

A Preliminary Studies of Fish Richness in the Tondano River Estuary Manado Bay

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Abstract

The purpose of this study was to analyze the richness of fish species in the Tondano River estuary. Sampling was done for two months, in July and August 2022, new moon phase, during the low tide at 13.00-16.00 pm. Sampling used a 20-m beach seine with a cod-end part of 0.2 cm mesh and wings of 2-m height and 1.5 cm mesh. The beach seine was operated 10 times starting from the lowest tide at 13.00 pm to the tide condition at 16.00 pm. As a whole, 736 individuals were caught, consisting of 24 species and 17 families, 14 migrant species, and 10 resident species. The number of fish varied from 1 to 445 individuals, in which *Terapon jarbua* (445 ind) was the most abundant, followed by *Neovespicula depressifrons* (70 ind). The dominant index (C) was 0.38 and the diversity index (H) was 1.65. The resident species were 120 individuals varying from 2 to 70 ind., and the most abundant was *Neovespicula depressifrons* (70 ind.). The dominant index (C) was 0.37 and the diversity index was 1.47.

Keyword: beach seine; migrant; species; resident

INTRODUCTION

An estuary is an aquatic ecosystem possessing high environmental fluctuations, such as salinity, temperature, turbidity, and river and tidal currents. As a transitional area between seawater and freshwater, this water is occupied by a combination of both marine and freshwater fish species. The estuary fish group comprises freshwater fish occasionally entering the brackish water, anadromous and catadromous species in transit, the fish group spending their entire life in the estuary (resident species), and the marine fish utilizing the estuary as spawning and nursery ground as described in detail by Elliott et al. (2007). The estuarine fish group is characterized by low diversity, but high abundance, especially in the juvenile stage (Whitfield, 2010). The estuarine ecosystem structure is controlled by environmental variables determining the characteristics of the ecosystem. These environmental condition variations will cause changes in the composition and the distribution of the estuarine fish (Arkeo-Caranza & Vega-Cendejas, 2009; Barletta & Blaber, 2007; Johnston et al., 2007; Barletta et al., 2005).

The fish composition in the estuary is also controlled by the combination of biotic and abiotic factors, particularly competition for space and food, and tolerance to changes in salinity, turbidity, and daily temperature or season. The dominant environmental factor affecting the fish composition in the estuary is salinity (Barletta et al., 2005).

Information on fish assemblage in the estuary of the north coast of North Sulawesi in relation to fish composition, seasonal variations, and biomass is still very few. Previous studies by Bataragoa et al., (1997) and Bataragoa et al., (2012) briefly addressed fishes in five estuaries in North Sulawesi. Bataragoa (2014) and Bataragoa et al (2014) reported that utilizing the estuary of Poigar River (composition, number of species, and biomass), while the fish assemblage in the estuary of Tondano River is poorly understood. This study was aimed at describing the abundance and the species richness of fish in the Tondano River estuary.

METHODS

Study Area

The estuary of Tondano River is located in the northern Peninsula of

Sulawesi Island, Manado City Indonesia 124° 50' 30" E and 1° 30' 0" N (Fig. 1). Lower estuary is sandy and muddy, with a depth

of 0.5-1.5 meters at low tide and 1.5-2 meters at tide.

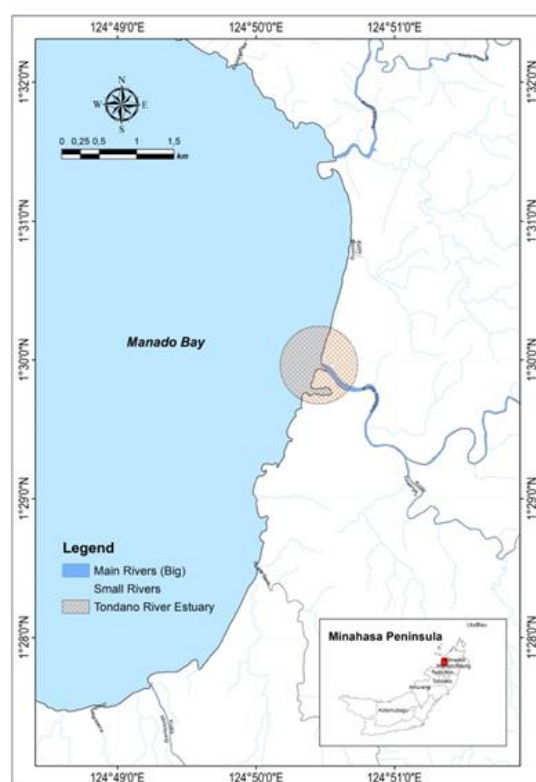


Figure 1. Map of Sampling Area of Tondano River Estuary Manado Bay Minahasa Peninsula of Sulawesi Island Indonesia

Fish Sampling

Sampling was done for two months, in July and August 2022, at the new moon phase, during the low tide at 13.00-16.00 pm. Prior to sample collections, physicochemical (temperature, salinity, and dissolved oxygen) variables were measured *in situ* using a Multi-parameter water quality checker, HORIBA type U-50.

Sampling used a 20-m long beach seine with a cod-end of 0.2 cm mesh and wings of 2-m height with 1.5 cm mesh. The beach seine was operated 10 times starting at the lowest tide at 13.00 pm until the tide condition at 16.00 pm. Samples were packed in labeled sample bags, put into a cool box with ice crushes, taken to the laboratory, and stored in a freezer at -10°C. Fish identification followed the identification guide of Kottelat et al., (1993), Masuda et al., (1984), FAO Species Identification Guide for Fishery Purposes, (Fischer &

Whitehead, 1974), and FishBase <https://www.fishbase.se>.

Data analysis

Dominance index (C) was calculated based on the formula $C = \sum (n_i/N)^2$ where n_i is the number of individuals of a species and N is the number of individuals of all species. Diversity index (H) estimation used Shannon index $H' = -\sum_{i=1}^n p_i \ln p_i$, where p_i is the proportion of individuals belonging to the i th species in the dataset of interest (Spellerberg and Fedor, 2003).

RESULTS

Water Quality

The estuary area is brackish water with a salinity of 6.86 ± 2.27 ppm. This area is inhabited by two fish groups, namely the sedentary or resident fish whose entire life occurs in the estuary and the migratory fish that only live in this area for a certain time. Water quality parameters are presented in

Table 1. Water pH is in the normal range and the TDS value indicates that the estuary waters are classified as turbid waters.

Species richness

As a whole, 735 individuals were caught, consisting of 23 species and 17 families during the study, 13 migratory species (Table 2; Figure 3) and 10 resident species (Table 2; Figure 4). The best-represented families by the number of species were Carangidae (2 genera and 3 species) and Gobiidae (2 genera and 2 species). As a whole, the number of fish varied from 1 to 445 individuals. The most

abundant species were *Terapon jarbua* (445 individuals) and followed by *Neovespicula depressifrons* (Richardson, 1848) (70 individuals). The number of fish for the other 21 species ranged from 1 to 40 individuals). The dominance index (C) was 0.38 and the diversity Index(H) was 1.65. The resident species were 120 individuals varying from 2 to 70 individuals and the most abundant species was *Neovespicula depressifrons* (70 individuals). The number of fish for the other 11 species ranged from 2 to 8 individuals). The dominance index (C) was 0.37 and the diversity index was 1.47.

Table 1. Water Quality of Tonadno River Estuary

Month	Sites	Temperature (°C)	Salinity (ppm)	pH	DO	TDS (NTU)
July	ST-1	29.07	5.99	7.18	9.31	130.00
	ST-2	29.67	4.05	7.25	8.99	165.00
Agustus	ST-1	29.75	8.70	8.03	7.36	40.70
	ST-2	29.89	8,70	7.97	7.36	255.00
Mean		29.60	6.86	7.61	8.26	147.68

Table 2. List of migrant and resident species of Tondano River Estuary

Migrant		Resident	
Family	Species	Family	Species
Carangidae	Longfin trevally <i>Carangoides armatus</i> (Rüppell, 1830),	Ambassidae	Long-spined glass perch let, <i>Ambassis interrupta</i> Bleeker, 1853
	Giant trevally <i>Caranx ignobilis</i> (Forsskål, 1775)	Callionymidae	Flap-gilled dragonet <i>Eleutherochir opercularis</i> (Valenciennes, 1837)
	Bigeye trevally <i>Caranx sexfasciatus</i> Quoy & Gaimard, 1825,	Gobiidae	Goby, <i>Bathygobius</i> sp
Clupeidae	Spotted sardinella, <i>Amblygaster sirm</i> (Walbaum, 1792)		Goby, <i>Glossogobius robertsi</i> Hoese & Allen, 2009
Cynoglossidae	Doublelined tonguesole, <i>Paraplagusia bilineata</i> (Bloch, 1787),	Leiognathidae	Smalltoothed ponyfish, <i>Gazza aklamys</i> Jordan & Starks, 1917,
Drepaneidae	Concertina fish, <i>Drepane longimana</i> (Bloch & Schneider, 1801),		Toothpony, <i>Gazza minuta</i> (Bloch, 1795),
Engraulidae	Commerson's anchovy, <i>Stolephorus commersonii</i> Lacepède, 1803	Mugilidae	Mullet, <i>Osteomugil cunnesius</i> (Valenciennes, 1836),
	Baelama anchovy, <i>Thyssa baelama</i> (Forsskål, 1775)	Polynemidae	Sixfinger threadfin, <i>Polydactylus sexfilis</i> (Valenciennes, 1831),
Haemulidae	Silver grunt, <i>Pomadasys argenteus</i> (Forsskål, 1775)	Sillaginidae	Silver sillago, <i>Sillago sihama</i> (Forsskål, 1775),
Mullidae	Sulphur goatfish, <i>Upeneus sulphureus</i> Cuvier, 1829,	Tetrarogidae	Goblinfish, <i>Neovespicula depressifrons</i> (Richardson, 1848),
	Yellow striped goatfish, <i>Upeneus vittatus</i> (Forsskål, 1775)		
Sphyraenidae	Obtuse barracuda, <i>Sphyraena obtusata</i> Cuvier, 1829		
Terapontidae	Jarbua terapon, <i>Terapon jarbua</i> (Forsskål, 1775)		



Figure 1. Migrant species of Tondano River Estuary

Discussion

In estuarine waters in Indonesia, we can generally find species of fish members of the Family Ambassidae, Apogonidae, Belonidae, Carangidae, Gerridae, Gobiidae, Haemulidae, Hemiramphidae, Leiognathidae, Lethrinidae, Lutjanidae, Mugilidae, Sillaginidae, Siganidae, Scatophagidae, Theraponidae, and Toxotidae (Bataragoa et al., 2012; Bataragoa et al., 2009; Göltenboth et al., 2006; Susanti and Sugeha, 2008; Genisa,

2003; Genisa, 1990). In the Tondano River Estuary, the present study found 23 species with 17 families. The families are Ambassidae, Carangidae, Clupeidae, Cynoglossidae, Drepaneidae, Engraulidae, Haemulidae, Mullidae, Sphyrænidae, Theraponidae, Callionymidae, Gobiidae, Leiognathidae, Mugilidae, Polynemidae, Sillaginidae, and Tetrarogidae, as shown in Tables 2. In a recent study, Salindeho et al (2022) also found five species of the amphidromous gobi fry (Gobiidae),

Awaous grammepomus, *Siciopterus pugnans*, *S. lagocephalus*, *S. Longifilis*, and *S. Cynocephalus*.

Compared to the estuaries in several rivers in the Minahasa Peninsula, North

Sulawesi, where only one sampling of species richness was carried out as shown in Table 3. (Bataragoa et al., 2009).

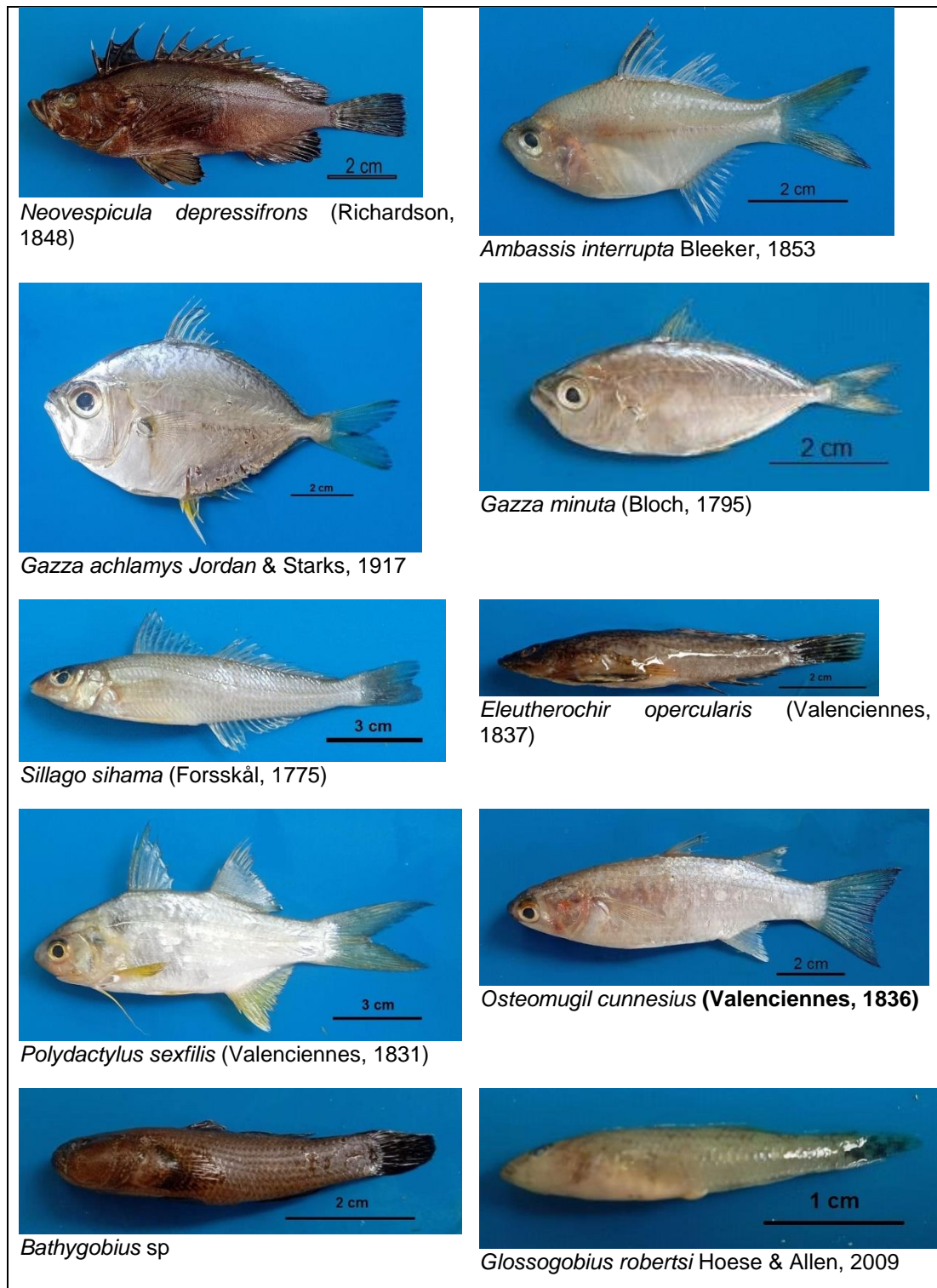


Figure 2. Resident species of Tondano River Estuary

Table 3. Species Richness Some Estuaries in North Sulawesi

Estuary	Number		
	Family	Genera	Species
Ranoyapo	19	27	35
Maruasey	18	23	26
Talawaan	15	22	23
Likupan	12	13	18

Surveys in the Poigar River Estuary with 12 sampling times for 6 months (Bataragoa, 2014 and Bataragoa et al., 2014) obtained a total of 27 families, 40 genera, and 54 species. Based on findings in the Poigar River estuary, it is apparent that a longer sampling activity will get more fish species. So it is estimated that for the Tondana River Estuary and the Ranoyapo, Maruasey, Talawaan, Likupang River Estuaries and even the Tondano River Estuaries, there could be more families, genera, and species obtained if the sampling period is increased. Bataragoa and Kambey (2021) also found 10 estuary species that migrated to fresh water in the river of the Northern Peninsula of Sulawesi Island, namely *Lutjanus fuscescens* (Lutjanidae), *Caranx sexfasciatus*, *C. papuensis* (Carangidae), *Scatopagus argus* (Scathopagidae), *Ambassis gymnocephalus* (Ambassidae), *Mugil cephalus*, *Liza macrolepis*, *Valamugil cunnesius* (Mugilidae) and family Anguillidae, *Anquilla marmorata*, *A. celebesensis* (occur in estuary during the glass ell stage).

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REFERENCES

Arceo-Carranza, D., and M.E. Vega-Cendejas, 2009. Spatial and temporal

characterization of fish assemblages in a tropical coastal system influenced by freshwater inputs: Northwestern Yucatan peninsula. *Int. J. Trop. Biol.* Vol. 57:89-103.

Barletta, M., and S.J.M. Blaber, 2007. Comparison of fish assemblages and guilds in tropical habitats of the Embley (Indo-West Pacific) and Caetê (Western Atlantic) estuaries. *Bulletin of Marine Science*, 80(3): 647–680.

Barletta, M., A. Barletta-Bergan, U. Saint-Paul, and G. Hubold, 2005. The role of salinity in structuring the fish assemblages in a tropical estuary. *Journal of Fish Biology* 66 (1):45-72.

Bataragoa, N.E., 2014. The Dynamic of Tidal Migratory Fish Community in the Estuary of Poigar River, North Sulawesi, With Emphasis on the Biological of Trevally, *Caranx sexfasciatus* Quoy and Gaimard, 1825. (Dissertation) Barawijaya University Indonesia. 193 p.

Bataragoa, N.E., D. Setyohadi, A. Sartimbul and D. Arfiati, 2014. Biodiversity of fish utilizing intertidal estuary of poigar river during high-tide North Coast of North Celebes, Indonesia. *J. Bio. & Env. Sci.*: 4 (4):370-378.

Bataragoa, N.E., D. Arfiati, D. Setyohadi, and A. Sartimbul, 2012. A Preliminary Study on Fish Assemblages in Estuaries at Northern Peninsula of Sulawesi Island: With Emphasis on the Presence of Marine Migrant Jacks *Caranx sexfasciatus* and *Caranx papuensis* (Carangidae). International Seminar of Indonesian Ichthyological Society, Makassar Indonesia June 12, 2012.

- Bataragoa, N.E., A.D. Kambey dan A.P. Harahap, 1997. River Fish in Minahasa Minahasa Peninsula. Sam Ratulangi University Research Report 55 p.
- Bataragoa, N.E and A. D. Kambey, 2021. Species of Fish in rivers in the Northern Peninsula of Sulawesi Island. *Jurnal Ilmiah Platax* 9(1): 66-88
- Elliott, M., A.K Whitfield, I.C Potter, S.J.M. Blaber, D.P. Cyrus, F.G. Nordlie, and T.D Harrison. 2007. The guild approach to categorizing estuarine fish assemblages: a global review. *Journal Compilation Fish and Fisheries* 8: 241–268.
- Fischer, W., and P.J.P. Whitehead, 1974. *FAO Species Identification Sheets For Fishery Purposes, Eastern Indian Ocean (fishing area 53) and Western Central Pacific (fishing area 71) Vol. I-IV. Food and Agriculture Organization of the United Nations. Roma.*
- Genisa, A.S., 1990. Fauna ikan di muara Sungai Pemali Brebes Jawa Tengah. Makalah disampaikan pada Seminar Ilmiah Nasional, Lustrum ke VII Fakultas Biologi Universitas Gajah Mada 20-21 September 1990.
- Gölsenboth, F., K.H. Timotius, P.P. Milan, and J. Margraf, 2006. *Ecology of Insular Southeast Asia the Indonesian Archipelago.* Elsevier Radarweg 29, PO Box 211, 1000 AE Amsterdam, The Netherlands.
- Johnston, R., M. Sheaves and B. Molony, 2007. Are distributions of fishes in tropical estuaries influenced by turbidity over small spatial scales?. *Journal of Fish Biology* 71: 657–671.
- Kottelat, M., A.J. Whitten, S.N. Kartikasari and S. Wirjoatmodjo, 1993. *Freshwater fishes of Western Indonesia and Sulawesi.* Periplus Editions, Hong Kong. 221 p
- Masuda, H., K. Amaoka, C. Araga, T. Uyeno and T. Yoshino, 1984. *The fishes of the Japanese Archipelago. Vol. 1.* Tokai University Press, Tokyo, Japan. 437 p. (text)
- Salindeho, I.R.N., R.C. Kepel, N.E. Bataragoa, and R.A. Tumbol. 2020. First report on the seasonal and spatial variation of the species composition of amphidromous goby fry schools in Tondano and Poigar-river Estuaries, North Sulawesi, Indonesia. *AACL Bioflux* 15 (1): 44-53
- Sasanti RS and HY Sugeha. 2008. Recruitment Pattern of Juvenile Fishes into Pami River Estuary (West Papua, Indonesia). *Marine Research in Indonesia*, 33(2): 145-153
- Spellerberg, I.F and P.J Fedor, 2003. A tribute to Claude Shannon (1916–2001) and a plea for more rigorous use of species richness, species diversity, and the ‘Shannon–Wiener’ Index. *Global Ecology and Biogeography* 12(3): 177-179.
- Whitfield, A.K., 2010. A century of fish research in South African estuaries. *African Journal of Aquatic Science*, 35:3, 211-225.