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Differences in ichthyofauna composition among tropical seagrass habitats in the small semi-enclosed bay

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Abstract. *Latuconsina H, Zulfahmi I, Prasetyo HD, Rangkuti AM, Nur M, Kautsari N, Marasabessy I. 2025. Differences in ichthyofauna composition among tropical seagrass habitats in the small semi-enclosed bay. Biodiversitas 26: 992-1007.* The seagrass ecosystem is an important habitat for ichthyofauna in coastal waters and small islands in tropical areas. The richness of ichthyofauna species in seagrass habitats is highly dependent on the physical characteristics of the habitat and the support of other nearby habitats. This research aims to compare the number of species, families and orders of ichthyofauna among different seagrass habitats in the waters of a semi-enclosed bay. The research stations were based on different seagrass habitats in Inner Ambon Bay (IAB), Maluku, Indonesia, single-vegetation seagrass meadows and mixed-vegetation seagrass meadows. We conducted fish sampling using beach seines at monthly intervals for one year. We collected a total of 10,772 fish specimens representing 123 species from 46 families and 22 orders. Of note, 69.1% were juveniles. Different species were present in different seagrass habitats, each with its own physical characteristics. Fish abundance, species richness, and similarity indices were higher in mixed-vegetation seagrass habitats than single vegetation habitats. Proximity between seagrass habitats supports high similarity in species, families and orders. Therefore, protecting different types of seagrass habitats is the right strategy for supporting the abundance and diversity of the ichthyofauna. In addition, the protection of habitats surrounding seagrass meadows, such as mangroves and coral reefs, which are ecologically linked through tidal migration of ichthyofauna, is also important to support the conservation of ichthyofauna to achieve sustainable fisheries use in IAB to support food security.

Keywords: Conservation status, fish utilization, ichthyofauna, Inner Ambon Bay, seagrass meadows

INTRODUCTION

Seagrass ecosystems are one of the most important habitats for ichthyofauna in coastal areas and small islands in tropical regions. In general, coral reef fishes undergo ontogenetic migrations, using seagrass ecosystems as transitional habitats from their juvenile to pre-adult stages. However, as they mature and prepare to spawn, they inhabit coral reef ecosystems (Moussa et al. 2020; Simanjuntak et al. 2020; Latuconsina et al. 2023). The high biodiversity of fish in seagrass ecosystems is also influenced by the ability of seagrass meadows to provide various microhabitats that support fish life at the juvenile stage, including various species from nearby ecosystems such as mangrove and coral reef habitats (Du et al. 2020a,b). The type of seagrass habitat, location and season determine the fish assemblages in seagrass meadows (Park and Kwak 2018). The density or cover of seagrass vegetation, and the structure of the seagrass canopy affect the abundance and number of fish species (Susilo et al. 2018). The ecological function of seagrass meadows is critical for supporting fish stocks and facilitating subsistence, commercial and recreational fishing activities. The easy accessibility of seagrass meadows makes them a source of livelihood for fishers and communities in coastal areas and small islands that are highly dependent on marine biological resources (Nordlund et al. 2017; Jones et al. 2021). Thus, the seagrass ecosystem becomes a vital supplier of food needs and supports global fisheries (Unsworth et al. 2019).

One area with the potential for seagrass meadows as a fish habitat is in the waters of Inner Ambon Bay (IAB), Maluku, Indonesia (Latuconsina et al. 2020a,b). Geomorphologically, the waters of Ambon Bay are divided into two parts: Inner Ambon Bay, covering an area of 11.6 km^2, and Outer Ambon Bay (OAB) with an area of 114 km^2. A narrow sill, approximately 12 m deep, 800 m in length, and 600 m wide, separates these two areas. This configuration results in inefficient circulation of water masses entering and leaving IAB (Salamena et al. 2021). The circulation of water masses in the IAB is influenced by El Niño events, causing stronger water masses with shallower thermoclines and high densities to enter the IAB. Conversely, during La Niña events, the circulation of water masses is weakened because the thermocline layer becomes deeper than usual (Saputra et al. 2018). This dynamic certainly affects the lives of various marine biota in the IAB, including in the seagrass habitat. Seagrass habitats in IAB are threatened by human activities such as garbage dumping, organic waste release, beach sand dredging (Manullang et al. 2021), and sedimentation (Irawan and Nganro 2016). The presence of human settlements, land use around the IAB, and numerous small river estuaries are dominant factors contributing to water quality degradation in the area (Kakisina et al. 2015; Salamena et al. 2021). This condition can cause habitat fragmentation and decreased habitat quality including seagrass habitat, which can reduce its ecological function as an important habitat for various fauna including ichthyofauna. According to Yarnal et al. (2024), seagrass habitat is the main and positive driver of the density of various fauna including ichthyofauna, and the existence of different habitat use patterns between fauna groups and their life stages that do not solely depend on certain areas, proves that various landscape configurations support its function as an important nursery area for fauna including ichthyofauna. Therefore, research to determine the presence of ichthyofauna in various seagrass habitats is important. To understand whether different seagrass habitats can affect differences in ichthyofauna composition regarding the number of individuals, species, families, and orders.

Research on seagrass ichthyofauna has been conducted quite a lot in tropical areas such as Southeast Asia (Susilo et al. 2018; Moussa et al. 2020; Simanjuntak et al. 2020; Espadero et al. 2021; Jones et al. 2021; Macário et al. 2021; Syukur et al. 2021; Manangkalangi et al. 2022; Tongnunui et al. 2024; Latuconsina et al. 2025). Recent research that is specifically related to seagrass fish in different seagrass habitats has not been conducted much, for example Susilo et al. (2018) in the Karimunjawa Islands, Central Java, Indonesia, found that the density and structure of seagrass canopy affect the abundance and number of fish species. Tongnunui et al. (2024) found significant differences in the number of fish species and individuals in intertidal and subtidal seagrass habitats in Trang Province, Southern Thailand. However, little research has been done comparing fish communities between seagrass habitats at different distances within small semi-enclosed bays, such as the IAB. Therefore, this study is essential to determine whether the differences in seagrass habitat types (single vegetation and mixed vegetation) with the support of surrounding habitats such as mangroves and coral reefs can affect the composition of ichthyofauna, especially in terms of species, families, and orders, even when the distance between these habitats is very close. The results of this study can serve as a reference for setting conservation priorities based on seagrass habitats to support sustainable fisheries.

MATERIALS AND METHODS

This study was conducted in the waters of Inner Ambon Bay (IAB), Maluku, Indonesia, for 1 year (August 2022 to July 2023), by determining four observation stations that have large seagrass meadow areas and represent different seagrass habitat characters (Latuconsina et al. 2020a), Mixed-vegetation with habitat conditions was located far from the river flow that flows into the TAD waters, with a habitat type of fine sand to coarse sand substrate, covering two stations, namely Tanjung Tiram and Halong, and single-vegetation with habitat conditions adjacent to the river flow that flows into the IAB waters, with a mud substrate habitat type; includes two observation stations, namely Poka and Nania (Table 1 and Figure 1).

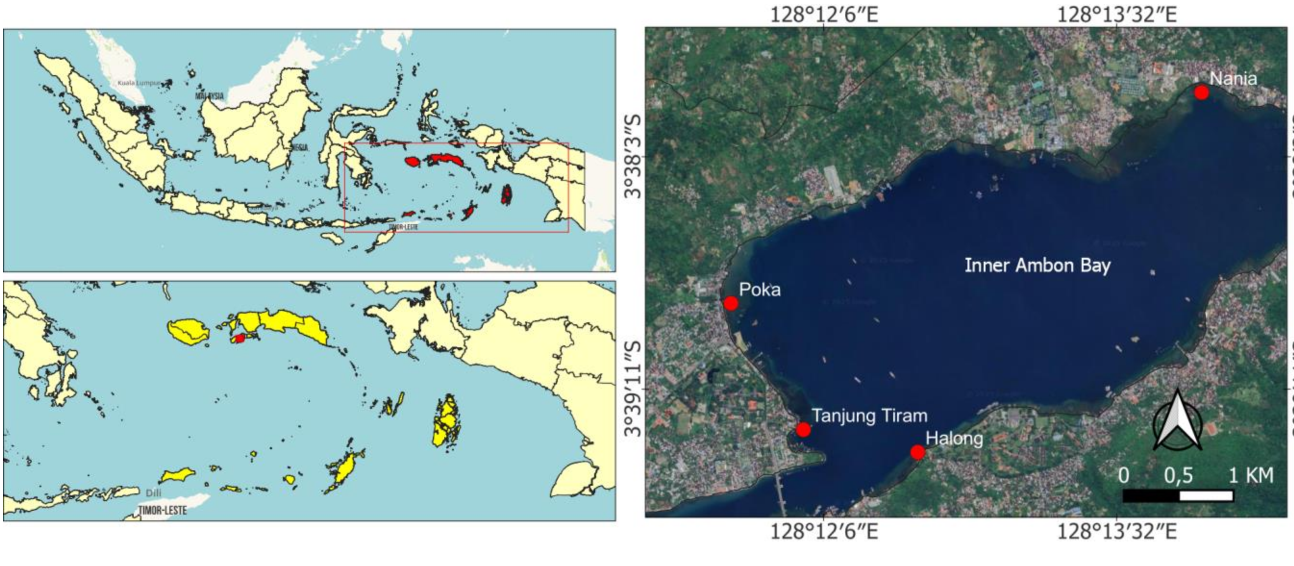

Figure 1. Map of research locations in Inner Ambon Bay (IAB) waters, Maluku, Indonesia with four sampling stations representing different seagrass habitats

Table 1. Description of research stations in the waters of Inner Ambon Bay (IAB), Maluku, Indonesia

Research station	Position location	Location description
Tanjung Tiram (T)	3°39'16.5" S, 128°12'0.43" E	Very close to residential areas, mangrove vegetation is growing around the coast but not densely, usually a place for fishing boats to anchor in the area
Halong (H)	3°39'32.9" S, 128°12'31.2" E	It is relatively far from residential areas because it is close to the Indonesian Navy Base, and there is a coral reef transplantation area in the surrounding area
Poka (P)	3°38'36.48" S, 128°11'42.54" E	Relatively close to residential areas, there is a diesel power plant (PLTD), and a mangrove rehabilitation area
Nania (N)	3°37'58.7" S, 128°13'45.1" E	Relatively far from residential areas and supported by dense mangrove vegetation that has been made a conservation area by the local government, and close to several floating net cages owned by the community.

Fish were collected using a beach seine with a total length of 30 m, and each wing measuring 14 m with a net height of 2 m, a mesh size of 1.88 cm, having a pocket with an opening of 3 m and a mesh size of 1.63 cm. Fishing operations were carried out on the same day between research stations, with the determination of the fishing time when the sea water conditions were high tide, carried out in the morning with a time difference of 30-40 minutes between research stations. Fishing operations using beach seines require 6 field technicians with the help of a speed boat to stretch the fishing gear and sweep the seagrass meadows with the same area at all stations (±3,000 m^2). The fishing time is around 30 minutes at each research station, with a travel time between research stations of ±5-10 minutes using a speed boat as a means of transportation between research stations.

Fishing was carried out at four observation stations simultaneously, carried out once a month for a year. Fish caught by beach seine were then collected and stored in a cooler box for further identification at the Fish Biology Laboratory, Deep Sea Research Center, National Research and Innovation Agency (BRIN), Ambon. Fish sampling without being returned to the sea at each fishing operation was carried out for 12 times (a year) of field observations. Identification of fish species including feeding habits and maximum body length to determine the life stage of the fish (juvenile, pre-adult, and adult) refers to White et al. (2013), Allen and Erdmann (2012a,b,c), Latuconsina et al. (2023), and Froese and Pauly (2024). Determination of conservation status refers to The IUCN Red List of Threatened Species, Version 2024-2.

Data analysis

With the help of MS. Excel Excel 2022 software, descriptive data analysis was displayed in the form of the tables, graphs, and diagrams covering the composition of species, families, and orders of ichthyofauna. The Bray-Curtis similarity index was used to see the similarities of species, families, and orders between research stations, and software of Past 3.14 was used. A one-way ANOVA test was used to compare differences in the number of individuals, species, families and orders between research stations. However, the Kruskal Wallis test is also used if the data is not normally distributed. Data analysis used SPSS 20 software.

RESULTS AND DISCUSSION

Composition of ichthyofauna

A total of 10,772 individuals (specimens) of fish belong to 123 species, 46 families and 22 Orders during one year of sampling (Table 2, Figure 2). The fish community inhabiting the IAB seagrass ecosystem is dominated by juvenile fish 87 species (70.7%), pre-adult phase 43 species (34.9%), adult phase 13 species (10,6%), sizes from juvenile to adult phase 16 species (13.0%), sizes from juvenile to pre-adult phase 27 species (21.9%), sizes from pre-adult to adult phase 8 species (6.5%), and only juvenile, pre-adult and adult phase 43 species (34.9%), 14 species (11.4%) and 13 species (9.8%) respectively (Table 2). Figure 2 shows the number of Individuals, species, families and orders between observation stations, the highest at Station 1 (Tg. Tiram) representing mixed-vegetation seagrass habitat and the lowest at Station 3 (Poka) representing single vegetation seagrass habitat.

Comparison of the average number of individuals, species, families and orders between research stations during 12 months of sampling (Figure 3), showed the highest average number of fish individuals at Station 1 (Tg. Tiram) and the lowest at Station 3 (Poka) although the results of the Kruskal Wallis test showed no significant difference between observation stations (Sig. 0.288; P>0.05). Result of One-Way ANOVA Comparison of the average number of species identified during 12 months of observation also showed a significant difference (Sig. 0.033; P<0.05) between research stations, the highest at Station (Tg. Tiram) and the lowest at Station 2 (Halong). Comparison of the average number of families (Sig. 0.253; P>0.05) and orders (Sig. 0.212; P>0.05) of fish between observation stations during 12 months of research also showed the highest at Station 1 (Tg. Tiram) and the lowest at Station 2 (Halong), although it was not significantly different.

Stations 1 (Tg. Tiram) and 4 (Nania) each represent different seagrass habitat characteristics but have the same number of families, namely 35, although their compositions are different (Figure 4). The composition of species, families and orders between research stations that represent different seagrass habitats (Figure 3). The composition of families based on the number of species shows variations between research stations. This phenomenon proves that each seagrass habitat has an ichthyofauna association with the characteristics of each habitat, although in general it shows the same family.

Table 2. Number of orders, families, species, individuals and utilization and conservation status of ichthyofauna inhabiting seagrass meadows in the Inner Ambon Bay (IAB), Maluku, Indonesia

Order: Sub order Family Spesies	Sampling station				Total specimen	Body length (cm TL)			Life stage	Utilization	Conservation status / IUCN
	T	H	P	N		Range	Average ±SD	Length of theory			
I Anguilliformes											
1. Congridae											
Heteroconger taylori				1	1	30	30	40****	Adult	NU	DD
II Clupeiformes											
2. Engraulidae											
Encrasicholina heteroloba	2	1			3	6.3-9.0	6.3±7.55	12******	Pre-adult to Adult	C	LC
Stolephorus indicus		1			1	5.5	5.5	19****	Juvenile	C	LC
III Siluriformes											
3. Plotosidae											
Plotosus lineatus	1	410	797	790	1998	7.8-21.0	9.8±2.53	32****	Juvenile to Adult	C	LC
IV Aulopiformes											
4. Synodontidae											
Saurida gracilis	19	11	15	16	61	5.5-19.9	13.2±3.73	28*****	Juvenile to Adult	C	LC
Saurida tumbil		1			1	21.0	21.0	30*****	Adult	C	LC
V Mugiliformes											
5. Mugilidae											
Mugil cephalus				9	9	13.1-27.0	18.3±4.68	79*****	Pre-adult	C	LC
Crenimugil buchanani				1	1	24.0	24.0	35*****	Adult	C	LC
VI Atheriniformes											
6. Atherinidae											
Doboatherina duodecimalis	83	7	20		110	4.5-10.1	9.0±1.04	11*****	Adult	C	LC
VII Beloniformes											
7. Belonidae											
Strongylura leiura	1			1	2	27.0-35.0	31±5.66	73*****	Pre-adult	C	LC
8. Hemirampidae											
Hemiramphus lutkei	43		3	2	48	5.0-23.0	12.7±3.46	40******	Juvenile to Pre-adult	C	LC
Hyporhamphus quoyi		1		2	3	16.5-29.5	20.8±7.51	34*****	Pre-adult to Adult	C	LC
VIII Syngnathiformes											
9. Centriscidae											
Centriscus cristatus	265	324	12	14	615	9.5-15.1	13.5±1.41	15*****	Pre-adult to Adult	O	DD
Aeoliscus strigatus	771	1234	76	107	2188	11.0-19.1	13.6±1.41	20*	Pre-adult to Adult	O	DD
10. Fistularidae											
Fistularia petimba	15	1	4	1	21	14.5-60.0	45.6±14.21	128*	Juvenile to Adult	O	LC
11. Syngnathidae											
Syngnathoides biaculeatus	219	41	141	106	507	10.5-26.0	18.2±3.08	28*	Juvenile to Adult	O	LC
Corythoichthys intestinalis	41	183			224	12.3-15.0	13.7±0.78	17*	Juvenile to Adult	O	LC
Hippocampus kuda				7	7	5.1-13.0	9.6±3.28	30*	Juvenile to Adult	O, F	VU

IX Blenniiformes											
12. Blenniidae											
Petroscirtes variabilis	52	2	36	51	141	3.1-10.5	6.5±1.34	15*****	Juvenile to Pre-adult	O	LC
Petroscirtes mitratus		1			1	3.3	3.3	9.5*****	Juvenile	O	LC
X Callionymiformes											
13. Callionymidae											
Dactylopus dactylopus	1	3			4	8.3-16.0	13.1±3.34	30****	Juvenile to Pre-adult	O	LC
XI Scorpaeniformes											
14. Scorpaenidae											
Paracentropogon longispinis	63	3	1	7	74	6.0-10.1	7.8±1.05	11*	Pre-adult to Adult	NU	LC
Scorpaenopsis venosa	1				1	16.5	16.5	22*	Adult	NU	LC
15. Platycephalidae											
Platycephalus indicus		5	3		8	11.5-19.5	15.8±2.28	70*****	Juvenile to Pre-adult	NU	DD
Sorsogona tuberculata				1	1	7.1	7.1	14******	Pre-adult	NU	LC
Papilloculiceps nematophthalmus		1		5	6	10.5-17.0	13.4±2.95	58****	Juvenile to Pre-adult	NU	LC
Onigocia spinosa		2			2	11.5-12.0	11.8±0.35	13*	Adult	NU	LC
XII Gobiiformes											
16. Gobiidae											
Exyrias puntang			2	3	5	11.5-15.5	13.5±1.74	15*****	Adult	O	LC
Amblygobius phalaena	2		1		3	8.0-12.9	7.6±5.21	15*****	Adult	O	LC
XIII Mulliformes											
17. Mullidae											
Parupeneus barberinus	112	24	42	15	192	8.0-14.5	10.6±1.62	53**	Juvenile to Pre-adult	C, O	LC
Upeneus vittatus	3	2		10	15	9.2-15.0	12.2±1.70	28**	Juvenile to Pre-adult	C, O	LC
Upeneus sulphureus				1	1	14.1	14.1	20**	Adult	C, O	LC
Upeneus tragula	1	9	2	12	24	6.5-16.0	10.2±2.88	30**	Juvenile to Pre-adult	C, O	LC
XIV Carangiformes											
18. Carangidae											
Caranx sexfasciatus	1	1	23	116	141	5.1-17.5	11.5±1.96	85***	Juvenile	C, O	LC
Carangoides chrysophrys				5	5	8.0-9.9	9.04±0.82	44****	Juvenile	C, O	LC
Carangoides malabaricus				2	2	6.0-9.8	7.9±2.69	60*****	Juvenile	C, O	LC
Scombroides commersonnianus				2	2	7.1-9.5	8.3±1.70	120**	Juvenile	C, O	LC
Scombroides tol	2				2	5.0-6.0	5.5±0.71	51**	Juvenile	O	LC
XV Perciformes: Scombroidei											
19. Sphyraenidae											
Sphyraena barracuda	4	14	3	4	25	5.0-32.5	13.0±7.71	170***	Juvenile to Pre-adult	C, O	LC
Sphyraena pinguis	13	6	1		20	5.5-17.5	12.3±8.23	50*****	Juvenile to Pre-adult	C, O	LC
XVI Perciformes: Percoidei											
20. Apogonidae											
Pterapagon kauderni				80	80	5.0-7.5	5.6±0.92	8*	Adult	O	EN
Cheilodipterus quinquelineatus	253	7	79	2	341	4.0-12.0	7.1±1.62	12.5*	Juvenile to Adult	O	LC
Taeniamia fucata			1		1	6.0	6.0	10*****	Adult	O	LC
Fibramia lateralis	2		7		9	6.0- 8.0	7.1±0.73	10*	Pre-adult to Adult	O	LC
Fibramia amboinensis	3	20			23	2.2-3.9	2.9±0.50	7******	Adult	O	DD

Ostorhinchus hoeveni	98	1			99	3.0-6.6	5.5±0.78	7.5*****	Juvenile to Adult	O	LC
Sphaeramia orbicularis	12				12	7.5-10.5	8.9±1.03	10*****	Juvenile to Adult	O	LC
Fowleria variegata	1				1	5.1	5.1	7*	Adult	O	LC
21. Ambassidae											
Ambassis urotaenia			5		5	6.4-7.3	6.9±0.46	14*****	Pre-adult	O	LC
22. Monodactylidae											
Monodactylus argenteus	5	1	1		7	4.5-9.5	6.5±1.67	20**	Juvenile to Pre-adult	C, O	LC
23. Lutjanidae											
Lutjanus russellii				2	2	14.9-21.3	18.1±4.53	45**	Juvenile to Pre-adult	C, O	LC
Lutjanus fulviflamma	4				4	10.0-14.9	13.2±6.79	35**	Juvenile to Pre-adult	C, O	LC
Lutjanus carponotatus	2				2	4.1-5.5	5.8±2.47	40**	Juvenile	C, O	LC
Lutjanus biguttatus		4		172	176	7.2-10.5	9.2±0.52	20**	Juvenile to Pre-adult	C, O	LC
24. Lethrinidae											
Lethrinus ornatus	16	20			36	3.0-12.5	6.6±2.42	40**	Juvenile to Pre-adult	C, O	LC
Lethrinus variegatus	30	6	8	4	48	3.1-9.0	5.9±1.95	20**	Juvenile to Pre-adult	C, O	LC
Lethrinus nebulosus	1				1	9.5	9.5	80**	Juvenile	C, O	LC
Lethrinus lentjan	15	5	3		23	4.5-11.6	5.8±1.75	50**	Juvenile	C, O	LC
Lethrinus obsoletus	7				7	4.0-8.1	5.4±1.39	50**	Juvenile	C, O	LC
Lethrinus erythropterus	1				1	8.2	8.2	50**	Juvenile	C, O	LC
Lethrinus harak		2			2	7.2-8.2	7.7±0.71	50**	Juvenile	C, O	LC
Lethrinus amboinensis				3	3	4.1-6.8	5.6±1.39	50**	Juvenile	C, O	LC
25. Latidae											
Lates calcariver	2	3		44	49	18.0-50.0	28.6±7.02	200*****	Juvenile to Pre-adult	C, O	LC
26. Gerreidae											
Gerres oyena	2			2	4	8.0-15.5	10.9±3.56	20*****	Juvenile to Pre-adult	C	LC
27. Nemipteridae											
Scolopsis ciliata	16	14	27	28	85	9.0-12.0	10.5±0.87	25**	Juvenile to Pre-adult	C	LC
Scolopsis bilineata			3		3	5.3-5.5	5.4±0.14	25**	Juvenile	C	LC
Scolopsis trilineata				2	2	4.1-5.5	4.8±0.99	25**	Juvenile	C	LC
Pentapodus trivittatus	6	15	7		28	3.5-11.0	5.7±2.65	28**	Juvenile to Pre-adult	C	LC
Scolopsis margaritifera		2			2	6.1-6.7	6.4±0.42	24*****	Juvenile	C	LC
28. Haemulidae											
Plectorhinchus vittatus	7		1		8	2.0-11.8	3.6±3.60	60**	Juvenile	C, O	LC
Plectorhinchus albovittatus		1			1	7.5	7.5	100**	Juvenile	C, O	LC
29. Caesionidae											
Pterocaesio pisang				2	2	10.8-11.0	10.9±0.14	21**	Pre-adult	C, O	LC
*Caesio cuning (*Bloch, 1791)				1	1	13.5	13.5	35**	Pre-adult	C, O	LC
XVII Perciformes: Serranoidei											
30. Epinephelidae											
Epinephelus coioides	1		2		3	14.5-17.2	15.9±1.91	95*	Juvenile	C, O	LC
Epinephelus merra	1				1	9.0	9.0	32*	Juvenile	C, O	LC
Chromileptes altivelis	1		7	2	10	6.9-12.6	9.5±2.28	66*	Juvenile	C, O	DD

XVIII Perciformer: Labroidei											
31. Labridae											
Halichoeres scapularis	17	3	6	11	37	4.0-11.5	7.7±2.00	20**	Juvenile to Pre-adult	O	LC
Halichoeres argus	15	1			16	6.0-10.1	7.9±0.99	11**	Pre-adult to Adult	O	LC
Halichoeres papilionaceus	119	26		6	151	3.0-12.2	8.6±2.27	11*****	Juvenile to Adult	O	LC
Halichoeres melanurus	14	7	1		22	4.5-7.6	6.0±1.04	11**	Juvenile to Adult	O	LC
Halichoeres miniatus	5	12	3		20	4.4-7.5	5.9±1.37	14**	Juvenile to Adult	O	LC
Halichoeres chloropterus	12	1			13	3.1-7.5	5.4±1.53	19**	Juvenile	O	LC
Stethojulis interrupta	13	9			22	2.5-10.6	4.8±1.91	12**	Juvenile to Adult	O	LC
Stethojulis strigiventer	7				7	5.6-10.0	7.9±2.05	11**	Pre-adult to Adult	O	LC
Cheilinus undulatus	9				9	4.5-5.0	4.8±0.33	170**	Juvenile	O	EN
Pteragogus guttatus		1			1	6.6	6.6	9******	Adult	O	LC
Thalassoma purpureum	5				5	7.0-9.5	8.0±1.08	43**	Juvenile	O	LC
Choerodon anchorago	5			5	10	9.2-13,2	11.1±2.69	50**	Juvenile	O	LC
Cheilio inermis		1		2	3	8.1-22.9	12.1±3.55	50**	Juvenile	O	LC
32. Scaridae											
Scarus ghobban	223	30	39	8	300	5.0-22.9	9.6±2.57	75*****	Juvenile	O	LC
Leptoscarus vaigiensis	7	1			8	9.0-16.0	12.1±2.44	35*****	Juvenile to Pre-adult	O	LC
Bolbometopon muricatum	1		4		5	10.5-13.1	11.4±1.04	120*******	Juvenile	C, O	VU
Scarus globiceps	18				18	4.5-11.3	6.0±1.83	30****	Juvenile	C, O	LC
Scarus dimidiatus	3				3	20.0-22.5	21.0±1.32	34****	Pre-adult	C, O	LC
33. Pomacentridae											
Pomacentrus grammorhynchus	1				1	6.5	6.5	12****	Pre-adult	O	LC
XIX Centrarchiformes											
34. Terapontidae											
Pelates quadrilineatus	287	21	51	290	649	2.5-22.0	12.2 ±4.39	30*****	Juvenile to Adult	C, O	LC
XX Acanthuriformes											
35. Acanthuridae											
Acanthurus xanthopterus	1		2	1	4	7.0-8.7	7.4±0.72	70*****	Juvenile	C, O	LC
Acanthurus nigricans	2				2	5.3-5.5	5.4±0.14	67***	Juvenile	O	LC
36. Chaetodontidae											
Parachaetodon ocellatus	2	1	12	24	39	3.0-9.0	5.5±1.51	18**	Juvenile to Pre-adult	O	LC
Chaetodon vagabundus				1	1	6.7	6.7	23**	Juvenile	O	LC
Heniochus acuminatus		4	2	2	8	5.0-6.8	5.8±0.71	25**	Juvenile	O	LC
Chelmon rostratus			1	1	2	10.5-11.0	10.5±0.35	20**		O	LC
37. Epipphidae											
Platax teira			2		2	7.5-8.1	7.8±0.42	70***	Juvenile	O	LC
38. Leiognathidae											
Gazza minuta			3		3	5.0-5.3	5.1±0.17	14***	Juvenile	C	LC
39. Siganidae											
Siganus lineatus	26	1	8	14	49	7.0-20.1	13.4±2.25	43*****	Juvenile	C, O	LC
Siganus canaliculatus	292	49	314	339	994	3.0-27.3	10.1±5.81	35*****	Juvenile to Adult	C	LC
Siganus virgatus	5				5	3.8-8.5	5.6±2.07	30***	Juvenile	C, O	LC
Siganus vermiculatus				4	4	11.0-13.0	11.9±1.05	45*****	Juvenile	C, O	LC

Siganus punctatus		1			1	3.5	3.5	40[*****]	Juvenile	C, O	LC
Siganus doliatus	2				2	5.5-9.4	7.5±2.76	25[*****]	Juvenile	C, O	LC
40. Scatophagidae											
Scatophagus argus	34	1	10	177	222	6.1-13.1	9.8±1.88	30[***]	Juvenile to Pre-adult	C, O	LC
XXI Tetraodontiformes											
41. Tetraodontidae											
Chelonodontops patoca	108	7	25	10	150	6.8-16.5	8.8±1.88	33[***]	Juvenile to Pre-adult	O	LC
Arothron hispidus	1				1	26.5	26.5	48[***]	Pre-adult	O	LC
Arothron reticularis	21	5	18	8	52	3.4-23.0	8.4±6.18	43[***]	Juvenile to Pre-adult	O	LC
Arothron manilensis	7	18		12	37	7.0-23.0	12.8±5.43	31[***]	Juvenile to Adult	O	LC
Canthigaster compressa		3			3	5.5-7.5	6.7±1.08	11[***]	Pre-adult	O	LC
42. Monacanthidae											
Acriecthys tomentosus	167	36	26	82	311	5.5-10.5	7.7±1.05	11.5[***]	Juvenile to Adult	O	LC
Pseudomonacanthus macrurus	1				1	14.0	14.0	23[***]	Pre-adult	O	LC
43. Ostraciidae											
Rhynchostracion nasus	3	1			4	15.0-17.5	16.0±1.32	30[*****]	Pre-adult	O	LC
Lactoria cornuta	6	1			7	1.50-23.0	12.0±7.38	46[***]	Juvenile to Pre-adult	O	LC
XXII Pleuronectiformes											
44. Bothidae											
Bothus pantherinus		9			9	9.3-13.4	10.9±1.25	30[***]	Juvenile	C	LC
45. Cynoglossidae											
Cynoglossus arel				1	1	15.0	15.0	40[*****]	Pre-adult	C	DD
46. Soleidae											
Paradachirus pavoninus				1	1	9.5	9.5	30[***]	Juvenile	C	LC

Note: T: Tanjung Tiram; H: Halong; P: Poka; N: Nania; C: Consumption; F: Farmacy; O: Ornamental Fishes; NU: Not Utilized; NE: Not Evaluated; DD: Data deficient; LC: Least Concern; VU: Vulnerable; EN: Endangered (Source: IUCN 2024); [*]: Allen and Erdmann (2012a); [**]: Allen and Erdmann (2012b); [***]: Allen &=and Erdmann (2012c); [****]: Allen (1999); [*****]: Latuconsina et al. (2023); [******]: Froese and Pauly (2024); [*******]: White et al. (2013)

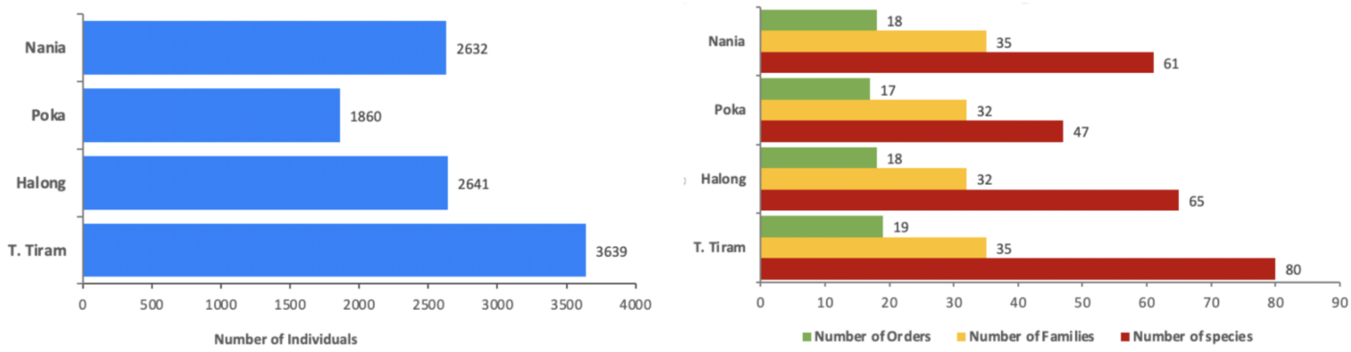

Figure 2. Number of individuals, species, families and orders of ichthyofauna between seagrass habitats in the Inner Ambon Bay (IAB), Maluku, Indonesia

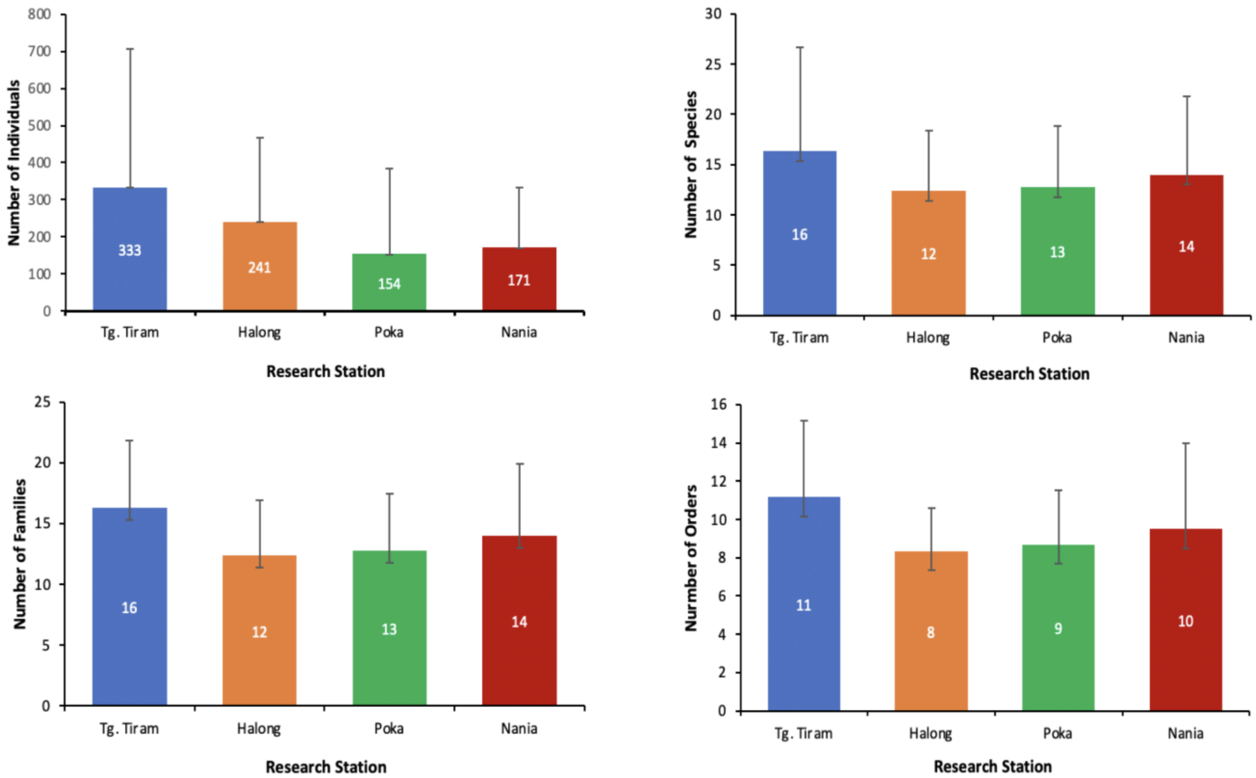

Figure 3. The average number of individuals, species, families, and orders of ichthyofauna between research stations shows variations during 12 sampling times at each research station, as shown by the error bar

The number and composition of dominant ichthyofauna between observation stations represented 9 families with represented different seagrass habitats in IAB (Table 3). As many as 75.43% of the individuals of dominant fish are from the individuals of all species found in seagrass habitats in IAB (Table 3). Two species of fish representing the family of Centriscidae were found abundantly at each research station, namely *Aeoliscus strigatus* and *Centriscus cristatus* as invertebrate feeders. Furthermore, *Plotosus lineatus* (Plotosidae) represents omnivores, and *Siganus canaliculatus* (Siganidae) represents herbivores.

Similarities of ichthyofauna between habitats

The highest similarity of species, families and orders between Stations 1 and 2 represents mixed-vegetation seagrass habitat, and the lowest between Stations 3 and 4 represents single-vegetation seagrass habitat (Table 4). The distance between habitats affects the similarity of species, families and orders. Where the closer the distance between seagrass habitats determines the high similarity of species, families and orders of ichthyofauna associated with seagrass habitats.

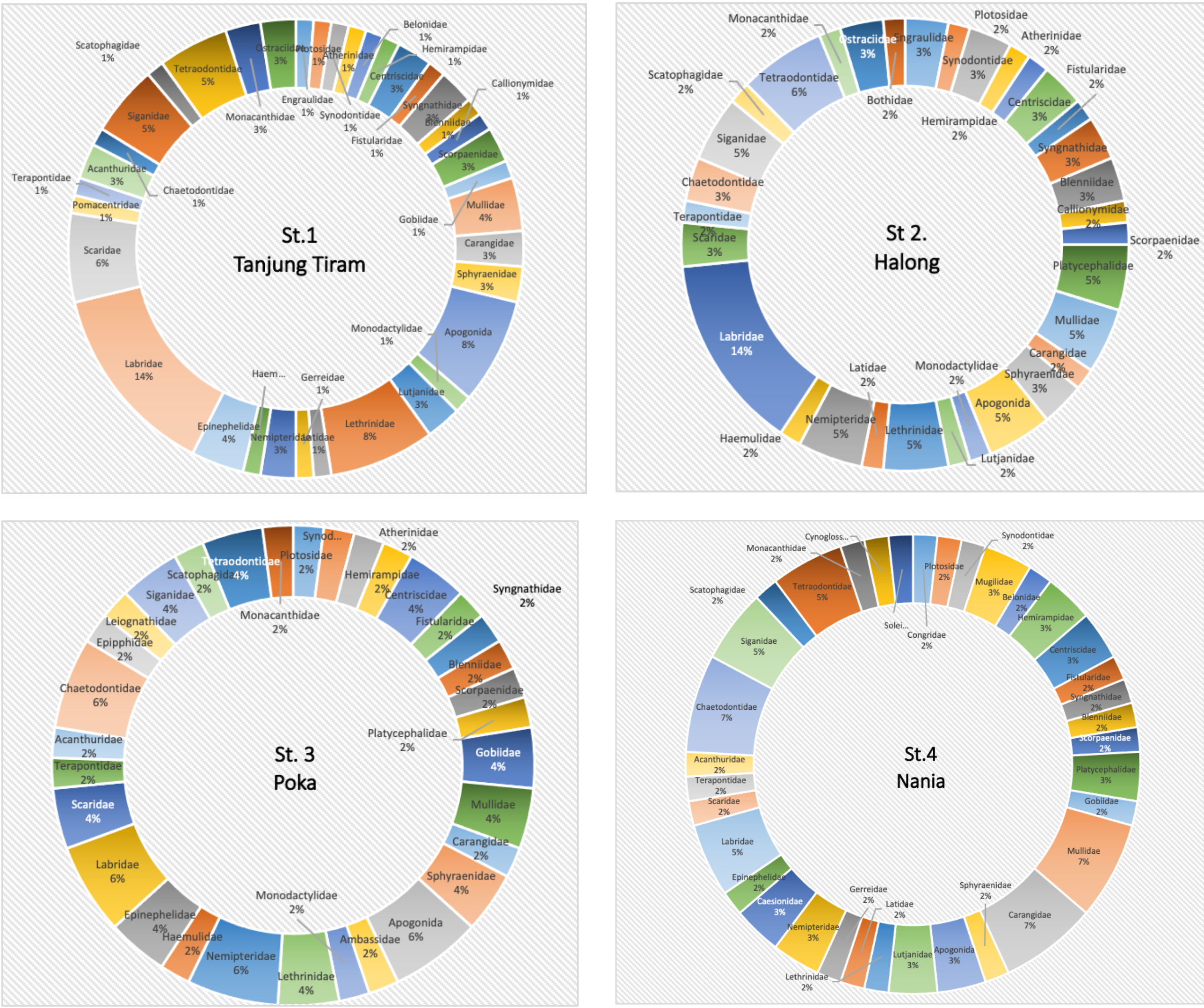

Figure 4. Composition of fish families between research stations based on the number of species in the Inner Ambon Bay (IAB), Maluku, Indonesia

Table 3. Composition of dominant ichthyofauna between different tropical seagrass habitats in the Inner Ambon Bay (IAB), Maluku, Indonesia

Family	Species	Trophic guild	Sampling station				Number of individuals	Sc (%)
			T	H	P	N		
Centriscidae	*A. strigatus*	I *	771	1234	76	107	2,188	20.31
Plotosidae	*P. lineatus*	O *	1	410	797	790	1,998	18.53
Siganidae	*S. canliculatus*	H **	292	49	314	339	994	9.23
Terapontidae	*P. quadrilineatus*	IF *	287	21	51	290	649	6.02
Centriscidae	*C. cristatus*	I *	265	324	12	14	615	5.71
Syngnathidae	*S. biaculeatus*	I *	219	41	141	106	507	4.71
Apogonidae	*C. quinquelineatus*	I *	253	7	79	2	341	3.17
Monacanthidae	*A. tomentosus*	I *	167	36	26	82	311	2.89
Scaridae	*S. ghobban*	H **	223	30	39	8	300	2.78
Scatophagidae	*S. argus*	O **	34	1	10	177	222	2.06
		Total number of individuals of dominant species					8,125	75.43
		Total number of individuals of all species					10,772	

Note: I: Invertebrate feeders; IF: Invertebrate/ Fish feeder; H: Herbivore; O: Omnivores; Sc: Species compotition. Sources: *Latuconsina et al. (2023); ** Froese and Pauly (2024)

Utilization and conservation status of ichthyofauna

The utilization of fish at four research stations, namely Tg. Tiram, Halong, Poka, and Nania, shows the dominance of consumption (Figure 5). Overall, 64 species out of 123 species are utilized for consumption, making it the main use at all locations. In Tg. Tiram Station, 41 species utilized for consumption, followed by Nania, Halong and Poka, respectively 35, 31 and 25 species. Only one species of fish has the potential to be utilized as a pharmaceutical raw material, namely *Hippocampus kuda*. Meanwhile, 94 species of fish have the potential to be utilized as ornamental fish, with the details for each location being the highest at 72 species at Tg. Tiram, 51 species at Halong, 46 species at Nania, and 42 species at Poka. As many as 7 species of fish have not been described their potential including *Heteroconger taylori*, *Paracentropogon longispinis, Scorpaenopsis venosa, Platycephalus indicus, Sorsogona tuberculata*, *Papilloculiceps nematophthalmus*, and *Onigocia spinosa*. Although some species of fish that have not been described, their use certainly has an ecological role in the food chain, thus supporting the diversity and abundance of fish communities associated with seagrass habitats.

The conservation status of seagrass fish communities in the IAB waters is dominated by the "Least concern" status (Figure 6), and the two least numerous statuses are "Vulnerable" and "Endangered". However, the existence of these species needs to be given conservation priority. This phenomenon shows how important it is to protect seagrass habitats in the IAB waters because they are essential habitats for various ichthyofauna.

Discussion

The results of the study obtained 10,772 specimens (individuals) of fishes from 123 species, 46 families, classified into 22 orders (Table 2). Aller et al. (2017) obtained 5,696 individuals of 114 species of 38 families in the Zanzibar marine conservation area (Tanzania) during three different seasons. Moussa et al. (2020) reported obtaining 8,288 individuals from 99 species and 28 on the western coast of Mayotte Island. Simanjuntak et al. (2020) obtained 10,000 individuals from 46 species and 26 families in the seagrass ecosystem of Karang Congkak Island, Seribu Islands, Indonesia. Syukur et al. (2021) found 20,352 individuals, 104 species, from 38 families, on the coast of Lombok Island. Jones et al. (2021) found 1,676 fish individuals representing 65 species and 26 families in the seagrass habitat of Zanzibar, Tanzania. The number of fish species is also higher than that in the seagrass ecosystem at Sindu Beach, Sanur, Bali, Indonesia. Manangkalangi et al. (2022) found 40 species and 21 families from 7 orders in the seagrass ecosystem of Nusmapi Island, West Papua, Indonesia.

Table 4. Bray-Curtis similarity for species, families, and orders of ichthyofauna between seagrass habitats in the Inner Ambon Bay (IAB), Maluku, Indonesia

Bray-Curtis similarity	Tg. Tiram (St.1)	Halong (St.2)	Poka (St.3)	Nania (St.4)
Species:				
Tg. Tiram (St.1)	1.00	0.66	0.62	0.51
Halong (St.2)		1.00	0.60	0.54
Poka (St.3)			1.00	0.56
Nania (St.4)				1.00
Families:				
Tg. Tiram (St.1)	1.00	0.78	0.64	0.63
Halong (St.2)		1.00	0.70	0.63
Poka (St.3)			1.00	0.67
Nania (St.4)				1.00
Orders:				
Tg. Tiram (St.1)	1.00	0.84	0.74	0.72
Halong (St.2)		1.00	0.74	0.74
Poka (St.3)			1.00	0.81
Nania (St.4)				1.00

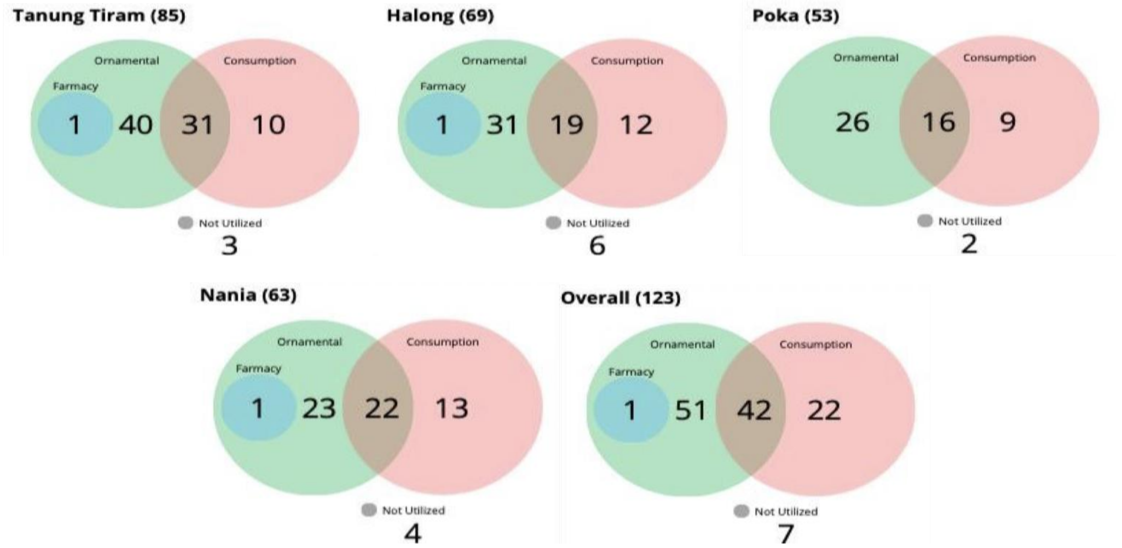

Figure 5. Utilization of ichthyofauna from each research station and a combination of all station in the Inner Ambon Bay (IAB), Maluku, Indonesia

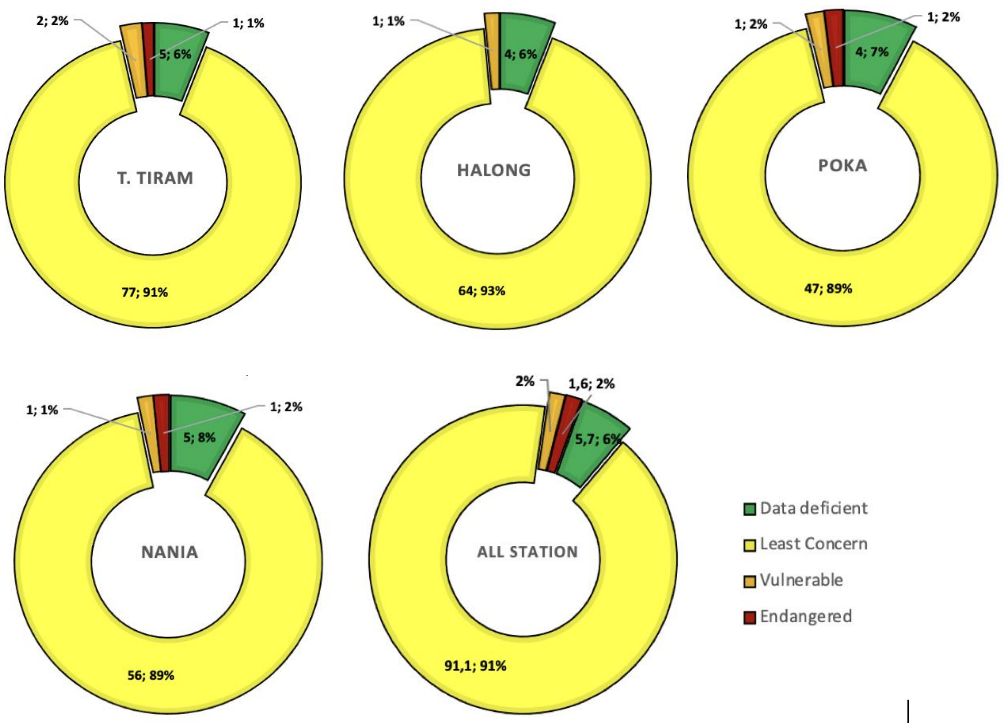

Figure 6. Conservation status (IUCN) of tropical seagrass fish species in the Inner Ambon Bay (IAB), Maluku, Indonesia

The majority of fishes collected in the IAB seagrass ecosystem during the study, 70.7% were in the juvenile stage (Table 2). Moussa et al. (2020) found that as many as 73% of juvenile fish comprised the entire fish assemblage in seagrass meadows, and only a few fish met the adult criteria. Simanjuntak et al. (2020) found that 90% of the identified fish species were in the juvenile phase, and Manangkalangi et al. (2022) found that 65.9% of the fish were in the juvenile phase. This fact highlights the seagrass ecosystem's role as a nursery area for ichthyofauna, which will mature into the pre-adult phase upon entering other habitats like deeper coral reefs.

This study also identified 10 dominant species, accounting for a total of 8,125 individuals, or 75.43% of all species found (Table 3). The 10 dominant species include several economically important species, such as the food fish families Siganidae, Scaridae, Mullidae, Plotosidae, and Carangidae. Meanwhile, the dominant ornamental fish groups include the families Centriscidae, Apogonidae, Monacanthidae, Labridae, and Syngnathidae. Compared to Aller et al. (2017) ini Unguja Island, Zanzibar (Tanzania), found five families that dominated around 80% of all individual fish collected, namely: Scaridae (25%), Pomacentridae (19%), Labridae (17%), Acanthuridae (11%) and Siganidae (9%). Moussa et al. (2020) found three fish families that dominated the fish assemblage, namely Pomacentridae, Labridae, and Acanthuridae, representing 54% of the total fish composition in the seagrass habitat. Syukur et al. (2021) found several fish families that dominated, including Leiognathidae (27.78%), Apogonidae (21.41%), Clupeidae (11.61%), Carangidae (8.03%), Channidae (4.75%), Sillaginidae (4.57%), and Mullidae (2.97%). Jones et al. (2021) found that five fish families (Siganidae, Lethrinidae, Lutjanidae, Scaridae, and Labridae) dominate more than 85% of the total fish abundance, with Lethrinidae accounting for 75% of the total fish abundance. These findings suggest that the seagrass ecosystem plays a critical role in providing strategic habitat for ichthyofauna in the shallow waters of IAB waters, serving as both temporary and permanent homes. According to Espadero et al. (2021), intertidal seagrass meadows provide permanent habitat for the fishes that inhabit them and a large feeding area for incoming fishes, including commercially fishes.

The results of this study found significant differences in the number of fish species between different seagrass habitats (Figures 3). It was found that the family composition tended to differ based on the number of fish species in mixed vegetation seagrass habitats (Stations 1 and 2) dominated by the Labridae family. While in single vegetation seagrass habitat (Stations 3 and 4) namely: Chaetodontidae, Labridae, Apogonidae, Nemipteridae, and Carangidae (Figure 4). In contrast, the number of individuals, families, and orders does not differ significantly between habitats. However, there is a tendency for seagrass habitats with high vegetation density and diversity to support high abundance and diversity of species, families, and orders. Susilo et al. (2018) also found that the highest fish family composition based on the number of species was Leognathidae (10.37%), Carangidae and Tetraodontidae each 7.55%, Pomacentridae (6.60%), and Apogonidae 5.66%. Furthermore, Susilo et al. (2018) reported that the abundance and number of fish species in seagrass meadows were largely determined by the level of density or cover of seagrass vegetation, and the structure of the seagrass canopy affected the abundance and number of fish species associated with seagrass habitats. Simanjuntak et al. (2020) found that the dominant ichthyofauna families based on the number of species were Labridae with 6 species, Apogonidae, Gobiidae, Siganidae (with 4 species), and Atherinidae with 3 species. Meanwhile, the dominant families based on the total number of individuals were Clupeidae, Atherinidae, Siganidae and Gerreidae. Syukur et al. (2021) found several dominant fish families in the seagrass habitat of Lombok Island, namely Leiognathidae, Apogonidae, Clupeidae, Carangidae, Channidae, Sillaginidae, and Mullidae, which are families with high abundance and are the main targets for small-scale fishermen in the area.

The interesting aspect of this study is the discovery of fish with different trophic structures. In mixed-vegetation seagrass habitats (Tg. Tiram and Halong), invertebrate feeders such as *A. strigatus* (Centriscidae) dominate at the station of Tg. Tiram and Halong. Conversely, omnivorous species like *P. lineatus* (Plotosidae) dominate seagrass habitats at Poka and Nania stations. All research stations found a widespread presence of herbivorous fishes, especially *S. canaliculatus* (Table 3). Relatively different when compared with the research results of Simanjutak et al. (2020) who found the dominance of zooplanktivores and crustacivores, and as many as 15 species classified as predatory fish were also found even though the number of individuals was not large in the seagrass habitat of Karang Congkak Island, Seribu Islands. Manangkalangi et al. (2022) found 3 species of fish based on eating habits, namely herbivores, carnivores and omnivores. However, it is more dominated by omnivorous and carnivorous fish in the seagrass habitat of Nusmapi Island, West Papua, Indonesia. In the seagrass habitat with the specification of *Thalassia hemprichii* seagrass vegetation, Macusi et al. (2023) found that herbivorous fish (3 species) dominated with a total relative abundance of 65.19%, while omnivorous fish (9 species) were in second place with a total relative abundance of 27.21%, and finally planktivorous fish which only 1 species with a relative abundance of 7.62%. This shows that seagrass meadows with different vegetation are also inhabited by fish with trophic dominance levels that tend to differ, one of the important commercial species found dominant in different types of seagrass habitats in IAB waters during the study was *S. canaliculatus*, which tended to be found more in seagrass habitats with single vegetation than mixed-vegetation. Latuconsina et al. (2020a) observed that *S. canaliculatus* exhibited a preference for different types of habitats. Adult-size groups generally preferred seagrass habitat types with single vegetation, while pre-adults were more likely to be found in seagrass habitats with mixed-vegetation, and juveniles were broadly distributed across all habitat types in IAB waters. According to Tongnunui et al. (2024), the abundance of *S. canaliculatus* in intertidal seagrass habitats is likely due to the availability of food sources in both habitats. The abundance of *S. canaliculatus* in intertidal seagrass habitats likely stems from the availability of food sources in these habitats.

The composition of fish families varies between seagrass habitats in IAB (Figure 4). However, there are relatively high similarities in species, families, and orders based on the physical characteristics of seagrass habitats (Table 4). In addition, the distance between seagrass habitats influences these similarities: the closer the distance between seagrass habitats, the higher the similarity of species, families, and orders, and vice versa. It is believed that the similarity of species, families, and orders of ichthyofauna inhabiting seagrass habitats in the IAB is due to the contributions of surrounding habitats such as mangrove and coral reef ecosystems and the presence or absence of rivers. According to Latuconsina et al. (2020a), The Tg. Tiram and Halong stations are mixed-vegetation seagrass habitat, home to five seagrass species: *Enhalus acoroides, T. hemprichii, Halophila ovalis, Cymodocea rotundata*, and *Halodule pinifolia*. Fine- to coarse-grained sand substrates dominate these ecosystems. The difference lies in Tg. Tiram Tiram's proximity to residential areas, where low-density mangrove vegetation persists. The difference lies in the proximity of Tg. Tiram to residential areas, where low-density mangrove vegetation persists. On the other hand, Halong Station is relatively remote from residential areas, devoid of mangrove vegetation, and encompasses a rehabilitated coral reef area. On the other hand, Poka and Nania stations serve as solitary seagrass habitat types. They consist entirely of *E. acoroides* seagrass, which has a low vegetation density due to its scattered distribution in patches. These patches form clumps with relatively few individuals, but their leaves are longer than those of the same type at Tg. Tiram they appear lush and expansive at Tg. Tiram and Halong stations. Rivers cross both Poka and Nania stations, resulting in high water turbidity. However, Poka station relies solely on rehabilitated mangroves, while Nania station has a large natural mangrove area with high density and diversity that serves as a conservation area. According to Hyndes et al. (2018) edge effects, adjacent habitats, and habitat fragmentation can greatly affect fish assemblages in seagrass habitats. In addition, seagrass structures complexity can increase juvenile fish survival and growth.

It is believed that the mangrove habitat surrounding low-density seagrass meadows, like those at Nania station, provides shelter and food, contributing to the high fish catch. On the other hand, seagrass meadows with high fish abundance at Halong and Poka stations may be due to the proximity of the nearest coral reefs, and seagrass meadows with high fish abundance at Tg. Tiram. The density and diversity of seagrass vegetation at Tg. Tiram Station, and the support of nearby mangrove and coral reef areas are believed to be the cause. Fish assemblages use the tidal rhythm to disperse to the mangrove habitat during high tide, migrate to the seagrass habitat during low tide, and reach the coral reefs during low tide. There is connectivity between seagrass meadows and other habitats at the seascape scale through the movement of fish and organic matter between habitats (Hyndes et al. 2018). This condition will support the spatial distribution of fish between habitats. As reported by Du et al. (2020b) who studied the connectivity of fish between mangrove-seagrass-coral reef habitats, found that 101 of the total 154 species (65.6% of species) lived in one habitat, 36 species were recorded in two habitats, and 17 species lived in three habitats (mangrove-seagrass-coral reef). This fact shows that many fish species generally depend on several habitats to support their life cycle. As emphasized by Macário et al. (2021), juvenile fish species depend on several habitats, and no species only uses one type of habitat exclusively. According to Latuconsina et al. (2023), reef fishes generally perform ontogenetic migrations to support their life cycle, starting from the larval, juvenile, and pre-adult stages in the seagrass ecosystem, and when they become adults and spawn, they move to coral reefs. Thus, the seagrass ecosystem is a transitional habitat supporting the life cycle of reef fish communities and fish associated with the closest habitats, such as mangrove and coral reefs.

Station 1 (Tg. Tiram) has the highest number of individuals, species, families, and orders, yet its seagrass ecosystem faces significant threats due to its proximity to residential areas and its use as a mooring site for fishing boats. This condition will certainly have a direct and indirect impact on the decline of seagrass bed quality. According to Jones et al. (2021), the interaction between seagrass cover and land use supports species richness; locations closer to the impact of anthropogenic activities have low species richness and abundance, while those far from anthropogenic activities have seagrass vegetation cover and canopy structure that strongly influence species richness and abundance of ichthyofauna. The high biodiversity of ichthyofauna in seagrass ecosystems is also due to the ability of seagrass meadows to provide a variety of microhabitats to support the life of ichthyofauna, including those from nearby ecosystems during the juvenile stage. Du et al. (2020b) found that ichthyofauna has diversified and specialized in using different microhabitats in seagrass ecosystems, increasing habitat function and faunal diversity in seagrass meadows. The results of this study confirm that each type of seagrass habitat (single or mixed vegetation) has its own role for fish species. It is believed that the proximity of seagrass habitats, together with their proximity to other supporting habitats, contributes positively to the high diversity of fishes.

Therefore, in order to maintain the abundance and diversity of ichthyofauna in the IAB, it is crucial to maintain the heterogeneity of seagrass habitats and support of the closest surrounding habitats. Various efforts can achieve this by controlling anthropogenic activities that could potentially degrade the quality of seagrass habitats and other nearby habitats. By implementing seascape conservation strategies, we can fully protect all ichthyofaunal habitats. Given that the seagrass ecosystem provides ecological services and serves as a potential habitat for various ichthyofauna, including ornamental fish, it is crucial to protect seagrass habitats in IAB waters (Figure 5). Figure 5 shows that many species of commercially important fish (for consumption and ornamental) use seagrass meadows as their rearing habitats such as from the Plotosidae, Siganidae, Apogonidae, Synganthidae, Monacanthidae, Scaridae, Labridae, Lutjanide, Lethrinidae, Nemipteridae, Terapontidae, and Mullidae families in the IAB seagrass habitat. Simanjuntak et al. (2020) also found that several species of economically important fish use seagrass meadows as their rearing habitats in the seagrass meadows of Karang Congkak Island, Seribu Islands, such as from and fish *Lutjanus fulviflamma, Lethrinus genivittatus*, *Epinephelus quoyanus, S. canaliculatus, S. punctatus*, *S. spinus*, and *S. virgatus*. This shows that seagrass meadows are an important habitat for rearing commercially valuable juvenile fish. Syukur et al. (2021) found that 94.37% of fish families found in seagrass habitats were commercially valuable fish, making them the target of small-scale fishermen. This fact provides evidence that the existence of seagrass habitats indirectly contributes positively to small-scale fisheries in the area. Therefore, the existence of seagrass habitats needs to be given conservation priority to support sustainable small-scale fisheries. We need to prioritize the conservation of seagrass ecosystems in IAB to protect the diverse ichthyofauna associated with them, each of which has a different conservation status (Figure 6). Despite the fact that most of the identified fish species have conservation statuses of "Least concern" (IUCN), there is a fear that their status could change in the future if their wild exploitation increases, leading to damage to seagrass habitats that provide initial stocks of juvenile to pre-adult ichthyofauna. Therefore, there is a need for understanding among different parties to make seagrass ecosystems a conservation area, not only mangroves and coral reefs. Espadero et al. (2021) say that understanding how important intertidal seagrass meadows are as homes for ichthyofauna in tropical areas can have a big effect on the protection and management of coastal fish biodiversity, leading to more sustainable integrated fisheries management.

Each observation station representing the seagrass habitat has different environmental characteristics. Based on the report of Latuconsina et al. (2020a), Poka and Nania stations are characterized by the presence of monospecific seagrass habitat, where both locations are flowed by rivers. This causes the environmental characteristics of both to be similar, such as higher turbidity, dissolved oxygen, chlorophyll-a, and water temperature values. On the other hand, Tanjung Tiram has high phosphate and nitrate levels. Together with Halong station, these two locations also show high salinity and pH. This condition may be due to the minimal influence of river flow in Tanjung Tiram and Halong, so that pH and salinity fluctuations are more stable than in Poka and Nania. The variability of environmental conditions certainly impact on the distribution and existence of various ichthyofauna species in each of these seagrass habitats. The condition of the seagrass ecosystem in IAB with an area of 11.6 km² faces various anthropogenic pressures including sedimentation from various river flows, coastal development, domestic waste, urban activities, and agricultural waste. These pressures can cause changes in the quality of IAB waters (Kakisina et al. 2015; Manullang et al. 2021) and high sedimentation rates. These pressures have the potential to have a negative impact on seagrass habitats (Irawan and Nganro 2016), including uncontrolled fishing (Latuconsina et al. 2020b), which in turn can result in a decrease in the abundance and diversity of ichthyofauna in the seagrass ecosystem. This fact is supported by the report of Unsworth et al. (2018), that in general seagrass meadows in Indonesia experience various anthropogenic pressures such as coastal development, coastal reclamation, deforestation, which causes sedimentation in coastal areas, excessive fishing, and waste disposal. These conditions can potentially to reduce the resilience of seagrass ecosystems to climate change and result in the loss of high ecosystem service values. Therefore, conservation efforts must also consider the management of several river basins that flow into the IAB waters to minimize the impacts of pollution and sedimentation. According to Quiros et al. (2017), agricultural activities and other anthropogenic activities in agricultural lands affect the condition of seagrass habitats. Therefore, properly managing seagrass ecosystems requires managing the surrounding river basins. Seagrass systems can respond to river impacts at three different levels: landscape, ecosystem, and individual. Protecting seagrass ecosystems with various types of habitats in the IAB waters can support sustainable fisheries in this area.

In conclusion, the ichthyofauna inhabiting seagrass habitats differ in species composition between seagrass habitats, with the degree of similarity of species, families and orders of fishes being high between mixed-vegetation seagrass habitats compared to single-vegetation seagrass habitats. The proximity between seagrass habitats also supports the high similarity of species, families and orders. The most dominant trophic group of fishes caught in mixed-vegetation seagrass habitats are invertebrate feeders from the family Centriscidae, while the most dominant fishes caught in single-vegetation seagrass habitats are omnivorous fishes from the family Plotosidae. In all types of seagrass habitats, herbivorous fishes of the families Siganidae and Scaridae tend to be widely distributed. Mixed-vegetation seagrass habitats have a higher total number of individuals and fish species compared to those with single-vegetation. This phenomenon proves that each type of seagrass habitat has a relatively different contribution to the abundance, number of species, families and orders. Therefore, protecting different types of seagrass habitats is the right strategy to support the abundance and diversity of the ichthyofauna. In addition, the protection of habitats surrounding seagrass meadows, such as mangroves and coral reefs, which are ecologically linked through tidal migration of ichthyofauna, is also important to support the conservation of ichthyofauna to achieve sustainable fisheries use in IAB to support food security.

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