especially as nursery grounds and for feeding. However, the concept of conservation as a method of achieving sustainability goals for fish resources is not yet understood by the majority of Indonesian people, including some government officials (Nadiarti *et al.*, 2012). The roots of the problems of the seagrass conservation in Indonesia are the following factors (e.g., rapid population growth and poverty; lack of implementation policy and poor enforcement; lack of awareness, lack of political will; lack of recognition of "adat" (local tradition); lack of integrated approaches; lack of capable human resources; lack of information as a basis for rational and optimal marine resource management and poor system to access available information (Hutomo and Moosa, 2005) and the worse threat for seagrass conservation might be the lack of information that its importance for coastal ecosystem health, its distribution and poor conservation status (Cunha and Serrão, 2011).

The importance of seagrass resources are highly underestimated and its conservation has thus not been prioritized in conservation management policies at the national level. This is despite studies showing that seagrass and therefore its conservation is key to the sustainability of small-scale fishermen's livelihoods (Syukur *et al.*, 2016). The objective of this study is therefore to determine the sources of threat to seagrass and the impact this has had on fish and other biota associated with seagrass and its ecological services. Our intention is that this research will inform seagrass conservation strategies and thus contribute to the sustainability of fish resources in the study area.

Methods

This study was conducted from April to August 2011 in the coastal areas of East Lombok Regency

West Nusa Tenggara Province, with geographic coordinates of 116°37'-116°45' east longitude and 8°17'-8°18' south latitude (Fig. 1). Seagrass beds in the study sites covered 154.21 ha and nine species of seagrass were found: *Halophila ovalis*, *Halophila minor*, *Halophila spinulosa*, *Cymodocea rotundata*, *Cymodocea serrulata*, *Halodule pinifolia*, *Thalassia hemprichii*, *Syringodium isotifolium* and *Enhalus acoroides* (Syukur *et al.*, 2012).

Data regarding the biota targets of small-scale fishing enterprises (of fish, mollusks, crabs, sea-urchins and sea cucumbers) in seagrass beds was obtained through the use questionnaires, interviews and focus group discussions. Our criteria for the selection of research participants were that they: (1) Had a minimum of 20 years' experience as fishermen; (2) fished more than 70% of their time around the seagrass beds; (3) had a knowledge of seagrass; (4) were aware of the changing conditions of the biota groups they targeted in the seagrass bed sites; and (5) had some knowledge regarding the dependence of the target group of organisms on seagrass bed habitats. From these criteria we selected 50 fishermen as respondents (Aswani, 2010).

The data generated from interviews were substantiated by focus group discussions (Galappaththi and Berkes, 2014). Collection of fish in the seagrass bed locations was carried out at night during full tides (the spring tides), using the fishermen's mini-trawlers, with 70 m long nets with wing mesh sizes of 1.25 inches, 1 inch, 0.75 inches and 0.625 inches and mesh bags of 0.5 inches. The nets were dragged by the boats at an average speed of 5 m/minutes. The fish caught were placed in containers were provided and were sorted into family and species. The number of individuals of each species were counted and measured (cm). The trophic status of fish in the seagrass bed sites was determined using secondary data (Syukur *et al.*, 2014). The data were analyzed using descriptive statistics and fish diversity was established using the Shannon-Weaver Index (Ludwig and Reynolds, 1988) and dominance index (Odum, 1983) with formula:

$$H' = -\sum (p_i \ln p_i)$$

where, p_i is the proportion of all individuals counted that were of species i .

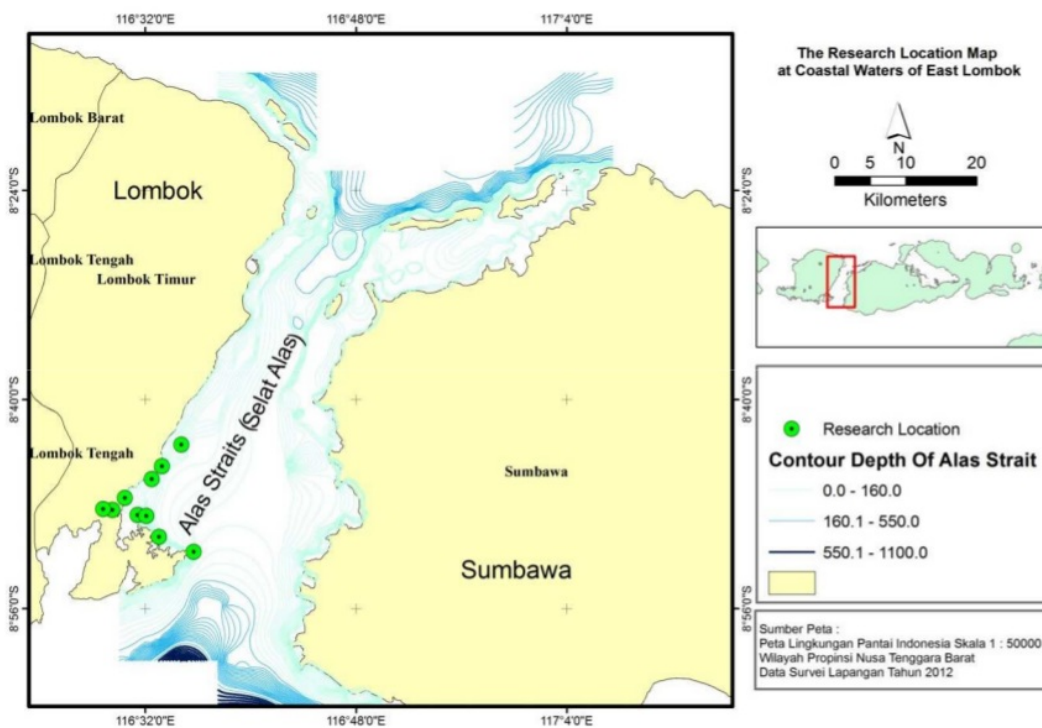


Fig 1. Research location of seagrass beds and surrounding areas of small fishing in East Lombok

Simpson dominance index with formula:

$$C = \sum_{i=1}^n \left[\frac{n_i}{N} \right]^2$$

Where:

C = Dominance index

n_i = The value of importance of each species

N = The total value of important of all species

Results

Small-scale fishing communities live in small villages scattered along the shoreline of our study area. Livelihoods are based on the extraction of natural resources, such as plants, fish and other animals. Small-scale fishing constitutes some 84.33% of livelihoods in the local communities in the study area. We divided small-scale fishermen into categories based on the type of equipment they used and their catchment area, as shown in Table 1.

All categories of fishermen (Table 1) were dependent on seagrass beds as the main target area for catching fish and other biota that have economic and/or consumption value. The most common fish targeted were Carangidae, Leiognathidae, Haemullidae, Scaridae, Siganiidae, Mugilidae and Lethrinidae. Crabs, *Portunus pelagicus* and *Portunus sanguinolentus*, were commonly targeted too.

Interview results showed that 64% of respondents stated that areas of seagrass habitat were very important for the sustainability of fish resources. Thirty percent stated they were quite important and only 6% said they were not very important. Respondents also stated that several species of fish and other biota had become considerably less abundant in recent years and that their catch often no longer met the needs of their families. Local residents themselves were a considerable threat to the sustainability of the ecological functions of seagrass in the study area. Activities such as gathering mollusks, crabs, sea cucumbers, sea-urchins, fruit and other

consumable biota were common. Our observations found that a large number of local people visited the seagrass sites, as is shown in Table 2.

The intensity of the utilization of seagrass areas by fishermen and local communities helps explain the level of exploitation of fish resources and other biota at the study sites. Such continuous exploitation can have a negative impact on the preservation of fish resources and other biota and can cause damage to the shoot density of seagrass. The implications of this over-exploitation can be gauged through our respondents' resource assessment results (Fig. 2). Some groups of marine organisms such as mollusks, crabs, sea-urchins and sea cucumber populations have declined significantly. Moreover the flagship groups *Syngnathoides biaculeatus* and *Synodus demogenys* of the family Syngnathidae were very difficult to find during the study period.

118 fish species and 16049 individuals were found during the sampling period. The location with the highest number of species was Gili Kere, while the location with the highest number of individuals was Kampung Baru. The location with the lowest number of species and individuals was Gili Maringkik (Table 3). The results of the analysis of the abundance of species in each sampling site showed great differences in the numbers of individual species abundance and frequency. The fish community structure in Gili Kere had 72 species. *Archamia goni*, *Leiognathus equulus*, *Leiognathus bindus*, *Ambassis buruensis*, *Plectorhinchus flavomaculatus*, *Sphyrna barracuda*, *Upeneus vittatus*, *Sardinella lemuru*, *Sardinella gibbos* and *Gerres filamentosus* all had above average numbers of individuals. The total number of individuals counted at Gili Kere was 4080. The species with the highest abundance was *Archamia goni* (32.79%), followed by *Leiognathus equulus* (16.66%), *Leiognathus bindus* (3.62%) and *Gerres filamentosus* (1.9%). There were 62 species with a below average number of individuals and one species, *Syngnathoides biaculeatus* of the family Syngnathidae.

Table 1. Fishermen categorized by equipment and catchment area

No	Category of fishermen	Equipment	Catchment area
1	Mixed	Mini trawler	Open waters, seagrass beds and estuaries
2	Drag net	Beach seine	Seagrass beds and estuaries
3	Fishermen catching shrimp and crab	Nets	Seagrass beds, estuaries and coral reefs

Table 2. Numbers of local people visiting the seagrass beds

No	Location of the seagrass	Number of local people visiting the seagrass beds more than five days /month			The average number of local people visiting the seagrass sites per day
		April	May	June	
1	Gili Kere	648	637	669	130
2	Poton Bakau	1156	907	968	202
3	Kampung Baru	187	155	136	31
4	Lungkak	226	208	214	43
Total	2217	1933	1987	406	

Table 3. Fish families, species and total number of fish in the study area

No	Location	Number of families	Number of species	Number of individuals	Width of seagrass beds (ha)	Number of Individuals/ha
1	Gili Kere	35	72	4080	46	89
2	Kampung Baru	29	60	4108	4	1027
3	Lungkak	28	48	2147	5,6	383
4	Poton Bakau	31	67	3975	55	72
5	Gili Maringkik	28	47	1739	32	54

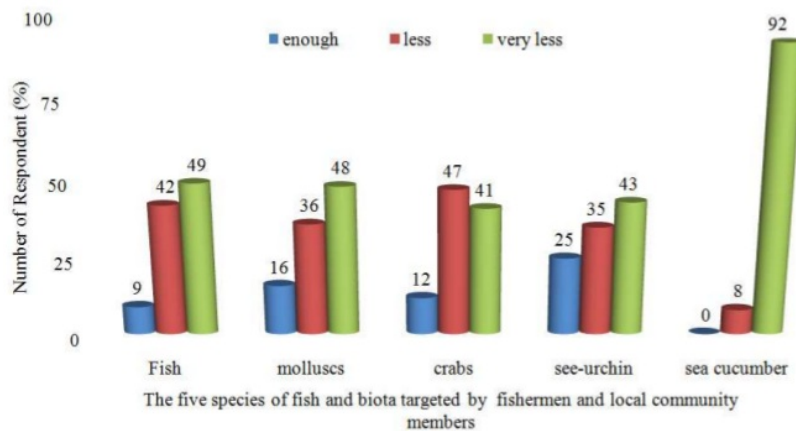


Fig. 2. Status of fish and marine life at the seagrass sites in the study area, n = 50

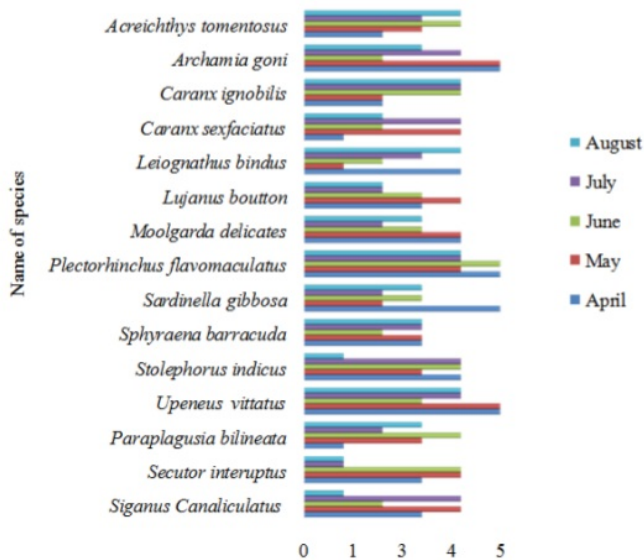


Fig. 3. The fifteen species of fish with the highest abundance during the study period

In Kampung Baru there were sixteen species with an above average number of individuals and twelve species with high frequency values. The species with the highest

number of individuals was *Sardinella gibbosa* and the species with the highest frequency value were *Stolephorus indicus* and *Plectorhinchus falvomaculatus*.

At the seagrass site in Gili Maringkik there were fourteen species which had an above average number of individuals and nine species with a high frequency value. The species with the highest number of individuals was *Leiognathus equulus* and the species with the highest frequency value were *Cheilio inermis*, *Acreichthys tomentosus* and *Siganus guttatus*. At this location the species the most individuals was *Upeneus vittatus* and the species with the highest frequency value were *Stolephorus indicus*, *Leiognathus oblongus*, *Moolgarda delicata* and *Upeneus vittatus*.

In the seagrass beds in Poton Bakau there were thirteen species with above average numbers of individuals and twelve species with a high frequency value. *Archamia goni* had the most individuals and the species with the highest frequency value were followed by *Stolephorus indicus*, *Plectorhynchus falvomaculatus*, *Moolgarda delicata* and *Upeneus vittatus*.

Seagrass ecology has a strong relationship with fish species abundance. Of the 118 species of fish found in the study area, 15 species had an abundance value of more than 50% (Fig. 3). 103 species (87.28%) had a frequency below 50% of the total sampling. The prevalence of these species indicates the importance of the ecological value of seagrass at the study site. Furthermore, fish species with a frequency value between 6-12 can be found in (Appendix 1). However, in their group, namely *Leiognathus equulus* (48%), *Gerres filamentosus* and *Sardinella clupei* (44%), *Trichiurus lepturus* and *Upeneus sulphureus* (40%) is a fish species with high abundance. The group had a frequency value between 1-5 (Appendix 2) and comprised 80 species (70%) of the total number of species, 77.66% of the number of fish species with a frequency value below 50%. Thirteen species (11.01%) were found during the study period at each of the seagrass bed sites (Appendix 3) and 12 species (10.26%) were found at only four of the sites (Appendix 4).

Fish diversity in seagrass beds is an important way of assessing the ecological role of seagrass beds in the conservation of fish resources. Diversity index values and dominance index values are good indicators to illustrate the importance of seagrass beds for the diversity of fish species. The diversity index value offers a different perspective to that of the dominance index value (Table 4). For our study these two values provided information on fish community structure at each seagrass bed site in the study area. The diversity of fish associated with seagrass is indicative, too, of how seagrass beds provide ecological services which lead to fish seeking them out. We observed the stomach contents of seventeen species of fish and these showed that 85% were from a carnivorous fish group (Appendix 5). This indicates that carnivorous fish were the dominant group in the structure of the fish communities.

Table 4. The value of the diversity index and dominance index of species of fish at each seagrass bed site in the study area

No	Location	Diversity index (H')	Dominance index (D)
1	Gili Kere	2.448	0.164
2	Kampung Baru	2.948	0.083
3	Lungkak	2.606	0.148
4	Poton Bakau	2.797	0.131
5	Gili Maringkik	2.942	0.077

Discussion

Threats to the Sustainability of the Ecological Functions of Seagrass

Seagrass meadows provide important ecosystem services; primary production, nursery habitat for juveniles and human food from seagrass associated species (Ambo-Rappe *et al.*, 2013; Buapet *et al.*, 2013; Cullen-Unsworth *et al.*, 2014; Jackson *et al.*, 2015; Giakoumi *et al.*, 2015). Others ecological services of seagrass are an estimated \$1.9 trillion per year in the form of nutrient cycling and the significant enhancement of coral reef fish productivity and they provide a habitat for thousands of fish, birds and invertebrate species and are a major food source for the endangered dugong, manatee and green turtle (Waycott *et al.*, 2009). Furthermore, seagrass beds are the most significant daily income source for fishermen and also provide the main sources of animal protein. Local communities use them, too, for harvesting traditional medicines, fertilizers and for other aesthetic, instrumental, spiritual and religious purposes (Unsworth *et al.*, 2007) and key ecosystems supporting small-scale fisheries (de la Torre-Castroa *et al.*, 2014), but in many areas, they are also threatening a way of life for those people closely associated with the system either directly or indirectly (Cullen-Unsworth *et al.*, 2014). Therefore, better understanding of which ecosystem services areas associated with specific seagrass genera and bioregions is important for improved coastal management and conservation (Nordlund *et al.*, 2016).

There are not many alternative sources of livelihoods for local communities in the study area. Many of our respondents were aware that their actions have caused a significant reduction in the fish populations that they target, as well as to another biota in and around the neighborhood of the seagrass beds. The dependency on fishing, however, makes it very difficult to implement effective strategies to prevent over-exploitation by fishermen and local communities and this has resulted in the decline of fish populations and other biota associated with seagrass. Other studies, too, have reported that small-scale fishing activities have had a negative impact on seagrass and other biota associated with seagrass in East Lombok (Satyawan *et al.*, 2014), in reef flats and

seagrass bed areas has reduced the population of the biota in the coastal waters (McCloskey and Unsworth, 2015) and high rates of exploitation mean that stocks generally cannot sustain expected levels of economic return (Aheto *et al.*, 2012) and a relationship between the significant decline in catches in Indonesian waters and damage to seagrass beds (Unsworth *et al.*, 2010). Furthermore, many of seagrass habitats damage caused to from community activities, commercial fishing and aquaculture (Brigitta *et al.*, 2014). Similarly, our study found that the two main sources of continual threat to the ecological functions of seagrass were small-scale fishing operations and the local community. We believe it is essential that local government understands this and initiates strategies for the management of seagrass at a local level, not least in order to protect and conserve fish stocks for the economic and social benefit of fishermen and local communities.

The Abundance and Diversity of Fish as Indicators of Seagrass Conservation

The richness in numbers of fish species associated with seagrass highlights: (1) The ecological importance of seagrass for the sustainability of fish resources; (2) the abundance of fish species that use seagrass habitats to survive; and (3) that the distribution of fish species is an indicator of ecological health, of the scale of seagrass damage and of the importance of its conservation for fish sustainability. Some fish species found in the study area had higher numbers than at other seagrass bed sites, such as at the Marine National Park at Wakatobi where there were 81 species (Unsworth *et al.*, 2007).

Of those 118 species, 13 species were found at all the seagrass bed sites (Appendix 3) and 12 species were found at four sites (Appendix 4). Three species had a high abundance value: *Plectorhynchus flavomaculatus* (88%), *Upeneus vittatus* (84%) and *Archamia goni* (76%). Of these *Archamia goni* is a permanent seagrass resident. Nevertheless, families Apogonidae using seagrass as an alternative habitat and reef as the main habitat, including *Archamia goni* (Bosire *et al.*, 2012). 37 fish that gather on seagrass, 87.5% come from other habitats, such as coral reefs, estuarine and other locations around seagrass 48 and over 90% of these fish species used multiple habitats, such as mangrove, seagrass and coral reef (Honda *et al.*, 2013). Furthermore, *Stolephorus indicus* and *Sardinella gibbosa* are both in the pelagic fish group on seagrass in the study area. Another study states that, *Sardinella gibbosa* is a pelagic fish that can be found in coastal waters dominated by mangrove and in turn 36 contributes to regional offshore fisheries (Khatoun *et al.*, 2014; Kumar *et al.*, 2016; Swapna *et al.*, 2016) and *Stolephorus indicus* is belonging pelagic-neritic and

become the target of a small 55 fishing catch (Asha *et al.*, 2014). Consequently, the abundance of fish species diversity in seagrass beds highlights the importance of seagrass for these fish to survive and is an important factor to be considered in conservation strategies for seagrass in the study area.

Several studies of fish associated with seagrass beds, especially in Southeast Asia. *Atherinomorus duodecimalis*, *Sillago sihama* and *Pelates quadrilineatus* dominant species in seagrass meadows at Sikao Bay, Trang Province, Thailand (Phinrub *et al.*, 2015) and *Sillago aeolus*, *Sillago sihama* and *Erres erythrorus* the highest of occurrence frequency in seagrass beds at Ban Pak Klong, Trang Province, Thailand (Phinrub *et al.*, 2014). Furthermore, *Siganus canaliculatus*, *Aeoliscus strigatus*, *Syngnathoides biaculeatus*, *Acreichthys tomentosus* and *Paracentropogon longispinis* dominant species in 29 Bon Bay Indonesia (Ambo-Rappe *et al.*, 2013) and the Engraulidae family 29 and *Lethrinus harak*, the most abundant being from in the Marine National Park at Wakatobi, Indonesia (Unsworth *et al.*, 2007) and *Chromis sp.* and *Pomacentrus sp.* was dominant in the artificial seagrass area in Sepanggar Bay at Northern Kinabalu Malaysia (Shahbudin *et al.*, 2011). In this respect, the abundance of different species with several other locations as we mentioned above, I believe this is a unique kind of fish abundance at the study 19 location, so it can be a major argumentation of seagrass conservation and sustainable fisheries in the study area.

The diversity of fish that assembled at our seagrass study sites, whether permanent seagrass residents or species that migrate to find food and shelter from predators, is an important indicator of the ecological services which seagrass beds provide for the sustainability of fish resources. The index value of diversity and dominance (Table 4) illustrates the distribution of the species and the number of individuals within a species or diversity index is a proportion of each species and dominance indices represent the relative number of individuals. 12 diversity index value of fish found in the study area is relatively equal to the index value diversity of fish with two locations of seagrass beds. The location of seagrass beds 54 are in Sikao Bay, Trang Province, Thailand with the value of the Shannon-Wiener index (H') = 2.7 (Phinrub *et al.*, 2015) and, in Formoso River Estuary-Pernambuco, Brazil (H') = 2.66 (Pereira *et al.*, 2010). Nevertheless, have considerable difference 18 with the value of fish diversity on seagrass beds in the Jordanian coast of the Gulf of Aqaba (H') = 1.4 (Khalaf *et al.*, 2013).

Other studies have shown, the vegetated habitats such as mangroves and seagrass beds showed higher species diversity (Sichum *et al.*, 2013) and species number and abundance were significantly lower in sandy areas and seagrass habitats presenting intermediate values (Giakoumi and Kokkoris, 2013). More of study showed,

the species diversity in seagrass beds were higher than those in the bare substrate (Horinouch, 2005) and fish assemblage structure and distribution pattern in *Thalassia hemprichii* and *Enhalus acoroides* were significantly different (Nadiarti *et al.*, 2015) and species diversity was significantly higher in high cover seagrass than in low cover seagrass (McCloskey and Unsworth, 2015).

The diversity of value is an ecological indicator that can evaluate the area for the conservation decisions. The extent that key attributes of biodiversity, including ecological (vegetation structure, species diversity and abundance and ecosystem functioning) and socioeconomic (Portley *et al.*, 2013). Moreover, diversity index as ecological indicators for monitoring environmental changes is reliable and cost-effective (Siddig *et al.*, 2016). It is this a useful tool for monitoring and evaluating conservation areas (Nemeth and Jackson, 2007) and informing conservation policy and also provides information about the fish within the habitat. However, the loss of or reduction in the value of biodiversity associated with seagrass fish will ultimately have an impact on the livelihood support to small-scale fisherman and long-term impact on the ecological service of seagrass. Therefore, the value diversity of fish is a very essential as information in seagrass conservation measures for sustainable of fish resource in the study area.

Our analysis of fish food (Appendix 5) showed that seagrass provides a diversity of fish food (e.g., fish, fish larvae, shrimp, crabs, sea-urchins, crustaceans and cephalopods) were found in the stomach contents of the other types of fish. Furthermore, a status of fish trophic in the study area was grouped into three categories; herbivores, carnivores and omnivores. carnivores (61,90%) were the most dominant, followed by herbivores and omnivores (19%). In this case, the group of fish is the most dominant carnivores on seagrass beds in the study areas. Similarly, the group of fish carnivores contributed about 70% of the total fish abundance in seagrass beds at Donghsa Island's (Lee *et al.*, 2014), but there was differences, the group of fish carnivores (20%) and herbivores (20%) in the Formoso River estuary-Pernambuco, Brazil (Pereira *et al.*, 2010). Besides that, (Appendix 6) showed that seagrass provides a diversity of fish food on seagrass in the study area. It is the substantial fact of for preventing the threat of damage seagrass and may be considered in seagrass conservation actions for the sustainability of fish resources in the study area. However, which was related to the greater movement of fish between the seagrass and adjacent habitats to forage and a breakdown in the association with seagrass habitat as a refuge from predation (Jackson *et al.*, 2006).

Understanding how fish use seagrass habitats is beneficial to informing the design of conservation

strategies at the level of species, communities and ecosystems. Effective conservation requires a minimum of three criteria: (1) A comprehensive description of an area's biodiversity and its conservation goals; (2) an indication of the potential suitability of the conservation area for the sustainability of the target species and ecological communities and (3) an estimation of the ability of an area to support a requisite number of individuals and species in the long term (Jelbart *et al.*, 2007). Another factor which is important to the conservation of fish resources is the extent of the area under protection. In order to protect fish stocks a minimum 20-30% of the total area is needed protected (Banks *et al.*, 2005), for the protection of species between 30-50% and for the protection of fish larvae a minimum of 40% (Gladstone, 2007).

Conclusion

Seagrass ecology is central for the preservation of biodiversity in many coastal areas in Indonesia, but is becoming increasingly threatened by human activity. Although seagrass conservation efforts have been attempted by governments and non-governmental organizations, they are limited to the Marine National Park, the Natural Park of the Sea and the Regional Marine Conservation Area. Initiatives for protecting seagrass ecosystems more widely in the coastal waters of Indonesia, such as those in our study area, need urgently to be implemented. This research is intended to inform such initiatives and contribute to the development of models that are based on scientific data, such as that generated by this study. We would like to highlight, too, that involving fishermen and local communities is key to achieving conservation goals and the sustainability of seagrass biodiversity.

Acknowledgement

The authors are thankful to the Directorate General of Strengthening Research and Development, Directorate of Research and Community Service, Ministry of Research, Technology and Higher Education of Indonesia for providing the funding for carrying out this study. The authors would also like to thank Sarah A. Bologna Ph.D for constructive criticism and comments during the preparation of this article.

Author's Contributions

Abdul Syukur: Conducted all experiments, data analysis and preparation of the draft manuscript.

Yusli Wardiatno, Ismudi Muchsin and Mohammad Mukhlis Kamal: Advised research design, organized the manuscript's structures and edited the manuscript.

Ethics

All authors have provided assurance that this paper is original research and has not been published elsewhere and all the author has read and approved the manuscript.

References

- Aheto, D.W., N.K. Asare, B. Quaynor, E.Y. Tenkorang and C. Asare *et al.*, 2012. Profitability of small-scale fisheries in Elmina, Ghana. *Sustainability*, 4: 2785-2794. DOI: 10.3390/su4112785
- Ahmad-Kamil, E.I., R. Ramli, S.A. Jaaman, J. Bali and J.R. Al-Obaidi, 2013. The effects of water parameters on monthly seagrass percentage cover in lawas, East Malaysia. *Scientific World J.*, 2013: 892746-892753. DOI: 10.1155/2013/892746
- Ambo-Rappe, R., M.N. Nessa, H. Latuconsina and D.L. Lajus, 2013. Relationship between the tropical seagrass bed characteristics and the structure of the associated fish community. *Open J. Ecol.*, 3: 331-342. DOI: 10.4236/oje.2013.35038
- Asha, C.V., P.S. Suson, C.I. Retina and S.B. Nandan, 2014. Decline in diversity and production of exploited fishery resources in vembanad wetland system: Strategies for better management and conservation. *Open J. Marine Sci.*, 4: 344-357. DOI: 10.4236/ojms.2014.44031
- Aswani, M.S., 2010. Indigenous knowledge and long-term ecological change: Detection, interpretation and responses to changing ecological conditions in Pacific Island communities. *Environ. Manage.*, 45: 985-99. DOI: 10.1007/s00267-010-9471-9
- Banks, S.A., G.A. Skilleter and H.P. Possingham, 2005. Intertidal habitat conservation: Identifying conservation targets in the absence of detailed biological information. *Aquatic Conserv. Marine Freshwater Ecosyst.*, 15: 271-288. DOI: 10.1002/aqc.683
- Blandon, A. and P.S.E. zu Ermgassen, 2014. Quantitative estimate of commercial fish enhancement by seagrass habitat in southern Australia. *Estuarine, Coastal Shelf Sci.*, 141: 1-8. DOI: 10.1016/j.ecss.2014.01.009
- Bosire, J.O., G. Okemwa and J. Ochiwo, 2012. Mangrove linkages to coral reef and seagrass ecosystem services in Mombasa and Takaungu, Kenya: Participatory Modelling Frameworks to Understand Wellbeing Trade-offs in Coastal Ecosystem Services: Mangrove sub-component. *Espa Ecosystem Service for Poverty Alleviation*.
- Brigitta, I., V. Tussenbroek, J. Cortés, R. Collin and A.C. Fonseca *et al.*, 2014. Caribbean-wide, long-term study of seagrass beds reveals local variations, shifts in community structure and occasional collapse. *PLOS One*, 9: 1-13. DOI: 10.1371/journal.pone.0090600
- Buapet, P., L.M. Rasmusson, M. Gullstro and M. Bjork, 2013. Photorespiration and carbon limitation determine productivity in temperate seagrasses. *Plos One*, 8: 1-9. DOI: 10.1371/journal.pone.0083804
- Coll, M., A. Schmidt, T. Romanuk and H.K. Lotze, 2011. Food-web structure of seagrass communities across different spatial scales and human impacts. *PLoS One*, 6: 1-13. DOI: 10.1371/journal.pone.0022591
- Cullen-Unsworth, L.C., L.M. Nordlund, J. Paddock, S. Baker and L.J. McKenzie *et al.*, 2014. Seagrass meadows globally as a coupled social-ecological system: Implications for human wellbeing. *Marine Pollut. Bull.*, 83: 387-397. DOI: 10.1016/j.marpolbul.2013.06.001
- Cunha, A.H. and E.A. Serrão, 2011. Tools for seagrass conservation and management in Portugal. *Ecologi@*, 3: 22-34.
- de la Torre-Castroa, M., G. Di Carlo and N.S. Jiddawi, 2014. Seagrass importance for a small-scale fishery in the tropics: The need for seascape management. *Marine Pollut. Bull.*, 83: 398-407. DOI: 10.1016/j.marpolbul.2014.03.034
- Di Carlo, G. and L. McKenzie, 2011. Seagrass syllabus: A training manual for resource managers. Conservation International 2011 Crystal Drive, Suite 500 Arlington, VA 22202 USA.
- Dunton, K., W. Pulich and T. Mutchler, 2011. A seagrass monitoring program for Texas coastal waters: Multi scale integration of landscape features with plant and water quality indicators. Final Report Contract No. 0627 to Coastal Bend Bays and Estuaries Program 1305 N. Shoreline Blvd., Suite 205 Corpus Christi, Texas 78401.
- Erfemeijer, P.L.A. and R.R.R. Lewis, 2006. Environmental impacts of dredging on seagrasses: A review. *Marine Pollut. Bull.*, 52:1553-1572. DOI: 10.1016/j.marpolbul.2006.09.006
- Fortes, M.D., 2011. A Review: Biodiversity, Distribution and Conservation of Philippine Seagrasses. *Philippine J. Sci.*, 142: 95-111. DOI:
- Galappaththi, K. and F. Berkes, 2014. Institutions for managing common-pool resources: the case of community-based shrimp aquaculture in northwestern Sri Lanka. *Maritime Stud.*, 13: 1-16. DOI: 10.1186/s40152-014-0013-6
- Giakoumi, S., B.S. Halpern, L.N. Michel, S. Gobert and M. Sini *et al.*, 2015. Towards a framework for assessment and management of cumulative human impacts on marine food webs. *Conserv. Biol.*, 29: 1228-1234. DOI: 10.1111/cobi.12468
- Giakoumi, S. and G.D. Kokkoris, 2013. Effects of habitat and substrate complexity on shallow sublittoral fish assemblages in the Cyclades Archipelago, North-eastern Mediterranean sea. *Mediterranean Marine Sci.*, 14: 58-68. DOI: 10.12681/mms.318

- Gladstone, W., 2007. Requirements for marine protected areas to conserve the biodiversity of rocky reef fishes. *Aquatic Conserv. Marine Freshwater Ecosyst.*, 17: 71-87. DOI: 10.1002/aqc.759
- Horinouch, M., 2005. A comparison of fish assemblages from seagrass beds and the adjacent bare substrata in Lake Hamana, central Japan. *Laguna*, 12: 69-72.
- Honda, K., Y. Nakamura, M. Nakaoka, W.H. Uy and M.D. Fortes, 2013. Habitat use by fishes in coral reefs, seagrass beds and mangrove habitats in the Philippines. *Plos One*, 8: 1-10.
DOI: 10.1371/journal.pone.0065735
- Hutomo, M. and M.K. Moosa, 2005. Indonesian marine and coastal biodiversity: Present Status. *Ind. J. Marine Sci.*, 34: 88-97.
- Khatoon, Z., R. Paperno and S.M. Hussain, 2014. Spatial and temporal changes in the fish communities from a mangrove-dominated creek system near Karachi, Pakistan. *J. Applied Ichthyol.*, 30: 350-358.
DOI: 10.1111/jai.12377
- Kumar, M.A., S. Venu and G. Padmavati, 2016. Habitat ecology and ichthyofaunal diversity of two creeks and their associated streams from port Blair, South Andaman Islands. *Int. J. Ecol.*, 2016: 1649368-1649375. DOI: 10.1155/2016/1649368
- Jackson, E.L., S.E. Rees, C. Wilding and M.J. Attrill, 2015. Use of a seagrass residency index to apportion commercial fishery landing values and recreation fisheries expenditure to seagrass habitat service. *Conserv. Biol.*, 29: 899-909. DOI: 10.1111/cobi.12436
- Jackson, E.L., M.J. Attrill, A.A. Rowden and M.B. Jones, 2006. Seagrass complexity hierarchies: Influence on fish groups around the coast of Jersey (English Channel). *J. Exp. Marine Biol. Ecol.*, 330: 38-54.
DOI: 10.1016/j.jembe.2005.12.016
- Jelbart, J.E., P.M. Ross and R.M. Connolly, 2007. Patterns of small fish distributions in seagrass beds in a temperate Australian estuary. *J. Marine Biol. Assoc. UK*, 87: 1297-1307.
DOI: 10.1017/S0025315407053283
- Khalaf, M.A., S. Al-Rousan and F.A. Al-Horani, 2012. Fish assemblages in seagrass habitat along the Jordanian coast of the Gulf of Aqaba. *Nat. Sci.*, 4: 517-525. DOI: 10.4236/ns.2012.48069
- Kenworthy, W.J., S. Wyllie-Echeverria, R.G. Coles, G. Pergent and C. Pergent-Martini, 2007. Seagrass Conservation Biology: An Interdisciplinary Science for Protection of the Seagrass Biome. In: *Seagrasses: Biology, Ecology and Conservation*, Kenworthy, W.J., S. Wyllie-Echeverria, R.G. Coles, G. Pergent and C. Pergent-Martini (Eds.), Springer Netherlands, pp: 595-623.
- Larkum, A.W.D., J.O. Robert and C.M. Duarte, 2006. *Seagrasses: Biology, Ecology and Conservation*. 1st Edn., Springer Science and Business Media, Dordrecht, ISBN-10: 1402029837, pp: 627.
- Lee, C.L., Y.H. Huang, C.Y. Chung and H.J. Lin, 2014. Tidal variation in fish assemblages and trophic structures in tropical Indo-Pacific seagrass beds. *Zool. Stud.*, 53: 56-56.
DOI: 10.1186/s40555-014-0056-9
- Ludwig, J.A. and J.F. Reynolds, 1988. *Statistical Ecology*. 1st Edn., John Wiley and Sons, New York.
- Maheswari, R.M., V. Naganathan and J.K. Patterson, 2011. Interrelation among coral reef and sea-grass habitats in the Gulf of Mannar. *Int. J. Biodiversity Conserv.*, 3: 193-205.
- Mamboya, F., L. Lugomela, E. Mvungi, M. Hamisi and A.T. Kamukuru *et al.*, 2009. Seagrass-sea urchin interaction in shallow littoral zones of Dar es Salaam, Tanzania. *Aquatic Conserv.: Marine Freshwater Ecosyst.*, 19: 19-26. DOI: 10.1002/aqc.1041
- McCloskey, R.M. and R.K.F. Unsworth, 2015. Decreasing seagrass density negatively influences associated fauna. *PeerJ*, 3: e1053-e1053.
DOI: 10.7717/peerj.1053
- McKenzie, L.J., S.M. Yaakub, R. Tan, J. Seymour and R.L. Yoshida, 2016. Seagrass habitats of Singapore: Environmental drivers and key processes. *Raffles Bull. Zool. Supplement*, 34: 60-77.
- McKenna, S., J. Jarvis, T. Sankey, C. Reason and R. Coles *et al.*, 2015. Declines of seagrasses in a tropical harbour, North Queensland, Australia, are not the result of a single event. *J. Biosci.*, 40: 389-398. DOI: 10.1007/s12038-015-9516-6
- Nadiarti, N., J. Jompa, E. Riani and M. Jamal, 2015. A comparison of fish distribution pattern in two different seagrass species-Dominated beds in tropical waters. *J. Eng. Applied Sci.*, 10: 147-153.
DOI: 10.3923/jeasci.2015.147.153
- Nadiarti, R.E., I. Djuwita, S. Budiharsono, A. Purbayanto and H. Asmus, 2012. Challenges for seagrass management in Indonesia. *J. Coastal Dev.*, 15: 234-242.
- Nemeth, D.J. and J.B. Jackson, 2007. A new method to describe seagrass habitat sampled during fisheries-independent monitoring. *Estuaries Coasts*, 30: 171-178. DOI: 10.1007/BF02782977
- Nordlund, L.M., E.W. Koch, E.B. Barbier and J.C. Creed, 2016. Seagrass ecosystem services and their variability across genera and geographical regions. *PlosOne*, 12: e0169942-e0169942.
DOI: 10.1371/journal.pone.0169942
- Odum, E.P., 1983. *Basic Ecology*. 3rd Edn., Saunders College Publishing, New York, ISBN-10: 0030584140, pp: 613.
- Orth, R.J., T.J.B. Carruthers, W.C. Dennison, C.M. Duarte and K.L. Fourqurean *et al.*, 2006. A global crisis for seagrass ecosystems. *BioScience*, 56: 987-996.
DOI: 10.1641/0006-3568(2006)56[987:AGCFSE]2.0.CO;2

- Pereira, P.H.C., B.P. Ferreira and S.M. Rezende, 2010. Community structure of the ichthyofauna associated with seagrass beds (*Halodule wrightii*) in Formoso River estuary-Pernambuco, Brazil. *Anais da Academia Brasileira de Ciências*, 82: 617-628.
DOI: 10.1590/S0001-37652010000300009
- Phinrub, W., B. Montien-Art, J. Promya and A. Suvannaraksha, 2015. Fish diversity and fish assemblage structure in seagrass meadows at sikao bay, trang province, Thailand. *Open J. Ecol.*, 5: 563-573. DOI: 10.4236/oje.2015.512047
- Phinrub, W., B. Montien-Art, J. Promya and A. Suvannaraksha, 2014. Fish diversity and fish community in seagrass beds at Ban Pak Klong, Trang Province, Thailand. *Int. J. Fisheries Aquatic Stud.*, 2: 197-201.
- Pitanga, M.E., M.J.E. Montes, K.M. Magalhães and T.N.V. Reis, 2012. Quantification and classification of the main environmental impacts on a *Halodule wrightii* seagrass meadow on a tropical island in northeastern Brazil. *Annals Brazil. Acad. of Sci.*, 84: 35-42.
DOI: 10.1590/S0001-37652012000100005
- Satumanatpan, S., S. Thummikpong and K. Kanongdate, 2011. Biodiversity of benthic fauna in the seagrass ecosystem of Kung Krabaen Bay, Chantaburi Province, Thailand. *Songklanakarinn J. Sci. Technol.*, 33: 341-348.
- Satyawan, N.M., Y. Wardiatno and R. Kurnia, 2014. Keanekaragaman spesies dan zonasi habitat echinodermata di perairan pantai semarang, lombok timur (Diversity of Species and Habitat Zonation of Echinoderm in Semarang Coastal Waters, East Lombok). *J. Biol. Tropis*, 14: 83-92.
- Schmidt, A.L., J.K.C. Wysmyk, S.E. Craig and H.K. Lotze, 2012. Regional-scale effects of eutrophication on ecosystem structure and services of seagrass beds. *Limnol. Oceanography*, 57: 1389-1402. DOI: 10.4319/lo.2012.57.5.1389
- Shahbudin, S., K.J.A. Jalal, Y. Kamaruzzaman, N. Mohammad-Noor and T. Cit-Dah *et al.*, 2011. Artificial seagrass: A habitat for marine fishes. *J. Fisheries Aquatic Sci.*, 6: 85-92.
DOI: 10.3923/jfas.2011.85.92
- Shokri, M.R., W. Gladstone and J. Jelbart, 2009. The effectiveness of seahorses and pipefish (*Pisces: Syngnathidae*) as a flagship group to evaluate the conservation value of estuarine seagrass beds. *Aquatic Conserv.: Marine Freshwater Ecosyst.*, 19: 588-595. DOI: 10.1002/aqc.1009
- Short, F.T., R. Coles, M.D. Fortes, S. Victor and M. Salik *et al.*, 2014. Monitoring in the Western Pacific region shows evidence of seagrass decline in line with global trends. *Marine Pollut. Bull.*, 83: 408-418. DOI: 10.1016/j.marpolbul.2014.03.036
- Short, F.T., B. Polidoro, S.R. Livingstone, K.E. Carpenter and S. Bandeira *et al.*, 2011. Extinction risk assessment of the world's seagrass species. *Biol. Conserv.*, 144: 1961-1971.
DOI: 10.1016/j.biocon.2011.04.010
- Short, F.T., T. Carruthers, W. Dennison and W. Waycott, 2007. Global seagrass distribution and diversity: A bioregional model. *J. Exp. Marine Biol. Ecol.*, 350: 3-20.
DOI: 10.1016/j.jembe.2007.06.012
- Short, F.T., E.W. Koch, J.C. Creed, K.M. Magalhaes and E. Fernandez *et al.*, 2006. SeagrassNet monitoring across the Americas: case studies of seagrass decline. *Marine Ecol.*, 27: 277-289.
DOI: 10.1111/j.1439-0485.2006.00095.x
- Siddig, A.A.H., A.M. Ellison, A. Ochsc, C. Villar-Leeman and M.L. Lau, 2016. How do ecologists select and use indicator species to monitor ecological change? Insights from 14 years of publication in *Ecological Indicators*. *Ecol. Indicators*, 60: 223-230.
DOI: 10.1016/j.ecolind.2015.06.036
- Sichum, S., P. Tanchidok and T. Jutagate, 2013. Diversity and assemblage patterns of juvenile and small sized fishes in the nearshore habitats of the gulf of thailand. *Raffles Bull. Zool.*, 61: 795-809.
- Stoner, E.W., L.A. Yeager, J.L. Sweatman, S.S. Sebilian and C.A. Layman, 2014. Modification of a seagrass community by benthic jellyfish blooms and nutrient enrichment. *J. Exp. Marine Biol. Ecol.*, 461: 185-192.
DOI: 10.1016/j.jembe.2014.08.005
- Swapna, A., R.R. Kumar and V. Sasidharan, 2016. spatial temporal assemblage structure of fishery resources in relation with environmental variables along the mangrove creeks of South Andaman. *Int. J. Recent Scientific Res.*, 7: 8797-8805.
- Syukur, A., Mahrus and A.R. Syachruddin, 2016. The potential assessment environment friendly aquaculture of small-scale fishermen as a conservation strategy seagrass beds in coastal areas of Tanjung Luar East Lombok, Indonesia. *Int. J. Fisheries Aquatic Stud.*, 4: 22-27.
- Syukur, A., Y. Wardiatno, I. Muchsin and M.M. Kamal, 2014. Status trofik ikan yang berasosiasi dengan lamun (*seagrass*) di tanjung luar lombok timur: Trophic status of fish associated with seagrass in east Lombok. *J. Biol. Tropis*, 14: 162-170.
- Syukur, A., Y. Wardiatno, I. Muchsin and M.M. Kamal, 2012. Desain Konservasi lamun untuk Keberlanjutan Sumberdaya Ikan di Wilayah Pesisir Tanjung Luar Lobok Timur: Seagrass conservation design for sustainability of fish esources in Tanjung Luar East Lombok. *Disertasi Bogor Agriculture University Indonesia*.

Unsworth, R.K.F., C.J. Collier, W. Waycott, L.J. McKenzie and L.C. Cullen-Unsworth, 2015. A framework for the resilience of seagrass ecosystems. *Marine Pollut. Bull.*, 100: 34-46.
 DOI: 10.1016/j.marpolbul.2015.08.016

Unsworth, R.K.F. and L.C. Cullen, 2010. Recognising the necessity for Indo-Pacific seagrass conservation. *Conserv. Lett.*, 3: 63-73.
 DOI: 10.1111/j.1755-263X.2010.00101.x

Unsworth, R.K.F., L.C. Cullen, J.N. Pretty, D.J. Smith and J.J. Bel, 2010. Economic and subsistence values of the standing stocks of seagrass fisheries: potential benefits of no-fishing marine protected area management. *Ocean Coastal Manage.*, 30: 1-7.
 DOI: 10.1016/j.ocecoaman.2010.04.002

Unsworth, R.K.F., E. Wyle, O.J. Smith and J.J. Bell, 2007. Diel trophic structuring of seagrass bed fish assemblages in the Wakatobi Marine National Park, Indonesia. *Estuarine Coastal Shelf Sci.*, 72: 81-88.
 DOI: 10.1016/j.ecss.2006.10.006

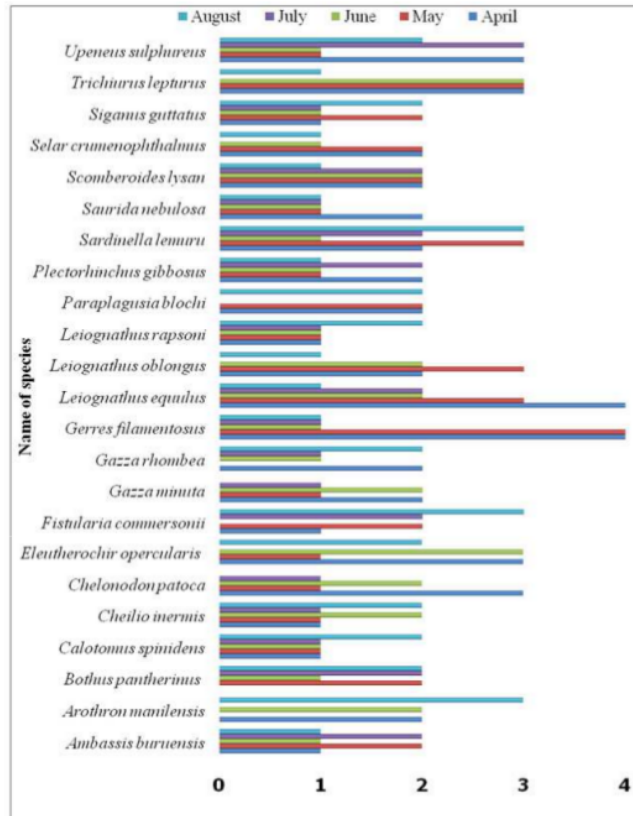
van Tussenbroek, B.I., J. Cortes, R. Collin, A.C. Fonseca and P.M.H. Gayle *et al.*, 2014. Caribbean-wide, long-term study of seagrass beds reveals local variations, shifts in community structure and occasional collapse. *PLOS One*, 9: 1-13.
 DOI: 10.1371/journal.pone.0090600

Verweij, M.C., I. Nagelkerken, S.L.J. Wartenbergh and I.R.P. Gerard van der Velde, 2006. Caribbean mangroves and seagrass beds as daytime feeding habitats for juvenile French grunts, *Haemulon flavolineatum*. *Marine Biol.*, 149: 1291-1299.
 DOI: 10.1007/s00227-006-0305-5

Waycott, M., C.M. Duarte, T.J.B. Carruthers, R.J. Orth and W.C. Dennison *et al.*, 2009. Accelerating loss of seagrasses across the globe threatens coastal ecosystems. *PNAS*, 106: 12377-12381.
 DOI: 10.1073/pnas.0905620106

Wortley, L., J.M. Hero and M. Howe, 2013. Evaluating ecological restoration success: A review of the literature. *Restorat. Ecol.*, 21: 537-543.
 DOI: 10.1111/rec.12028

Appendices



Appendix 1. Fish species with a frequency of between 6-12 of the total sampling

Appendix 2. Frequency of species 1-5 at the seagrass bed study sites during the study period

No	Species	Month					Total of Frequency
		April	May	June	July	August	
1	<i>Abudefduf septemfasciatus</i>		1				1
2	<i>Amphiprion frenathus</i>				1		1
3	<i>Acreeichthys sp</i>	1		1			2
4	<i>Aeoliscus strigatus</i>				1		1
5	<i>Alticus saliens</i>			1	1		2
6	<i>Ambassis urotaenia</i>		2				2
7	<i>Amphiprion frenathus</i>				1		1
8	<i>Andamia tetradactylus</i>				1		1
9	<i>Antherinomorus duodeccimalis</i>				1		1
10	<i>Antherinomorus lacunosus</i>					1	1
11	<i>Apogonichthys ocellatus</i>		2		1		3
12	<i>Archamia compressus</i>				1		1
13	<i>Archamia zosterophora</i>					1	1
14	<i>Arothron immaculatus</i>		1	1			2
15	<i>Atherinomorus duodeccimalis</i>		1				1
16	<i>Atherinomirus lacunosus</i>				1		1
17	<i>Atule mate</i>		1	1		1	3
18	<i>Balistapus undulates</i>				1		1
19	<i>Canthigaster compressa</i>				1	2	3
20	<i>Chaetodon sp.</i>		1				1
21	<i>Chanos chanos</i>		1				1
22	<i>Chinocentrus dorab</i>			1		1	2
23	<i>Cheilodipterus macrodon</i>		1	2			3
24	<i>Diodon holocanthus</i>		1		1		2
25	<i>Diodon litorosus</i>			1			1
26	<i>Drepane punctata</i>			2			2
27	<i>Foa brachygramma</i>	1					1
28	<i>Filimanus xanthonema</i>	1	1	1			3
29	<i>Gazza achlamys</i>		1				1
30	<i>Gerres erythourus</i>		1				1
31	<i>Gerres oyena</i>	1	1	1	2		5
32	<i>Gerres macracanthus</i>		1				1
33	<i>Gymnocranius elongates</i>		1	1		2	4
34	<i>Hemiramphus far</i>		1	1		1	3
35	<i>Helichoeres papilionaceus</i>			1	1		2
36	<i>Hyporamphus quoyi</i>	1					1
37	<i>Johnius amblycephalus</i>	1		1		2	4
38	<i>Johnius borneensis</i>	1				1	2
39	<i>Johnius macropterus</i>		1	1	1	1	4
40	<i>Lagocephalus ivheeleri</i>	1					1
41	<i>Lagocephalus gloveri</i>	1					1
42	<i>Lagocephalus lunaris</i>				1		1
43	<i>Leiognathus daura</i>	2		2			4
44	<i>Leiognathus splendens</i>	2	1				3
45	<i>Leiognathus smithursi</i>	1	1		1	1	4
46	<i>Leptoscarus vaigiensis</i>	2		1	1	1	5
47	<i>Lethrinus harak</i>	1	1		1		3
48	<i>Lethrinus variegates</i>	1	1	1		1	4
49	<i>Lutjanus argenteimaculatus</i>		3		1		4
50	<i>Lutjanus erythropterus</i>					1	1
51	<i>Lutjanus lutjanus</i>		1		1		2
52	<i>Neopomacentrus azysron</i>	1	1	1	1	1	5
53	<i>Petroscirtes variabilis</i>	1		1	1	1	4
54	<i>Pisodonophis cancrivorus</i>				1		1
55	<i>Platax boersi</i>	3					3
56	<i>Plectorhinchus celebicus</i>		2	1	1		4
57	<i>Polynemus pelbeius</i>		1			1	2
58	<i>Pomacentrus lepidogenys</i>				1		1
59	<i>Pomadasys argenteus</i>		1	1			2

Appendix 2. Continue

60	<i>Pomadasys maculatum</i>	1	1	1			3
61	<i>Saurida gracilis</i>	2			1	1	4
62	<i>Scomberoides tala</i>	1	3		1		5
63	<i>Sheilodipterus quinquelinatus</i>	1					1
64	<i>Siganus argenteus</i>			1	1	1	3
65	<i>Sillago chondropus</i>	2		1			3
66	<i>Sillago macrolepis</i>	1		1			2
67	<i>Sillago sihama</i>		2				2
68	<i>Sphyaena flavicauda</i>	1				1	2
69	<i>Syngnathoides biaculeatus</i>			1		1	2
70	<i>Synodus dermatogenys</i>					2	2
71	<i>Sphyaena flavicauda</i>	1				1	2
72	<i>Synodus dermatogenys</i>					2	2
73	<i>Takifugu radiates</i>		1				1
74	<i>Thalossoma hardwickii</i>	1	1				2
75	<i>Thryssa mystax</i>		1				1
76	<i>Thryssa setirostrus</i>		1			1	2
77	<i>Trachinotus blochii</i>	1		2	1	1	5
78	<i>Trachinotus botola</i>				1		1
79	<i>Upeneus indicus</i>			1			1
80	<i>Upeneus tragula</i>	1				1	2

Appendix 3. Family and species of fish at the seagrass bed research sites

No	Family	Species
1	Apogonidae	<i>Archamia goni</i>
2	Bothidae	<i>Bothus pantherinus</i>
3	Carangidae	<i>Caranx ignobilis</i> <i>Caranx melampygus</i> <i>Caranx sexfasciatus</i>
4	Clupeidae	<i>Sardinella gibbosa</i>
5	Cynoglossidae	<i>Paraplagusia bilineata</i>
6	Enggaulidae	<i>Stolephorus indicus</i>
7	Fistulariidae	<i>Fistularia commersonii</i>
8	Haemulidae	<i>Plectorhinchus falvomaculatus</i>
9	Leiognathidae	<i>Leiognathus bindus</i> <i>Leiognathus equulus</i> <i>Secutor interuptus</i>
10	Lutjanidae	<i>Lutjanus bouton</i>
11	Mullidae	<i>Upeneus vittatus</i>
12	Monacanthidae	<i>Acreichthys tomentosus</i>
13	Siganidae	<i>Siganus canaliculatus</i>

Appendix 4. Family and species of fish distributed at four seagrass bed sites in the study area.

No	Family	Species	Location of seagrass beds				
			Gili Kere	Gili Maringkik	Kampung Baru	Lungkak	Poton bakau
1	Callionymidae	<i>Eleutherochir opercularis</i>	1	1		1	1
2	Carangidae	<i>Scomberoides lysan</i>	1	1	1		1
3	Chandidae	<i>Ambassis buruensis</i>	1		1	1	1
4	Gerreidae	<i>Gerres filamentosus</i>	1	1	1		1
5	Haemulidae	<i>Plectorhinchus gibbosus</i>		1	1	1	1
6	Leiognathidae	<i>Leiognathus oblongus</i>	1	1	1	1	
7	Mugilidae	<i>Moolgarda delicates</i>	1		1	1	1
8	Tetraodontidae	<i>Arothron manilensis</i>	1	1	1	1	
9	Sphyaenidae	<i>Sphyaena barracuda</i>	1		1	1	1
10	Synodontidae	<i>Saurida nebulosa</i>	1		1	1	1
11	Trichiuridae	<i>Trichiurus lepturus</i>	1	1		1	1
12	Tetraodontidae	<i>Chelonodon patoca</i>	1		1	1	1
Total	11	7	10	10	10		

Appendix 5. Families and species of fish observed to assess the diversity of types of fish food at the seagrass bed sites in the study area

No	Family	Species	Biota obtained from the stomach contents
1	Siganidae	<i>Siganus canaliculatus</i> <i>Siganus guttatus</i>	seagrass dan algae seagrass and algae
2	Scaridae	<i>Calotomus spinidens</i>	seagrass and algae
3	Atherinidae	<i>Atherinomirus lacunosus</i>	seagrass and algae
4	Apogonidae	<i>Archamia goni</i>	shrimp, crab and squid
5	Tetraodontidae	<i>Canthigaster compressa</i> <i>Arothron immaculatus</i>	fish and shrimp fish and shrimp
6	Gerridae	<i>Gerres oyena</i>	fish
7	Mugilidae	<i>Moolgarda delicates</i>	fish and shrimp
8	Pomacentridae	<i>Abudefduf notatus</i>	fish and shrimp
9	Haemulidae	<i>Plectorhinchus celebicus</i>	fish and crabs
10	Lutjanidae	<i>Lutjanus bouton</i> <i>Lutjanus argentimaculatus</i>	fish, larvae of fish and shrim fish, larvae of fish and shrim
11	Lethrinidae	<i>Lethrinus lentjan</i> <i>Lethrinus variegates</i>	crabs crabs
12	Mullidae	<i>Upeneus vittatus</i>	shrimp
13	Balistidae	<i>Balistapus undulates</i>	Larvae of sea-urchin and shell
14	Monacanthidae	<i>Acreichthys tomentosus</i>	crustaceans, fish, larvae of sea-urchin and seagrass
15	Carangidae,	<i>Caranx sexfasciatus</i>	Phytoplankton and zooplankton
16	Leiognathidae	<i>Leiognathus bindus</i>	Phytoplankton and zooplankton
17	Clupeidae	<i>Sardinella gibbosa</i>	Phytoplankton and zooplankton

Appendix 6. Attraction of seagrass beds for fish

No	The location of seagrass beds	Famili	Species	The main habitat for several species of fish	The type of fish food in seagrass beds	Ecological function of seagrass for fish
1	Gili Kere	Apogonidae	<i>Archamia goni</i> ¹	Seagrass beds	Shrimp, crabs and cephalopods	Habitat
		Lutjanidae	<i>Lutjanus bouton</i> ²	Coral reefs and areas near mangroves	Fish, larvae of fish and shrimp	Feeding ground
2	Kampung Baru	Clupeidae	<i>Sardinella gibbosa</i>	Marine waters	Plankton	Feeding ground
		Haemulidae	<i>Plectorhinchus falvomaculatus</i> ²	Coral reefs	Fish and crab	Feeding ground
3	Gili Maringik	Leiognathidae	<i>Leiognathus equulus</i> ¹	Coastal waters	Phytoplankton and zooplankton	Feeding ground
		Monacanthidae	<i>Acreichthys tomentosus</i> ²	Seagrass beds and areas with sandy bottom	Crustaceans, fish, larvae of sea-urchin and seagrass	Habitat and feeding ground
		Siganidae	<i>Siganus guttatus</i> ²	Coral reefs and seagrass beds	Seagrass and algae	Nursery and feeding ground
4	Lungkak	Mullidae	<i>Upeneus vittatus</i> ¹	Coral reefs	Shrimp	Feeding ground
		Leiognathidae	<i>Leiognathus oblongus</i> ²	Marine waters	Phytoplankton and zooplankton	Feeding ground
		Mugilidae	<i>Moolgarda delicates</i> ²	Mangroves and estuaries	Fish and shrimp	Feeding ground
		Mullidae	<i>Upeneus vittatus</i> ²	Coral reefs	Shrimp	Feeding ground
5	Poton Bakau	Apogonidae	<i>Archamia goni</i> ¹	Seagrass beds	Shrimp, crabs and cephalopods	Habitat
		Apogonidae	<i>Archamia goni</i> ²	Seagrass beds	Shrimp, crabs and cephalopods	Habitat
		Haemulidae	<i>Plectorhinchus falvomaculatus</i> ²	Coral reefs	Fish and crab	Feeding ground
		Mugilidae	<i>Moolgarda delicates</i> ²	Mangroves and estuaries	Fish and shrimp	Feeding ground
		Mullidae	<i>Upeneus vittatus</i> ²	Coral reefs	Shrimp	Feeding ground

¹Fish species with the highest number of individuals

²Fish species with the highest abundance

ORIGINALITY REPORT

15%

SIMILARITY INDEX

%

INTERNET SOURCES

15%

PUBLICATIONS

%

STUDENT PAPERS

PRIMARY SOURCES

- 1** A Seghosime, A Ebeigbe, S Oduro-Kwarteng, R Buamah, O Oriakhi, J Awudza. "Effect of Sodium Chloride Extract of Dacryodes edulis and Chrysophyllum albidum Seeds on Enteric Pathogens", Annual Research & Review in Biology, 2018 2%

Publication
- 2** Abdul Syukur, Agil Al-Idrus, Lalu Zulkifli. "Ecotourism Development Based on the Diversity of Echinoderms Species in Seagrass Beds on the South Coastal of Lombok Island, Indonesia", Journal of Environmental Science and Technology, 2020 1%

Publication
- 3** Agil Al Idrus, Abdul Syukur, Lalu Zulkifli. "The livelihoods of local communities: Evidence success of mangrove conservation on the coastal of East Lombok Indonesia", AIP Publishing, 2019 1%

Publication

Klaus Koren, Kasper E. Brodersen, Sofie L.

4

Jakobsen, Michael Kühl. " Optical Sensor Nanoparticles in Artificial Sediments—A New Tool To Visualize O Dynamics around the Rhizome and Roots of Seagrasses ", Environmental Science & Technology, 2015

Publication

1%

5

"The Wetland Book", Springer Science and Business Media LLC, 2018

Publication

1%

6

Pitanga, Maria Elisa, Manuel J.F. Montes, Karine M. Magalhães, and Thiago N.V. Reis. "Quantification and classification of the main environmental impacts on a Halodule wrightii seagrass meadow on a tropical island in northeastern Brazil", Anais da Academia Brasileira de Ciências, 2012.

Publication

1%

7

Jackson, E.L.. "Seagrass complexity hierarchies: Influence on fish groups around the coast of Jersey (English Channel)", Journal of Experimental Marine Biology and Ecology, 20060307

Publication

<1%

8

Wikit Phinrub, Bunyat Montien-Art, Jongkol Promya, Apinun Suvarnaraksha. "Fish Diversity and Fish Assemblage Structure in Seagrass Meadows at Sikao Bay, Trang Province,

<1%

9

Short, Frederick T., Robert Coles, Miguel D. Fortes, Steven Victor, Maxwell Salik, Irwan Isnain, Jay Andrew, and Aganto Seno.

"Monitoring in the Western Pacific region shows evidence of seagrass decline in line with global trends", Marine Pollution Bulletin, 2014.

Publication

<1%

10

Desalegn Tadele, Ermias Lulekal, Destaw Damtie, Adane Assefa. "Floristic diversity and regeneration status of woody plants in Zengena Forest, a remnant montane forest patch in northwestern Ethiopia", Journal of Forestry Research, 2013

Publication

<1%

11

Wortley, Liana, Jean-Marc Hero, and Michael Howes. "Evaluating Ecological Restoration Success: A Review of the Literature : Trends and Gaps in Empirical Evaluations", Restoration Ecology, 2013.

Publication

<1%

12

S. Shahbudin, K.C.A. Jalal, Y. Kamaruzzam, N. Mohammad- Noor, T. Chit Dah, B. Akbar John. "Artificial Seagrass: A Habitat for Marine Fishes", Journal of Fisheries and Aquatic Science, 2011

Publication

<1%

13

Cullen-Unsworth, Leanne C., Lina Mtwana Nordlund, Jessica Paddock, Susan Baker, Len J. McKenzie, and Richard K.F. Unsworth. "Seagrass meadows globally as a coupled social–ecological system: Implications for human wellbeing", *Marine Pollution Bulletin*, 2013.

Publication

<1%

14

Richard K. F. Unsworth, Benjamin L. Jones, Leanne C. Cullen-Unsworth. "Seagrass meadows are threatened by expected loss of peatlands in Indonesia", *Global Change Biology*, 2016

Publication

<1%

15

Schmidt, Allison L., Jessica K. C. Wysmyk, Susanne E. Craig, and Heike K. Lotze. "Regional-scale effects of eutrophication on ecosystem structure and services of seagrass beds", *Limnology and Oceanography*, 2012.

Publication

<1%

16

Abigayil Blandon, Philine S.E. zu Ermgassen. "Quantitative estimate of commercial fish enhancement by seagrass habitat in southern Australia", *Estuarine, Coastal and Shelf Science*, 2014

Publication

<1%

17

Lina Mtwana Nordlund, Evamaria W. Koch,

Edward B. Barbier, Joel C. Creed. "Seagrass Ecosystem Services and Their Variability across Genera and Geographical Regions", PLOS ONE, 2016

Publication

<1%

18

"Oceanographic and Biological Aspects of the Red Sea", Springer Science and Business Media LLC, 2019

Publication

<1%

19

"The Small-Scale Fisheries Guidelines", Springer Science and Business Media LLC, 2017

Publication

<1%

20

A. FRIEDLANDER. "Designing Effective Marine Protected Areas in Seaflower Biosphere Reserve, Colombia, Based on Biological and Sociological Information", Conservation Biology, 12/2003

Publication

<1%

21

Jay Mar D. Quevedo, Yuta Uchiyama, Ryo Kohsaka. "Perceptions of the seagrass ecosystems for the local communities of Eastern Samar, Philippines: Preliminary results and prospects of blue carbon services", Ocean & Coastal Management, 2020

Publication

<1%

22

L S Syafei, R S Siregar, M F Rahardjo, C P H

Simanjuntak. "Diet composition and trophic niche similarities of engraulid fishes in Pabean bay, Indramayu, Indonesia", IOP Conference Series: Earth and Environmental Science, 2019

Publication

<1%

23

Abdullah R.A. Al-Kandari. "The importance of water in the ecosystem and marine crisis in the gulf region", Geojournal, 1992

Publication

<1%

24

"Collateral Values", Springer Science and Business Media LLC, 2019

Publication

<1%

25

J. Emmett Duffy, Lisandro Benedetti-Cecchi, Joaquin Trinanes, Frank E. Muller-Karger et al. "Toward a Coordinated Global Observing System for Seagrasses and Marine Macroalgae", Frontiers in Marine Science, 2019

Publication

<1%

26

Chen-Lu Lee, Yen-Hsun Huang, Chia-Yun Chung, Hsing-Juh Lin. "Tidal variation in fish assemblages and trophic structures in tropical Indo-Pacific seagrass beds", Zoological Studies, 2014

Publication

<1%

27

Ahmed A.H. Siddig, Aaron M. Ellison, Alison Ochs, Claudia Villar-Leeman, Matthew K. Lau. "How do ecologists select and use indicator

<1%

species to monitor ecological change? Insights from 14 years of publication in Ecological Indicators", Ecological Indicators, 2016

Publication

28

Rosemary M. McCloskey, Richard K.F. Unsworth. "Decreasing seagrass density negatively influences associated fauna", PeerJ, 2015

Publication

<1%

29

Richard K.F. Unsworth, James J. Bell, David J. Smith. "Tidal fish connectivity of reef and sea grass habitats in the Indo-Pacific", Journal of the Marine Biological Association of the United Kingdom, 2007

Publication

<1%

30

Skye McKenna, Jessie Jarvis, Tonia Sankey, Carissa Reason, Robert Coles, Michael Rasheed. "Declines of seagrasses in a tropical harbour, North Queensland, Australia, are not the result of a single event", Journal of Biosciences, 2015

Publication

<1%

31

A A Idrus, A Syukur, L Zulkifli. "The diversity of fauna in mangrove community: Success replanting of mangroves species in South Coastal East Lombok, Indonesia", Journal of Physics: Conference Series, 2019

Publication

<1%

32

Rohani Ambo-Rappe, Muhammad Natsir Nessa, Husain Latuconsina, Dmitry L. Lajus.

"Relationship between the tropical seagrass bed characteristics and the structure of the associated fish community", Open Journal of Ecology, 2013

Publication

33

Wikit Phinrub, Bunyat Montien-Art, Jongkol Promya, Apinun Suvarnaraksha. "Fish Diversity and Fish Assemblage Structure Seagrass Meadows at Sikao Bay, Trang Province, Thailand", Open Journal of Ecology, 2015

Publication

34

"Advances in Marine Vertebrate Research in Latin America", Springer Science and Business Media LLC, 2018

Publication

35

"Ecological Connectivity among Tropical Coastal Ecosystems", Springer Science and Business Media LLC, 2009

Publication

36

"Seagrasses of Australia", Springer Science and Business Media LLC, 2018

Publication

37

Chester B. Zarnoch, Noshin Hossain, Erika Fusco, Mary Alldred, Timothy J. Hoellein, Sophia Perdikaris. "Size and density of upside-

<1%

<1%

<1%

<1%

<1%

<1%

down jellyfish, *Cassiopea* sp., and their impact on benthic fluxes in a Caribbean lagoon", *Marine Environmental Research*, 2020

Publication

38

Nurul Dhewani Mirah Sjafrie, Luky Adrianto, Ario Damar, Mennofatria Boer. "Human appropriation of net primary production (HANPP) in seagrass ecosystem: an example from the east coast of Bintan Regency, Kepulauan Riau Province, Indonesia", *Environment, Development and Sustainability*, 2017

Publication

39

Heti Herawati, Nisa Hidayati Fitri, Zahidah ., Asep Sahidin, Izza Mahdiana Apriliani, Lantun Paradhita Dewanti. "Perifiton Community Structure in Citarik River", *Asian Journal of Fisheries and Aquatic Research*, 2020

Publication

40

Margareth S. Copertino, Joel C. Creed, Marianna O. Lanari, Karine Magalhães, Kcrishna Barros, Paulo C. Lana, Laura Sordo, Paulo A. Horta. "Seagrass and Submerged Aquatic Vegetation (VAS) Habitats off the Coast of Brazil: state of knowledge, conservation and main threats", *Brazilian Journal of Oceanography*, 2016

Publication

<1%

<1%

<1%

41

Benham, Claudia F., Sara G. Beavis, Rebecca A. Hendry, and Emma L. Jackson. "Growth effects of shading and sedimentation in two tropical seagrass species: Implications for port management and impact assessment", *Marine Pollution Bulletin*, 2016.

Publication

<1%

42

Timothy H. Frawley, Larry B. Crowder, Kenneth Broad. "Heterogeneous Perceptions of Social-Ecological Change Among Small-Scale Fishermen in the Central Gulf of California: Implications for Adaptive Response", *Frontiers in Marine Science*, 2019

Publication

<1%

43

A. B. Novak, M. C. Pelletier, P. Colarusso, J. Simpson, M. N. Gutierrez, A. Arias-Ortiz, M. Charpentier, P. Masque, P. Vella. "Factors Influencing Carbon Stocks and Accumulation Rates in Eelgrass Meadows Across New England, USA", *Estuaries and Coasts*, 2020

Publication

<1%

44

Marieke C. Verweij. "Caribbean mangroves and seagrass beds as daytime feeding habitats for juvenile French grunts, *Haemulon flavolineatum*", *Marine Biology*, 09/2006

Publication

<1%

45

N. S. Sales, T. L. P. Dias, A. Baeta, A. L. M.

Pessanha. "Dependence of juvenile reef fishes on semi-arid hypersaline estuary microhabitats as nurseries", *Journal of Fish Biology*, 2016

Publication

<1%

46

Zairion, , Yusli Wardiatno, and Achmad Fahrudin. "Sexual Maturity, Reproductive Pattern and Spawning Female Population of the Blue Swimming Crab, *Portunus pelagicus* (Brachyura: Portunidae) in East Lampung Coastal Waters, Indonesia", *Indian Journal of Science and Technology*, 2015.

Publication

<1%

47

Pedro H.C. Pereira, Beatrice P. Ferreira, Sérgio M. Rezende. "Community structure of the ichthyofauna associated with seagrass beds (*Halodule wrightii*) in Formoso River estuary - Pernambuco, Brazil", *Anais da Academia Brasileira de Ciências*, 2010

Publication

<1%

48

Rakamaly Madi Moussa, Frederic Bertucci, Hendrikje Jorissen, Camille Gache et al. "Importance of intertidal seagrass beds as nursery area for coral reef fish juveniles (Mayotte, Indian Ocean)", *Regional Studies in Marine Science*, 2020

Publication

<1%

49

Denis Aheto, Noble Asare, Belinda Quaynor,

<1%

Emmanuel Tenkorang, Cephas Asare, Isaac Okyere. "Profitability of Small-Scale Fisheries in Elmina, Ghana", Sustainability, 2012

Publication

50

Paul Radomski, Kristin Carlson, Donna Perleberg. "Advancing aquatic vegetation management for fish in north temperate lakes", Lake and Reservoir Management, 2019

Publication

51

N Kholis, M P Patria, T Soedjiarti, A Suryanda. "Composition and diversity of fish species in mangrove ecosystem at Muara Binuangeun, Lebak, Banten", Journal of Physics: Conference Series, 2019

Publication

52

"Conservation news", Oryx, 2007

Publication

53

G. Brodie, J. Brodie, M. Maata, M. Peter, T. Otiawa, M.J. Devlin. "Seagrass habitat in Tarawa Lagoon, Kiribati: Service benefits and links to national priority issues", Marine Pollution Bulletin, 2020

Publication

54

M P Pertiwi, N Kholis, M P Patria, A Suryanda. "Fish community structure in the mangrove forest of Panjang Island, Banten Bay, Banten, Indonesia", Journal of Physics: Conference

<1%

<1%

<1%

<1%

<1%

Series, 2019

Publication

55

C P H Simanjuntak, Noviana, A K Putri, M F Rahardjo, Djumanto, L S Syafei, D Abdillah. "Species composition and abundance of small fishes in seagrass beds of the Karang Congkak Island, Kepulauan Seribu National Park, Indonesia", IOP Conference Series: Earth and Environmental Science, 2019

Publication

<1%

56

C.J. Collier, A.B. Carter, M. Rasheed, L. McKenzie et al. "An evidence-based approach for setting desired state in a complex Great Barrier Reef seagrass ecosystem: A case study from Cleveland Bay", Environmental and Sustainability Indicators, 2020

Publication

<1%

Exclude quotes Off

Exclude matches Off

Exclude bibliography On