

The Potential of Waterbird Feed in the Aopa Swamp Ecosystem of the Aopa Watumohaoi National Park in Southeast Sulawesi

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Abstract: The Aopa Wetland Ecosystem, a Ramsar site, supports 1% of global species, including diverse waterbirds. However, populations are under serious threat from human activities, especially illegal hunting that disturbs habitats. The decline of waterbirds in Aopa Watumohai National Park (TNRAW) is the highest compared to other Indonesian national parks. This study, conducted from January to March 2023, aimed to analyze waterbird food resources through field observations. Data collected included distribution, number of species and individuals, diversity (Shannon index), and food types. Observations were carried out by boat across swamp areas. Results recorded 17 species of waterbirds totaling 1,217 individuals, with the highest abundance in open vegetation dominated by *Irediparra galinacea* (23.2%). Food resources were identified from 418 individuals representing 14 species, grouped into four classes: Insecta (5 species), Pisces (5), Gastropoda (3), and Malacostraca (1). The observation area was classified into vegetation types: open (VT), closed (VTP), and water body (BA). VT provided 14 food types, VIP 13 types, and BA 11 types. These findings emphasize the importance of protecting wetland habitats to sustain waterbird populations in TNRAW.

Keywords: Bird abundance; Feed potential; Swamp ecosystem; Water bird feed

Introduction

The Aopa Swamp ecosystem is one of the swamp areas designated as the fourth Ramsar Site in Indonesia (Gwilliam, 2011) because it is home to 1% of the world's species, one of which is water birds. Aopa Swamp covers an area of approximately 31,400 hectares, but only about 13,608.34 hectares are managed (Pratiwi, 2015). The presence of waterbirds in a habitat is influenced by food availability and water levels. Water levels at feeding sites vary among groups of waterbirds, and differences in habitat use are related to species morphology (Colwell et al., 1993). The bird communities that inhabit wetland habitats are influenced by species interactions (Palmer et al., 2003). Therefore, species with similar resource utilization patterns are vulnerable to competitive

interactions that affect communities (Pérez-Crespo et al., 2013).

Food availability is the most important ecological factor in determining the survival of waterbirds. The type and amount of food available will affect the distribution, foraging behavior, reproduction, and population dynamics of waterbirds (Vennesland et al., 2011). Wetland ecosystems have high productivity and therefore serve as a natural food source for various species of waterbirds (Ramadhani et al., 2022). These food sources include fish, amphibians, small reptiles, crustaceans, and aquatic and terrestrial invertebrates, which are key components in the waterbird food chain.

The dependence of waterbirds on food availability makes this aspect an important indicator in understanding ecology and formulating conservation

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measures (Guo et al., 2017; Purify et al., 2019). Sufficient and diverse food availability not only ensures the survival of individual waterbirds but also supports the long-term success of waterbird populations. Conversely, limited food can lead to a decline in waterbird populations and disrupt the balance of the ecosystem.

However, wetland ecosystems are also a habitat for humans who utilize the resources in these ecosystems, such as fish, crabs, and other aquatic biota, for the economic needs of the community. Direct competition between humans and waterbirds for resources often puts pressure on the sustainability of waterbird populations (Adhikari et al., 2019; Lee et al., 2006). This pressure is even higher in conservation areas adjacent to settlements or community activities.

The objective of this study is to analyze the potential food sources for waterbirds in the Swamp Ecosystem, National Park Management Section (SPTN) I, Rawa Aopa Watumohai National Park. This information will serve as a reference for waterbird conservation efforts in the area.

Method

Research Location and Time

The research area is located in SPTNW I Rawa Aopa Watumohai National Park, which is located in South Konawe Regency, Southeast Sulawesi. SPTNW 1 is an area with a high concentration of water birds. The research will be conducted from January to March 2023. Research design and method should be clearly defined.

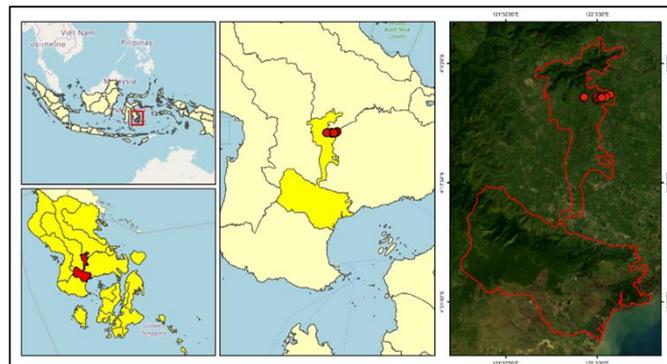


Figure 1. Research location

Tools and Materials

Waterbird observation requires tools that can help identify birds, such as binoculars, monoculars, cameras, bird guidebooks, tally sheets, sieves, sample bottles, and tweezers (Sabrina et al., 2019). Sieves are needed to sort and collect the types of feed to be studied.

Data Collection

There are two groups of food data collection for water birds, namely invertebrates, which are specialized

for macrozoobenthos, and vertebrates that live in water, namely fish. Macrozoobenthos constitute the majority of the main food source for waterbirds (Hutabarat, 2013), divided into six classes: worms (Class Poychaeta), shrimp (Order Decapoda), clams (Class Bivalvia), snails (Class Gastropoda), and crabs (Class Crustacea). The technique for collecting macrozoobenthos food uses a core tube with a diameter of 12 cm. At each bird observation station, data collection is conducted at three points selected using the Concentration Count method, which are points with high potential as feeding sites for waterbirds (Sutopo et al., 2017).

Result and Discussion

Number of Waterbird Species

Observations recorded a total of 2,702 waterbird individuals from 17 species and 9 families of waterbirds. This total is distributed across three vegetation types designated as observation areas, with the highest number of individuals found in open vegetation areas totaling 1,382. The highest number of individuals per species were the Red-necked Grebe (*Irediparra galinacea*), Common Moorhen (*Gallinula chloropus*), and Black-necked Grebe (*Gallinula tenebrosa*).

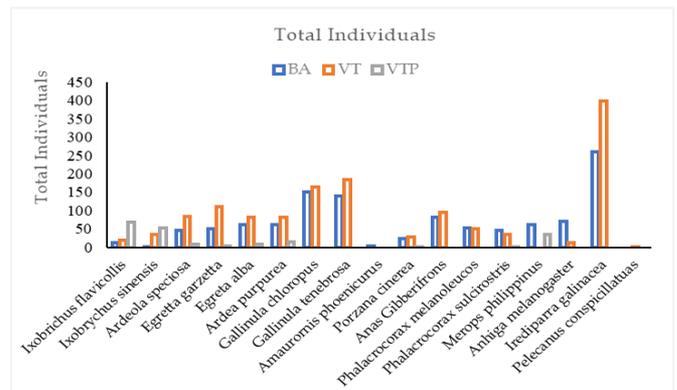


Figure 2. Graph of the number of water birds

Based on the results of the analysis in (Figure 2), each location has a different diversity of bird species with distributions influenced by local environmental factors. Some species show dominance in certain locations, while others are more evenly distributed. Species with very low numbers require more attention in terms of habitat protection or species conservation. The varying numbers of individuals in the three locations are likely influenced by environmental factors, such as abundant food sources, like fish, insects, or aquatic plants, which attract more birds to forage and breed, as well as human threats or natural predators and climatic and vegetation conditions. This aligns with research indicating that the foraging behavior and mobility of waterbirds in seeking and obtaining food are

significantly influenced by habitat conditions, weather, and disturbances (Battley et al., 2012; Howes et al., 2003).

The total number of individuals per observation period based on the analysis results shows that the highest number of individuals was found in open vegetation and the lowest number of individuals was found in closed vegetation, as shown in the analysis results table below.

Table 1. Number of Individuals per Observation Period

Location	Period I (Individual)	Period II (Individual)	Period III (Individual)
Water body	483	351	290
Open vegetation	552	449	381
Closed Vegetation	56	73	67

Description: Period I (January), Period II (February), Period III (March)

Based on the table above, which illustrates the number of individuals in three different locations (water bodies, open vegetation, and closed vegetation) over three time periods, several perspectives can be observed, including population decline trends and influencing factors. In water bodies, there was a significant decline in the number of individuals from Period I to Period III. In Period I, there were 483 individuals, but this number continued to decline until only 290 individuals remained in Period III. Open vegetation also showed a population decline, but at a more moderate rate compared to Water Bodies. From 552 individuals in Period I, the number decreased to 381 individuals in Period III. This decline may be due to degradation, changes in aquatic ecosystem conditions, or human disturbance. Natural factors such as drought or climate change may also play a role in this population decline (Cao et al., 2024; Hammana et al., 2024; Liu et al., 2019; Zhang, 2024). Additionally, waterbirds during Periods II and III may have migrated to other areas with less habitat disturbance. With the increasing intensity of human development, waterbird populations gradually migrate to other natural and artificial habitats with less human activity (Xie et al., 2025), or to buffer zones around areas showing isolated conditions (Wang et al., 2021).

Unlike the other two locations, closed vegetation actually showed a small increase in Period II (from 56 to 73 individuals) before declining again to 67 individuals in Period III. Although the fluctuations are not significant, this condition may indicate that closed vegetation offers more protection for some species, especially if there are changes in the surrounding environment. Closed vegetation often serves as a hiding place or breeding ground for water birds, thus providing more stability than open habitats (Rendón et al., 2008).

Overall, all three locations showed a decline in population, although at different rates and patterns. The

most drastic decline occurred in water bodies, while open and closed vegetation experienced a slower decline. Changes in temperature, rainfall patterns, or other environmental conditions can alter the availability of natural resources needed by species to survive. Human disturbances such as poaching, pollution, or land-use changes can put pressure on populations living in these three habitats. As noted by Adhikari et al. (2019), human settlements can disrupt bird populations, making humans a threat to waterbirds, which can affect population numbers and the diversity of waterbird species.

Abundance and Density of Waterbird Species

The species abundance index in the water body area shows that the dominant species are *Irediparra galinacea* (23.2), *Gallinula chloropus* (13.4), *Gallinula tenebrosa* (12.3), and *Anhinga melanogaster* (6.2), while *Egretta alba* (5.5), *Merops philippinus*, and *Ardea purpurea* (5.4) are also present. Other species have values below 5.0. In open vegetation, the dominant species are still *Irediparra galinacea* with a percentage of (28.9), *Gallinula tenebrosa* (13.3), *Gallinula chloropus* (11.9), *Egretta garzetta* (8.0), *Anas gibberifrons* (6.9), *Ardeola speciosa* (6.1), *Ardea purpurea* (5.9), and *Egretta alba* (5.9), while other species have a percentage below 4.0. In closed vegetation, the values differ from the two vegetation types, with *Ixobrychus flavicollis* having the highest percentage at 34.7, followed by *Ixobrychus sinensis* at 27.0, *Merops philippinus* at 17.9, *Ardea purpurea* at 7.1%, while *Ardeola speciosa*, *Egretta garzetta*, *Egretta alba*, *Porzana cinerea*, and *Anhinga melanogaster* have percentages below 5.0%. Abundance values can be seen in the table 2.

From these three areas, it can be seen that the only difference between the vegetation between the water body and the open vegetation is one species, *Amaurornis phoenicurus*, which is only found in the water body and not in the open vegetation, even though its percentage is relatively low. In the closed vegetation, there are only seven species with high abundance values. This is because the bird species found in the closed vegetation have high probability and mobility, enabling them to reach the closed vegetation despite it being densely covered by *Pandanus helicopus* plants. The species found in water bodies and open vegetation are dominated by marsh birds such as *Irediparra galinacea* and *Gallinula chloropus* because these species have limited ability to fly and reach closed vegetation, so they do not use closed vegetation as an area for daily activities. According to Ramadhani et al. (2022), areas with small sizes result in high levels of bird species richness and abundance.

Table 2. Abundance of bird Species at Observation Sites

Famili	Name	Scientific Name	Abundance (%)		
			BA	VT	VTP
Ardeidae	Black bittern	<i>Ixobrychus flavicollis</i>	1.2	1.4	34.7
	Yellow bittern	<i>Ixobrychus sinensis</i>	0.2	2.5	27.0
	Javan pond heron	<i>Ardeola speciosa</i>	4.1	6.1	4.1
	Little egret	<i>Egretta garzetta</i>	4.4	8.0	2.0
	Great egret	<i>Egretta alba</i>	5.5	5.9	4.1
	Grey heron	<i>Ardea purpurea</i>	5.4	5.9	7.1
Rallidae	Purple heron	<i>Gallinula chloropus</i>	13.4	11.9	0.0
	Common moorhen	<i>Gallinula tenebrosa</i>	12.4	13.3	0.0
	Dusky moorhen	<i>Amaurornis phoenicurus</i>	0.4	0.0	0.0
	White-breasted waterhen	<i>Porzana cinerea</i>	2.0	2.0	0.5
Anatidae	White-browed Crake	<i>Anas Gibberifrons</i>	7.3	6.9	0.0
Phalacrocoracidae	Sunda teal	<i>Phalacrocorax melanoleucos</i>	4.7	3.7	0.0
	Little pied cotmorant	<i>Phalacrocorax sulcirostris</i>	4.1	2.5	1.0
Meropidae	Great cotmorant	<i>Merops philippinus</i>	5.4	0.0	17.9
Anhingidae	Blue tailed bee eater	<i>Anhinga melanogaster</i>	6.2	0.9	0.0
Jacaniidae	Oriental darter	<i>Irediparra galinacea</i>	23.2	28.9	0.0
Pelecanidae	Dusky moorhen	<i>Pelecanus conspicillatus</i>	0	0.1	0.0

Description: BA (Water body) VT, (Open vegetation), VTP (Closed vegetation)

Bird species abundance is the total number of individuals that provide an overview of the composition of a community (Facrul, 2006). A habitat is considered good if it is supported by the stability of a population community.

The number of waterbirds based on estimates from the three study areas was 2,702 individuals from the three sampling locations, which appeared to be evenly distributed. There were 1,124 individuals/0.215 ha in the water body, while the closed vegetation had the lowest percentage with 196 individuals/0.037 ha.

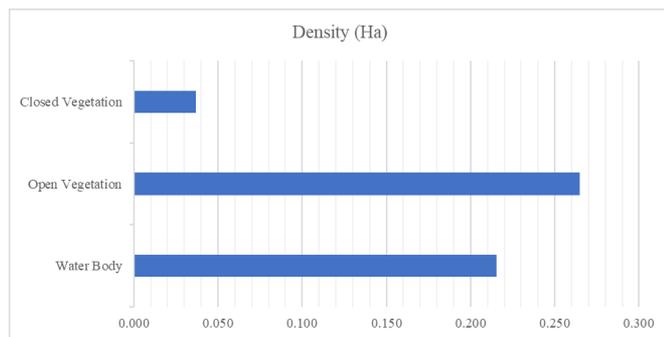


Figure 3. Average population density in each observation area

The density value of waterbird species in the wetland ecosystem area of Rawa Aopa Watumohai National Park has just been determined, making this density value one of the references for information. However, when compared to the research conducted by Sutopo (2017) in Gresik Regency, the population density in that area was 111. This result is better because the intensity of disturbance in the mudflat area is low, so it is likely still safe for waterbirds to forage and rest. In another study conducted by Ma (2012) at Fife Park

(United Kingdom) using radar-based counting methods, the population of waterbirds in the area was found to be 19,253 individuals, with a population density of 987 individuals/km². Thus, the population density in the study area is relatively low due to human activities (fishing) in the area, which affect the waterbird population. Additionally, the boats used by fishermen are a contributing factor, as they produce loud noises, leading to a low population density in the study area. The following figure shows the average density for each study area.

Feed Potential

Observations conducted in the Aopa Swamp ecosystem of the Aopa Watumohai National Park found 14 types of water bird feed from 4 classes, including Insketa, Pisces, Gastropoda, and Malacostraca. The total number of feed was 418 individuals, divided among each observation area. The observation areas were categorized based on vegetation type, including open vegetation (VT), closed vegetation (VTP), and water bodies (BA). Among these three areas, only the open vegetation area contained all 14 types of waterbird feed, while the water body area had 11 types of feed and the closed vegetation area had 13 types of feed. Based on class, there were 5 species from the insect class, 5 species from the fish class, 3 species from the gastropod class, and 1 species from the crustacean class. The types of food can be seen in the table 3.

Based on observations of the number of individuals from the three different types of vegetation, the Insecta class was more dominant in water bodies and open vegetation, with 174 individuals out of a total of 418 found, while the Pisces class had five species, with

Monopterus albus being the most dominant across all locations, with 54 individuals. The Gastropoda class also had 3 species spread across the three areas and had 76 individuals, while the Malacostraca class had only 1 species, *Paranephrops plabifrons*. Although there was only 1 species, it had a very high number of individuals, with 56 individuals spread evenly across all observation

locations. According to Colwell et al. (1993) and (Zou et al. (2017), differences in the dominance of food types can influence the distribution and habits of waterbird species. Food availability is often considered one of the main factors influencing bird distribution patterns (Strong et al., 2000). Additionally, food availability can influence bird diversity (Putri, 2015).

Table 3. Classes and Types of Waterfowl Feed

Class	Local Name	Type	Location			Total
			BA	VT	VTP	
Insekta	Pond skater	<i>Gerris marginatus</i>	15	23	0	38
	Water bug	<i>Belastoma lutarium</i>	25	12	3	40
	Dragonfly larvae	<i>Dragonfly larvae</i>	38	9	2	49
	Water scorpion	<i>Nepa cinerea</i>	12	18	1	31
Pisces	Flowerhorn cichlid		7	3	6	16
	Asian swamp eel	<i>Monopterus albus</i>	27	15	12	54
	Nile tilapia	<i>Orheochromis niloticus</i>	12	23	1	36
	Striped snakehead	<i>Channa striatus</i>	0	1	4	5
Gastropoda	Mozambique tilapia	<i>Oreochromis mossambicus</i>	0	4	1	5
	Three-spot gourami	<i>Trichogaster trichopterus</i>	6	5	1	12
	Freshwater snail	<i>Pila ampullacea</i>	17	3	5	25
Malacostraca	Golden apple snail	<i>Pomacea canaliculata</i> L	23	11	3	37
	Freshwater snail	<i>Stenomelania crenulata</i>	0	12	2	14
	Freshwater crayfish	<i>Paranephrops plabifrons</i>	17	20	19	56
Total			199	159	60	418

Description: BA (Water Body), VT (Open Vegetation), VTP (Vegetation)

From the three observation sites, there were differences in the number of species and individuals of each food source for waterbirds. This is one of the factors that influence the distribution and feeding habits of waterbird species at the study site, which is consistent with what was reported by Colwell et al. (1993). Additionally, differences in vegetation are also a major factor for waterbirds in foraging. It is observed that in dense vegetation, bird sightings are very rare. This occurs because the vegetation in that area is so dense that it does not allow certain bird species to forage effectively (Makkatenni et al., 2023).

Food Diversity and Evenness Index

The main component of the habitat for every living creature is food. The main food sources for waterbirds include invertebrates and aquatic plants (Bibby et al., 1993), so waterbirds in wetland ecosystems are highly dependent on food. The results of the food analysis, calculated using the diversity index (H'), show moderate diversity (2.277) in open vegetation and water bodies (2.412), while closed vegetation shows relatively low diversity (0.139), while evenness (E') showed significant differences in water bodies (0.86), with open vegetation and closed vegetation showing low evenness (0.06). The following figure shows the diversity and evenness indices of food types. Elfidasari (2010) explains that the main food source for resident bird groups, especially

those from the Ardeidae family, is generally fish, although there is a chance of preying on crustaceans, particularly crabs. However, waterbird groups, especially herons, tend to prefer fish, while marsh birds and ducks tend to prefer insects and gastropods (Santya et al., 2024).

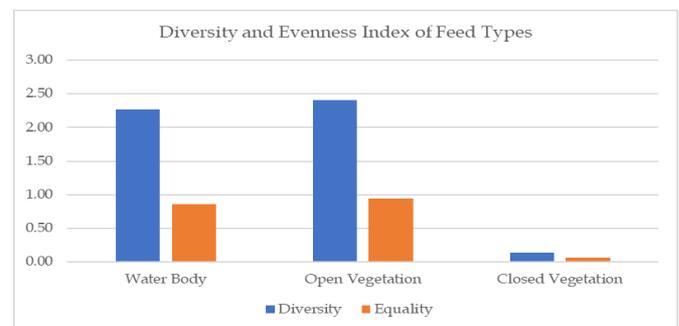


Figure 4. Feed diversity index

From these three locations, it can be seen that water birds are more dominant in water bodies and open vegetation because water birds prefer open areas with high food potential. Therefore, closed vegetation is rarely used by water birds for feeding and playing, even though closed vegetation is not used for feeding and playing, they are used for nesting. This is evidenced by the numerous abandoned nests found in closed vegetation, which aligns with the findings of Liodors (2010) and Hassan-Aboushiba et al. (2011), who noted

that the presence of birds in a habitat is regulated according to body size proportions, leg length, beak length, and eye size. According to Rajpar et al. (2011), waterbirds divide habitat use (abundance, spatial distribution) influenced by factors such as temperature, humidity, and vegetation composition, consistent with Shoo et al. (2005), who noted that most bird community habitats change seasonally due to resource availability for food, temperature, and water. This is also explained in the study by Burger et al (1997), which states that waterbirds will respond to changes in foraging space availability by moving from one area to another.

Abundance and Density Index of Feed Types

The abundance and density indices of feed types found in the three sampling areas show relatively similar values, with an abundance value of 0.07. However, this is inversely proportional because each observation area has different relative values: 0.05 for water bodies, 0.04 for open vegetation, and 0.01 for closed vegetation. Although the diversity and evenness values differ, the abundance index in the three areas is similar because the foraging results in the three areas are similar (Fabrina et al., 2022). However, what distinguishes them is the level of activity of waterbirds, which always use water bodies and open vegetation.

Table 4. Index of Feed Abundance

Class	Local Name	Type	Location		
			BA (%)	VT (%)	VTP (%)
Insekta	Pond skater	<i>Gerris marginatus</i>	7.54	14.47	0.00
	Water bug	<i>Belastoma lutarium</i>	12.56	7.55	0.00
	Dragonfly larvae	<i>Dragonfly larvae</i>	19.10	5.66	0.00
	Water scorpion	<i>Nepa cinerea</i>	6.03	11.32	0.00
Pisces	Flowerhorn cichlid		3.52	1.89	11.11
	Asian swamp eel	<i>Monopterus albus</i>	13.57	9.43	22.22
	Nile tilapia	<i>Orheochromis niloticus</i>	6.03	14.47	1.85
	Striped snakehead	<i>Channa striatus</i>	0.00	0.63	7.41
	Mozambique tilapia	<i>Oreochromis mossambicus</i>	0.00	2.52	1.85
	Three-spot gourami	<i>Trichogaster trichopterus</i>	3.02	3.14	1.85
Gastropoda	Freshwater snail	<i>Pila ampullacea</i>	8.54	1.89	9.26
	Golden apple snail	<i>Pomacea canaliculata</i> L	11.56	6.92	5.56
	Freshwater snail	<i>Stenomelania crenulata</i>	0.00	7.55	3.70
Malacostraca	Freshwater crayfish	<i>Paranephrops plabifrons</i>	8.54	12.58	35.19

The Abundance Index of feed types (Table 4) found in the 3 sampling areas shows that the highest relative abundance is the insect type (dragonfly larvae) of 19.10% in water bodies, the insect type *Gerris marginatus* and the pisces *orheochromis niloticus* type of 14.47% in open vegetation and the Malacostraca *Paranephrops plabifrons* type of 35.19% in closed vegetation. According to Hadris et al. (2024), Dragonflies live close to freshwater habitats, this is because dragonflies spend most of their lives as nymphs in fresh water. The life cycle of dragonflies, nymphs (larvae) will be at the bottom of the water in the water during their life. The main predators of dragonfly larvae are birds (Vatandoost, 2021), so the water body area is a potential foraging area for several types of insect-eating water birds. According to Juliantara et al. (2017), Anggang-anggang are long-legged insects that live on the surface of the water and are predators of small insects such as aerial insects, so that water areas with little vegetation (open vegetation) become places to find prey for these insects. Likewise, tilapia fish also look for insects so they tend to prefer areas with little vegetation. The abundance of anggang-anggang and tilapia insect

species in open vegetation makes it a potential area for water birds to find food, especially insectivorous and fish-eating species. Freshwater lobsters can inhabit stagnant or flowing water areas, namely in swamps, lakes, and rivers that have places to take shelter (Widigdo et al., 2020), so that closed vegetation is an ideal habitat for freshwater lobsters. Although closed vegetation is a potential habitat due to the abundance of freshwater lobsters, only a few water birds use it as a source of food (See Table 4).

The number of feed individuals based on the estimation results from the three study areas, there were 402 individuals from the three sampling locations, it can be seen that the average density of the water bird population in the water body is 11 species of 199 individuals/0.05 Ha. In open vegetation there are 14 species and 159 individuals/0.4 Ha, while in closed vegetation it has the lowest percentage with 10 species and 59 individuals/0.01 Ha. The density value of water bird species in the swamp ecosystem area in the Rawa Aopa Watumohai National Park has just been carried out so that the density value becomes one of the

references as information and reference material for water bird conservation efforts in the area.

Table 5. Density Index of Feed Types

Class	Local Name	Type	Location		
			BA (ind/ha)	VT (ind/ha)	VTP (ind/ha)
Insekta	Pond skater	<i>Gerris marginatus</i>	4.78	7.32	0.00
	Water bug	<i>Belastoma lutarium</i>	7.96	3.82	0.00
	Dragonfly larvae	<i>Dragonfly larvae</i>	12.10	2.87	0.00
	Water scorpion	<i>Nepa cinerea</i>	3.82	5.73	0.00
Pisces	Flowerhorn cichlid		2.23	0.96	1.91
	Asian swamp eel	<i>Monopterus albus</i>	8.60	4.78	3.82
	Nile tilapia	<i>Orheochromis niloticus</i>	3.82	7.32	0.32
	Striped snakehead	<i>Channa striatus</i>	0.00	0.32	1.27
	Mozambique tilapia	<i>Oreochromis mossambicus</i>	0.00	1.27	0.32
Gastropoda	Three-spot gourami	<i>Trichogaster trichopterus</i>	1.91	1.59	0.32
	Freshwater snail	<i>Pila ampullacea</i>	5.41	0.96	1.59
	Golden apple snail	<i>Pomacea canaliculata</i> L	7.32	3.50	0.96
Malacostraca	Freshwater snail	<i>Stenomelania crenulata</i>	0.00	3.82	0.64
	Freshwater crayfish	<i>Paranephrops plabifrons</i>	5.41	6.37	6.05
Total			63.38	50.64	17.20

The Density Index of feed species (Table 5) found in 3 sampling areas shows that the density of species in open vegetation is 63.38 ind/ha, open vegetation 50.64 ind/ha and closed vegetation 17.20 ind/ha. The high density of feed in the water body area and open vegetation is not only caused by the diversity of feed species, but is also likely caused by the organic material content of both vegetation types. The density of macrozoobenthos is caused by the organic material content of the substrate at the observation station (Sidik et al. 2016; Santya et al. 2023). The good density of feed species in water bodies and open vegetation makes it a potential area for the diversity of waterbirds in the TNRAW Area.

Based on the type of potential feed for waterbird groups, they are divided into groups of merandai, ducks, swamps, and migrants. The grouping is to see the potential for bird feed in the study area. Grouping of Potential feed resources for waterbird groups in pisces and macrozoobenthos species can be seen in Table 5.

Potential Feed Resources for Water Bird Groups

Based on the type of potential feed, water bird groups are divided into several groups, including merandai, ducks, swamps, and migrants. The grouping is to see the potential for bird feed in the study area. Grouping of potential feed resources for water bird groups in pisces and macrozoobenthos species can be seen in the table 7.

Table 6. Potential Food of Water Bird Groups

Type Group	Water Bird Species	Eating Potential			
		1	2	3	4
Group merandai	<i>Ixobrychus flavicollis</i>	**	*	-	-
	<i>Ixobrychus sinensis</i>	***	*	-	-
	<i>Ardeola speciosa</i>	*	*	*	*
	<i>Egretta alba</i>	*	***	*	*
	<i>Egretta garzetta</i>	*	**	-	*
	<i>Ardea purpurea</i>	-	***	-	*
Group duck	<i>Anas gibberifrons</i>	*	**	**	-
	<i>Phalacrocorax melanoleucos</i>	-	**	-	-
	<i>Phalacrocorax sulcirostris</i>	-	**	-	-
	<i>Gallinula chloropus</i>	**	*	**	-
Group swamp	<i>Gallinula tenebrosa</i>	**	*	**	-
	<i>Amaurornis phoenicurus</i>	***	*	*	-
	<i>Porzana cinerea</i>	***	*	-	-
	<i>Merops philippinus</i>	**	-	-	-
	<i>Anhinga melanogaster</i>	-	***	-	*
	<i>Irediparra galinacea</i>	***	*	-	-
	Group migrant	<i>Pelecanus conspicillatus</i>	-	***	-

Description: 1 (Insecta), 2 (Pisces), 3 (Gastropoda), 4 (Malacostraca)*** (Eat More), ** (Moderate), * (Little), - (Does Not Eat)

There are six species of magpie robins, including *Ixobrychus flavicollis*, *Ixobrychus sinensis*, *Ardeola speciosa*, *Egretta alba*, *Egretta garzetta*, and *Ardea purpurea*. The feeding potential of magpie robins varies. Some species, such as *Ixobrychus sinensis* and *Egretta garzetta*, have high feeding potential (denoted by ***), especially on insect-type foods, but these species do not eat Malacostraca food. *Ardea purpurea* tends to eat more Pisces, but avoids insects and malacostraca.

Species included in the duck group are *Anas gibberifrons*, *Phalacrocorax melanoleucos*, and *Phalacrocorax sulcirostris*. *Anas gibberifrons* has an even feeding potential, eating insects, pisces, and gastropods with moderate to high intensity, but does not eat malacostraca. The species *Phalacrocorax melanoleucos* and *Phalacrocorax sulcirostris* have a lower tendency in terms of feeding, with only the potential to eat Pisces.

The marsh birds consist of several species such as *Gallinula chloropus*, *Gallinula tenebrosa*, *Amaurornis phoenicurus*, *Porzana cinerea*, *Merops philippinus*, *Anhinga melanogaster*, and *Irediparra gallinacea*. *Amaurornis phoenicurus* and *Porzana cinerea* are the species with the highest feeding potential in this group, especially against insects, pisces, and gastropods. Several other species, such as *Gallinula chloropus* and *Gallinula tenebrosa*, feed with moderate intensity mainly on insects and pisces. *Merops philippinus* only eats insects, without consuming other food sources.

The migratory bird species mentioned is *Pelecanus conspicillatus*. This species focuses more on pisces as its main food source, and does not consume other types of food. The results of this analysis show variations in feeding potential based on the type of waterbird and the category of food available. Waterfowl and marsh birds tend to be more diverse in their diets, while ducks and migratory birds are more focused on certain types of food, according to Butler's research (1992). The availability of food sources in an area greatly affects the survival of waterbirds (Soendjoto, 2018). The types of waterbird food vary widely, such as fish, amphibians, reptiles, crustaceans and aquatic and terrestrial invertebrates. Food abundance can affect the population dynamics, survival, and behavior of individual waterbirds. According to Jumilawaty (2012), the variation in the number of individuals and species of waterbirds at each location is largely determined by the situation and conditions such as area size, connections between foraging. This data can be used to understand the ecological interactions between waterbird species and the food resources available in their environment. This information is also important in conservation efforts because it can provide an overview of the food resources needed to maintain waterbird populations in their habitat (Saeni et al., 2022).

Conclusion

This study shows that the aquatic bird feed in the study area consists of 14 species from four main classes, namely Insecta, Pisces, Gastropoda, and Malacostraca. Diversity analysis (H') indicates that open vegetation areas (2.277) and water bodies (2.412) have moderate diversity, while closed vegetation has relatively low

diversity (0.139). The evenness index (E') shows a more even distribution in water bodies (0.86), while in open vegetation and closed vegetation the value is low (0.06). Meanwhile, the highest feed density index was found in open vegetation (63.38 ind/ha), followed by water bodies (50.64 ind/ha), and the lowest in closed vegetation (17.20 ind/ha). Overall, these results confirm that open vegetation and water body habitats play a more important role in supporting the availability and distribution of water bird food sources than closed vegetation habitats.

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Author Contributions

Conceptualization, M. I, J. B. H., and L. B. P.; methodology, M. I, J. B. H., and L. B. P.; validation, M. I; formal analysis, M. I; investigation, M. I; resources, M. I; data curation, M. I.; writing-original draft preparation, M. I; writing - review and editing, M. I; visualization, M. I; supervision, J. B. H and L. B. P. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The author declares no conflict of interest in this research.

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