

2023 EAAFP Small Grant Fund (WG/TF) Final Report



SUMATRAN SHOREBIRD RESEARCH AND CONSERVATION PROJECT -
“MONITORING AND HABITAT ASSESSMENT FOR MIGRATORY SHOREBIRDS IN
IMPORTANT INTERTIDAL LANDSCAPES ON THE EASTERN COAST OF NORTH
SUMATRA PROVINCE (SUJONO INTERTIDAL LANDSCAPE), INDONESIA”.

CHAIRUNAS ADHA PUTRA

DATE OF SUBMISSION (30/06/2024)

WILD HERITAGE OF SUMATRA (WHIS) FOUNDATION
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Section 1. Project Overview – This report will be shared on EAAFP website.

1.1 BACKGROUND

Please give a brief and background of your project:

The Sumatran Shorebird Research and Conservation Project aims to enhance the management and conservation of critical migratory shorebird sites along the eastern coast of northern Sumatra (Aceh and North Sumatra Provinces), with sustained community and governmental engagement. This project is structured across three phases: During Phase 1 (2018-2021), a comprehensive fieldwork successfully identified key conservation sites across the eastern coast of Aceh and North Sumatra Provinces. This phase, supported by the EAAFP Small Grant 2019, also focused on gathering data regarding illegal hunting, local socio-economic conditions, and threats to wetland habitats at various sites including Ulee Matang Village in Aceh Province, Bagan Percut in Deli Serdang District, Sujono intertidal landscape in Batubara District, and Leidong intertidal landscape in Labuhan Batu Utara, North Sumatra Province.

Results from the 2018-2021 surveys in Batubara District (referred to as the "Sujono Intertidal Landscape") revealed significant populations of migratory shorebirds, ranging from 37,000 to 45,000 individuals. Notably, globally threatened species such as Nordmann's Greenshank (*Tringa guttifer*), Great Knot (*Calidris tenuirostris*), Far Eastern Curlew (*Numenius madagascariensis*), and Milky Stork (*Mycteria cinerea*) were observed across key sites including Kresek Beach, Sujono Beach, Datuk Nature Tourism Beach, Sejarah Beach, and Bunga Beach. Several of these sites were identified as important wintering habitats, supporting more than 1% of the EAAF population for various conservation priority species such as Nordmann's Greenshank (Putra *et al.*, 2021), Great Knot, Asian Dowitcher (*Limnodromus semipalmatus*), Black-tailed Godwit (*Limosa limosa*), Eurasian Curlew (*Numenius arquata*), Common Redshank (*Tringa totanus*), Lesser Sandplover (*Charadrius mongolus*), Grey-headed Lapwing (Putra & Hikmatullah, 2020), and the highest count of 167 resident Milky Storks (Putra & Hikmatullah, 2019). Additionally, the first recorded sighting of the Near Threatened Eurasian Oystercatcher (*Haematopus ostralegus*) in Indonesia was documented (Putra *et al.*, 2018).

Moving into Phase 2 (2021-2023), efforts have focused on empowering local government at the village level to take proactive measures and lead in establishing regulations for the protection of migratory shorebirds. Notably, four village regulations have been successfully enacted in the Sujono Landscape (Durian, Pematang Nibung, Lalang, and Gambus Laut Village). These sessions covered topics such as migratory shorebirds, Indonesian species protection laws, opportunities for community involvement as conservation cadres or forest ranger partners, and the crucial role of protected mangrove forests for both human communities and shorebirds. Future plans include the establishment of monitoring schemes and patrol teams within these villages.

As part of Phase-II Project that supported by EAAFP Small Grant Fund 2023/2024:

our objective focuses on conducting in-depth research on population trends and foraging ecology of migratory shorebirds in identified critical sites, particularly within the Sujono Intertidal Landscape in North Sumatra Province. This research aims to inform proposals for future inclusion in international conservation frameworks such as Flyway Site Networks, Ramsar listings, or other conservation schemes in collaboration with governmental agencies.

A. Describe about your organization by filling out the table below:

| | |
|--|------------------------|
| Type of the organization - Government/NGO/Private Sector/Other | NGO |
| Name(s) of the division and/or position | Principal Investigator |



List any contributions that your organizations or yourself might have been involved for the preservation of the migratory waterbirds, their habitats and East – Asian Australasian Flyway below.

- We identify four key sites (i.e Ulee Matang Village, Bagan Percut coastline, Sujono coastline, and Leidong coastline) for migratory shorebirds, with a focus on globally threatened species such as Nordmann's Greenshank, Great Knot, Far Eastern Curlew, and Asian Dowitcher in Northern Sumatra (Aceh and North Sumatra Province). These efforts aimed to support shorebird conservation by potentially designating the identified areas as protected sites under Ramsar, Flyway Site Network, Essential Ecosystem Areas, or other national/provincial-level frameworks like Biodiversity Parks. Our work also included gathering crucial data on illegal hunting, local socio-economic conditions, and habitat threats.

- We successfully enacted village regulations in four villages within the Sujono coastline/Landscape (i.e Durian, Pematang Nibung, Lalang, and Gambus Laut Village). Workshops held during this period engaged 139 participants including village heads, legislative bodies, youth leaders, traditional and religious leaders, and local communities. The workshops focused on raising awareness about migratory shorebirds, Indonesian species protection regulations, fostering partnerships for conservation roles like forest rangers, and emphasizing the importance of protected mangrove forests for both shorebirds and human communities.

- We conducted conservation awareness activities targeted local youth and the broader community, reaching 180 students and 19 teachers across three elementary schools with information about migratory shorebirds, endangered species, and species protection. Additionally, over 500 visitors of all ages and backgrounds enhanced their understanding of these topics through birdwatching activities at Sejarah Beach. Key stakeholders such as PT. Indonesia Asahan Aluminium (Persero) and the Military District Commander 0208/Asahan branch were also briefed on migratory shorebirds and village regulations concerning their protection in the Batubara coastal area. Educational outreach included the production and distribution of 50 awareness posters, 250 school calendars for 2022, and 200 community calendars for 2023 featuring species protection regulations. Furthermore, conservation boards were established at two locations within the Sujono Landscape, namely Sujono Beach and Sejarah Beach.

- We published a scientific paper on Nordmann's Greenshank, affirming it as a crucial non-breeding area for the species in North Sumatra. This effort provides scientific evidence of the importance of the location for conservation initiatives priorities.

Link to paper work;

https://www.researchgate.net/publication/348918437_Identifying_priority_shorebird_sites_for_conservation_on_the_East_Coast_of_Aceh?_sg%5B0%5D=oWjkOqlv-Ri8Kiv1oMNPcJv2OBnZdb3PpPxxqpbQFdiBzl4qMyfhHOq6lwc2Pk-bfpRUSStFOEOEyr04vVW4tPHSy8vWNhxfasXXj0KG.z7kqx2eg0yki2uHGyHtPzZTV8fLlxzmqM1UMrko9NO_zOjnjN2ZYI_83SoJbWUOyh1jskltk98xQBKDPah4Vyg&_tp=eyJjb250ZXh0Ijp7ImZpcnN0UGFnZSI6InByb2ZpbGUlLCJwYWdlIjoicHJvZmlsZSI6bnVbnRlbnQifX0

https://www.researchgate.net/publication/332411490_Spoon-billed_Sandpiper_a_new_species_for_Indonesia

https://www.researchgate.net/publication/353900977_2021_Wader_Study_Putra_et_al_North_Sumatra_is_an_internationally_significant_region_for_non-breeding_Nordmanns_Greenshank_Supplementpdf

Link to the activities ;

<https://www.youtube.com/watch?v=8IJYImu7FP8&t=32s>



<https://www.youtube.com/watch?v=rQ6WHWjSeGk>

B. Provide a brief abstract summary of your project. In the summary, please include its objective and its location (Name of Place, City and Country), and explain the significance and relations of the species and its location (in link with [EAAF Key Species](#) and [Flyway Network Site](#)) for your project.

Over a one-year monitoring period, the results indicate that shorebird counts ranged from 26 to 10,911 birds at Sujono, 89 to 12,956 birds at Sejarah, and 88 to 13,976 birds at Kresek Beach, located on the eastern coast of Batubara District in North Sumatra Province. These counts included 26 different species from the families Charadriidae and Scolopacidae, such as the Grey-headed Lapwing, Nordmann's Greenshank, Eurasian Curlew, Far Eastern Curlew, Great Knot, Asian Dowitcher, Black-tailed Godwit, Terek Sandpiper, Curlew Sandpiper, Broad-billed Sandpiper, Common Redshank, Sanderling, Ruddy Turnstone, and Red Knot. The shorebird populations at all sites were low between May and August, increased from September to December and January, and then gradually decreased from February to April. This trend was consistent across the three observation sites. The highest populations, exceeding 10,000 birds, were recorded in December at Sejarah and Kresek Beach, and in January at Sujono.

The diversity of macrozoobenthos at Sujono Beach, Sejarah Beach, and Bunga Beach includes three phyla, six classes, and 28 species. The abundance of macrozoobenthos is 2,459 ind/m³ at Sujono Beach, 1,525 ind/m³ at Sejarah Beach, and 1,218 ind/m³ at Bunga Beach. The species richness index and diversity index fall into the moderate category, while the evenness index is high, indicating no dominating species. The substrate texture is sandy loam at Sujono Beach and loam at Sejarah Beach and Bunga Beach. The diversity and abundance of shorebirds are related to the availability of macrozoobenthos as a food source, Humans also use several makrozoobenthos (oyster, etc) for food, highlighting the importance of these areas for both wildlife and human conservation efforts. These findings support the designation of Sujono Intertidal Landscape as a new Flyway Network Site or Ramsar Site in Indonesia.

1.2 DETAILS

Please provide a project description of the following:

- A. **Detailed Project Progress:** Describe about process of your project, including methodologies, field work, interview, conference, etc. Please include analysis of your process, if applicable. (Any visual data, including maps, graphs, tables, photos, etc. are strongly preferred).

Monthly shorebirds count start from May 2023 to April 2024; Shorebird counts were conducted at three specific locations: Sujono Beach, Kresek Beach, and Sejarah Beach, identified as significant sites based on our previous 2019-2020 survey which recorded more than 5,000 birds (**Figure 1**). Monthly data collection included species identification, population size estimation for each species, and observations of leg-flagged shorebirds through visual surveys. Access to optimal survey points, particularly at Kresek Beach, was facilitated by boat. Counts were primarily conducted during low tide, with supplementary observations during falling tide, rising tide, and high tide, particularly at high-tide roost sites. Observers, equipped with spotting scopes, tripods, and binoculars, typically worked in teams of two or three. For large flocks, a block-counting method was employed, while individual counting was performed whenever feasible. The surveyed area covering 336 ha of intertidal mudflat at Kresek (3°24'12.17"N 99°23'9.63"E), Sujono 129 ha (3°23'21.78"N 99°25'16.54"E) and Sejarah 72.9 ha (3°15'56.72"N 99°31'52.41"E). We followed Eaton *et al.* 2021 "*Bird of Indonesian Archipelago: Greater Sunda and Wallacea*" for bird names. We followed Wetlands International (2024) to assess 1% of EAAF population.

Reff; Eaton, J.A., Bas van Balen, N.W. Brickle & F.E. Rheindt. 2021. *Birds of the Indonesian Archipelago. Greater Sundas and Wallacea*. Lynx Edicions. Barcelona.



Figure 1. Monitoring and habitat assessment location in North Sumatra, Indonesia.

Food sources/benthos assessment; Sampling was conducted in December 2023, followed by sample identification from January to February 2024. Locations for sampling were chosen using purposive sampling based on the distribution of the largest or most abundant bird populations, categorized into three phases: (i) mid ebb tide, approximately three hours before low tide with a parallel current; (ii) late ebb tide, roughly 90 minutes before low tide as the current begins to recede; and (iii) low ebb tide, during the final receding current. Each location underwent sampling at three points, repeated three times. Equipment utilized included Surber nets, a cool box, GPS, digital camera, 10 kg plastic bags, 5 ml syringes, alcohol bottles, laminated graph paper, permanent markers, tweezers, a work board, and writing tools. Materials employed were 70% alcohol, Lugol's solution, label paper, and rolled tissues.

Sampling operations were divided into two teams: one comprising two individuals for sample collection on the mudflat, and another of three persons for sorting, preparing samples, and documentation. The sampling process unfolded in sequential stages:

1. Scraping of the bottom substrate to a depth of ± 10 cm using a modified Surber net (30x30x30cm), with three repetitions.
2. Sorting of captured macrozoobenthos using tweezers and documenting findings on laminated paper.
3. Placement of documented samples into designated bottles based on taxa (various Phyla/Classes).
4. Preservation of each sample in 70% alcohol and staining with Lugol's solution.
5. Transporting samples in a cool box filled with ice for laboratory identification.
6. Laboratory identification of samples to species or genus levels, with specific documentation.
7. Preservation of identified samples as specimens using formalin for future reference and further identification.



Data Analysis

The data analysis conducted includes population abundance, species richness index (R), Shannon-Wiener Diversity Index (H'), Species Evenness Index, and Dominance Index.

Population abundance of macrozoobenthos

Population abundance describes the number of individuals occupying a certain area, calculated using the formula:

$$K = \frac{\text{The number of individuals of a species.}}{\text{Total area of Surber ner}}$$

Species Richness Index

Species richness index can describe the species richness at a research location.

$$R = \frac{S-1}{\ln N}$$

Note:

- R = Indeks of species richness
- S = Total number of species
- N = The total number of individuals of all species.

Description value R:

- R < 3,0 = Low species richness
- 3,0 – 5 = Moderate species richness
- R > 5 = High species richness

Diversity Index/Shannon – Wiener (H')

The Shannon-Wiener Diversity Index analysis can depict the diversity level of a species within the overall species present, thereby revealing dominant species in the study.

$$H' = - \sum pi \ln pi$$

Note:

- H' = Indeks of diversity Shannon – Wiener
- Pi = the proporsion of spesies
- ln = logaritma Nature
- pi = $\sum ni / N$ (The calculation of the total number of individuals of all species)

Description value H:

- 0 < H' < 1 = Low diversity
- 1 < H' < 3 = Moderate diversity
- H' > 3 = High diversity

Eveness Index

The Eveness Index can describe the evenness of a species within the overall observation area.

$$E = \frac{H'}{\ln S}$$

Note:

- E = Indeks of eveness
- H' = Indeks of diversity



S = Total of species

Description value E:

$0 \leq E \leq 0,4$ = Low e

$0,4 \leq E \leq 0,6$ = Moderate

$E \geq 0,6$ = High

Dominance Index

The Dominance Index describes the dominance of a species over all species in the observation location

$$D = \sum \left(\frac{n_i}{N} \right)^2$$

Note: D = Indeks of Dominance.
ni = The total number of individuals of a species.
N = The total number of individuals of all species.

Description value D:

$D < 0,5$ = No species dominate

$D > 0,8$ = Species dominance exist

Environmental physical factors and characteristics of substrate texture assessment: In December 2023, alongside benthos sampling, we conducted assessments of Environmental Physical Factors and Substrate Texture Characteristics. In situ measurements of water temperature and pH were performed for environmental analysis, while substrate characteristics were analyzed in the laboratory, completed by February 2024.

B. **Problems Encountered/Adjustments:** If there were some changes made, please indicate them and explain (ex. unexpected circumstances, sudden cancellation, etc.)

Overall, all activities ran smoothly, and the desired outputs were successfully achieved. We made adjustments to the substrate assessment. Although our initial proposal mentioned measuring salinity, DO, BOD, COD, turbidity, phosphate, and nitrate, we have not yet conducted these measurements and decided to change our approach. Our observations suggest that salinity, BOD, COD, and other environmental factors in aquatic environments may not significantly influence macrozoobenthos at the mudflats. Consequently, we have shifted our focus to investigating physical environmental factors and substrate characteristics.

C. Details on any community education and public awareness activities associated with your project.

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D. Please include any additional supporters of this project.

The project is partially funded by a personal donation of approximately \$500, with the remaining costs covered by WHIS.

1.3 RESULT

Explain and evaluate the outcomes and findings of your project (Any visual data, including maps, graphs, tables, photos, etc. are highly preferred).

A. The trend of shorebirds population at intertidal mudflat of Sujono, Sejarah and Kresek beach May during May 2023 to April 2024.

Over a one-year monitoring period, the results indicate a total shorebird count ranging from 26 to 10,911 birds at Sujono, 89 to 12,956 birds at Sejarah, and 88 to 13,976 birds at Kresek Beach (**Figure 2**). These counts encompass 26 different species from the families Charadriidae and Scolopacidae, including the Grey-headed Lapwing, Pacific Golden Plover, Lesser Sand Plover Eurasian Curlew, Far Eastern Curlew, Great Knot, Asian Dowitcher, Black-tailed Godwit, Terek Sandpiper, Curlew Sandpiper, Broad-billed Sandpiper, Common Redshank, Rufous-necked Stint, Sanderling, Ruddy Turnstone, and Red Knot. Detailed shorebird counts for Sujono, Sejarah, and Kresek are presented in **Tables 1, 2, and 3**.

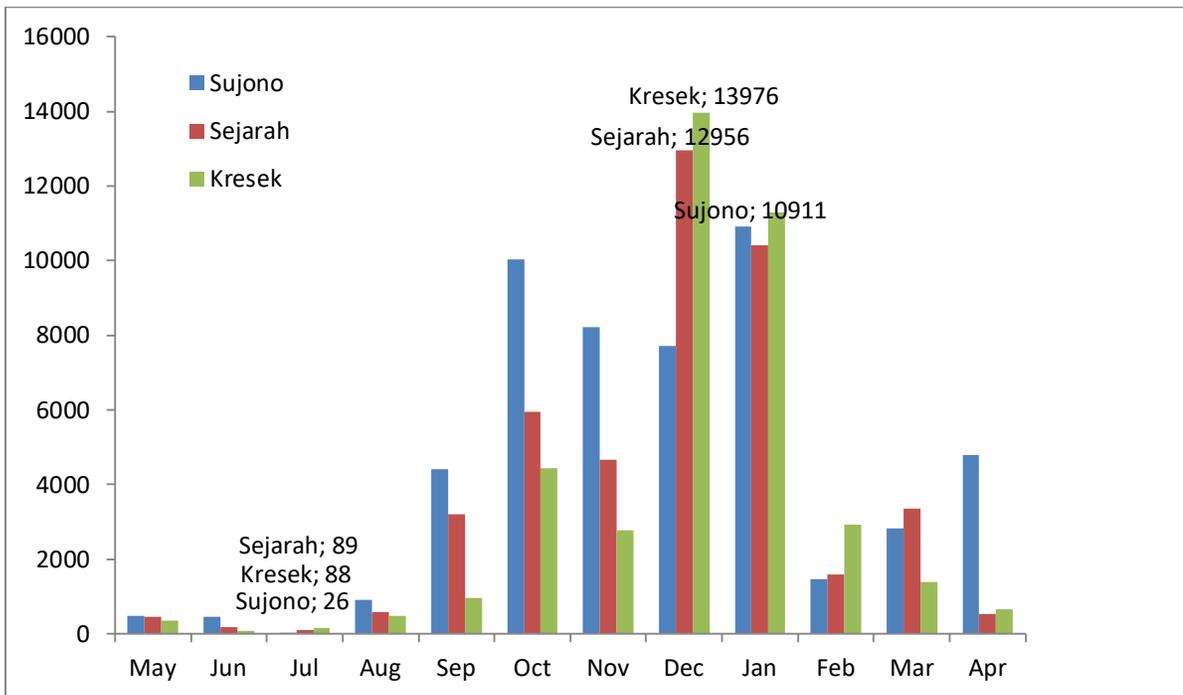


Figure 2. The trend of shorebirds population over one year (May 2023-April 2024) observation in the intertidal mudflat of Sujono, Sejarah and Kresek Beach.

Based on **Figure 2**, the shorebird populations at all sites are low between May and August, increasing from September to December and January. This trend is consistent across the three observation sites. The highest populations, exceeding 10,000 birds, were recorded in December at Sejarah and Kresek Beach, and in January at Sujono. We assume that all the birds have arrived at their wintering locations by December or January, resulting in higher numbers during these months compared to others. The total population then gradually decreases from February until April.



Table 1. The list of waterbird species and their population numbers at Sujono Beach.

| No. | Family | Scientific Names | Year | 2023/2024 | | | | | | | | | | | | |
|-----------------------------|-------------------|----------------------------------|------------------------|--------------|------------|------------|-------------|-------------|--------------|-------------|-------------|--------------|-------------|-------------|-------------|-----|
| | | | | Month | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr |
| | | | | Common Names | | | | | | | | | | | | |
| 1 | Anatidae | <i>Anas bahamensis</i> | White-cheeked Fintail | | | | | | 1 | | | | | | | |
| 2 | Phalacrocoracidae | <i>Phalacrocorax niger</i> | Little Black Cormorant | | 8 | 2 | | | 9 | | 5 | 18 | 4 | | | |
| 3 | Ardeidae | <i>Ardea cinerea</i> | Grey Heron | | 3 | | | | 2 | | 11 | 7 | 1 | | 2 | |
| 4 | | <i>Ardea alba</i> | Great Egret | 129 | 44 | 79 | 81 | 54 | 177 | 477 | 286 | 117 | 42 | 692 | 53 | |
| 5 | | <i>Egretta intermedia</i> | Yellow-billed Egret | | | | | 13 | 4 | 26 | 19 | 34 | 7 | | 12 | |
| 6 | | <i>Egretta garzetta</i> | Little Egret | 48 | 27 | 68 | 40 | 38 | 143 | 188 | 58 | 76 | 21 | 49 | 9 | |
| 7 | | <i>Butorides striata</i> | Striated Heron | 2 | | 1 | 1 | 2 | | 4 | 2 | 7 | | | 2 | |
| 8 | Ciconiidae | <i>Mycteria cinerea</i> | Milky Stork | 16 | 32 | 67 | 39 | | 83 | 58 | 52 | 42 | 15 | 21 | | |
| 9 | Charadriidae | <i>Pluvialis squatarola</i> | Grey Plover | | | | | | 7 | | 1 | 4 | 34 | | 8 | |
| 10 | | <i>Pluvialis fulva</i> | Pacific Golden Plover | | 54 | | | | 119 | 319 | 450 | 927 | 1370 | | 1430 | |
| 11 | | <i>Anarhynchus dealbatus</i> | White-faced Plover | | | | | | | | | 1 | | | | |
| 12 | | <i>Anarhynchus atrifrons</i> | Tibetan Sand Plover | 189 | 82 | 26 | 431 | 552 | 1082 | 985 | 2124 | 1455 | | 925 | 780 | |
| 13 | | <i>Anarhynchus leschenaultii</i> | Greater Sand Plover | | | | | 34 | 38 | 115 | 42 | 85 | | | | |
| 14 | Scolopacidae | <i>Numenius phaeopus</i> | Whimbrel | 37 | 47 | | | | 219 | 268 | 89 | 569 | 377 | | 58 | |
| 15 | | <i>Numenius arquata</i> | Eurasian Curlew | | | | | | 372 | 876 | 670 | 487 | 893 | | 211 | |
| 16 | | <i>Numenius madagascariensis</i> | Far Eastern Curlew | | | | | | | | 4 | 1 | | | | |
| 17 | | <i>Limosa limosa</i> | Black-tailed Godwit | | | | 27 | 589 | 3122 | 2100 | 113 | 1890 | | 34 | 2 | |
| 18 | | <i>Limosa lapponica</i> | Bar-tailed Godwit | | | | | 112 | 278 | 900 | 1275 | 764 | 220 | 7 | 29 | |
| 19 | | <i>Tringa totanus</i> | Common Redshank | 167 | 256 | | 367 | 414 | 1292 | 655 | 459 | 962 | 453 | 852 | 569 | |
| 20 | | <i>Tringa nebularia</i> | Common Greenshank | | | | | | | | | | | 1 | 1 | |
| 21 | | <i>Tringa guttifer</i> | Nordmann's Greenshank | | | | | | | 8 | | 16 | | | 2 | |
| 22 | | <i>Xenus cinereus</i> | Terek Sandpiper | 56 | 12 | | 47 | 276 | | 145 | 198 | 65 | 122 | 319 | 238 | |
| 23 | | <i>Actitis hypoleucos</i> | Common Sandpiper | | | | | 2 | 3 | 7 | 5 | 1 | 1 | | | |
| 24 | | <i>Arenaria interpres</i> | Ruddy Turnstone | 13 | | | | 43 | 17 | 3 | 1 | 88 | 57 | | 37 | |
| 25 | | <i>Limnodromus semipalmatus</i> | Asian Dowitcher | | | | | 348 | 518 | 355 | 219 | 687 | 413 | 2 | 236 | |
| 26 | | <i>Calidris tenuirostris</i> | Great Knot | | | | | 457 | 1178 | 788 | 568 | 1452 | | | 112 | |
| 27 | | <i>Calidris canutus</i> | Red Knot | | | | | 187 | 315 | | 6 | | | 44 | 3 | |
| 28 | | <i>Calidris alba</i> | Sanderling | | | | | | | | | 12 | | | 1 | |
| 29 | | <i>Calidris ruficollis</i> | Rufous-necked Stint | 23 | | | 37 | 211 | 192 | 683 | 332 | 476 | 32 | 126 | 35 | |
| 30 | | <i>Calidris ferruginea</i> | Curlew Sandpiper | | | | | 378 | 412 | 217 | 315 | 269 | 116 | 217 | 457 | |
| 31 | | <i>Calidris falcinellus</i> | Broad-billed Sandpiper | 4 | | | | 89 | 121 | 45 | 59 | 13 | 48 | 11 | 87 | |
| 32 | | <i>Calidris pugnax</i> | Ruff | | | | | | | | | 1 | | | | |
| 33 | | <i>Tringa brevipes</i> | Grey-tailed Tattler | | | | | | | | | | | | 1 | |
| 34 | Laridae | <i>Chlidonias hybridus</i> | Whiskered Tern | 87 | 77 | 118 | 36 | 49 | 281 | 155 | 211 | 125 | 248 | 132 | | |
| 35 | | <i>Chlidonias leucopterus</i> | White-winged Tern | | 237 | 180 | 112 | 69 | 438 | 235 | 45 | 87 | 354 | 287 | | |
| 36 | | <i>Gelochelidon nilotica</i> | Gull-billed Tern | 35 | 47 | 5 | 16 | 52 | 588 | 73 | 90 | 59 | 41 | 311 | | |
| 37 | | <i>Sterna hirundo</i> | Common Tern | 9 | 2 | | | 12 | | 36 | 12 | 89 | 11 | 37 | | |
| 38 | | <i>Sterna albifrons</i> | Little Tern | | 11 | | 46 | 37 | 12 | 47 | 93 | 66 | 9 | 12 | | |
| 39 | | <i>Sterna bengalensis</i> | Lesser Crested Tern | | | | | | | 48 | 8 | 21 | 4 | 1 | | |
| 40 | | <i>Sterna bergii</i> | Great crested Tern | | | | | | | 7 | | 2 | | | | |
| | | Un Id Shorebirds | Un Id Shorebirds | | | | | | | | | | 1500 | | | |
| Total All Waterbirds | | | | 815 | 939 | 546 | 1293 | 4738 | 11779 | 9579 | 8624 | 11614 | 3708 | 4374 | 4862 | |
| Total Shorebirds | | | | 489 | 451 | 26 | 909 | 4409 | 10031 | 8216 | 7708 | 10911 | 1463 | 2816 | 4800 | |

Based on **Table 1**, the highest total number of each shorebirds species at Sujono in one year was 15,232 birds from 25 species. The top three dominant species are the Black-tailed Godwit, Tibetan Sand Plover, and Great Knot. Tibetan Sand Plover and Common Redshank were present almost every month, while Ruff, Grey-tailed Tattler, Common Greenshank, White-faced Plover and Far Eastern Curlew were recorded in small numbers, ranging from 1 to 4 individuals. In September 2023, we observed a leucistic White-cheeked Pintail *Anas bahamensis* foraging with a flock of shorebirds. We also recorded Terek Sandpiper with Black Green and Black-tailed Godwit with Black-white on the right foot on October 2023.



Tabel 2. The list of waterbird species and their population numbers at Sejarah Beach.

| No. | Family | Scientific Names | Year | 2023/2024 | | | | | | | | | | | | |
|-----------------------------|-------------------|----------------------------------|------------------------|--------------|------------|------------|-------------|-------------|-------------|-------------|--------------|--------------|-------------|-------------|------------|-----|
| | | | | Month | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr |
| | | | | Common Names | | | | | | | | | | | | |
| 1 | Phalacrocoracidae | <i>Phalacrocorax niger</i> | Little Black Cormorant | 8 | 3 | 26 | 16 | 5 | 12 | 6 | 32 | 5 | | 4 | 3 | |
| 2 | Ardeidae | <i>Ardea cinerea</i> | Grey Heron | | 2 | | 2 | | | | 1 | | | | | |
| 3 | | <i>Ardea alba</i> | Great Egret | 25 | 11 | 5 | 18 | 69 | 39 | 7 | 57 | 66 | 43 | | 31 | |
| 4 | | <i>Egretta intermedia</i> | Yellow-billed Egret | 2 | | 5 | 4 | | | | 42 | 7 | | | 3 | |
| 5 | | <i>Egretta garzetta</i> | Little Egret | 21 | 34 | 7 | 37 | 48 | 21 | | 149 | 19 | | 32 | 7 | |
| 6 | | <i>Butorides striata</i> | Striated Heron | | | | 1 | 2 | | | 4 | | | | 1 | |
| 7 | Ciconiidae | <i>Mycteria cinerea</i> | Milky Stork | | | | 6 | 15 | | | 21 | | | | 8 | |
| 8 | | <i>Leptoptilos javanicus</i> | Lesser Adjutant | | | | | | | | | | | | 1 | |
| 9 | Charadriidae | <i>Vanellus cinereus</i> | Grey-headed Lapwing | | | | | | | | 8 | | | | | |
| 10 | | <i>Pluvialis squatarola</i> | Grey Plover | | | | | | | | 19 | | | | | |
| 11 | | <i>Pluvialis fulva</i> | Pacific Golden Plover | 12 | | | | 43 | 335 | | 127 | 785 | 89 | 273 | | |
| 12 | | <i>Anarhynchus atrifrons</i> | Tibetan Sand Plover | 54 | 16 | | 145 | 318 | 657 | 432 | 975 | 1650 | 874 | 228 | 54 | |
| 13 | | <i>Anarhynchus leschenaultii</i> | Greater Sand Plover | | | | | 11 | 33 | 4 | 69 | 117 | 45 | | | |
| 14 | Scolopacidae | <i>Numenius phaeopus</i> | Whimbrel | 6 | | | 3 | 187 | 37 | 150 | 219 | 88 | 7 | | | |
| 15 | | <i>Numenius arquata</i> | Eurasian Curlew | 27 | | | | 36 | | 560 | 211 | 893 | 750 | 45 | | |
| 16 | | <i>Limosa limosa</i> | Black-tailed Godwit | | | | | 745 | 1450 | 450 | 2850 | 3100 | 80 | 343 | 112 | |
| 17 | | <i>Limosa lapponica</i> | Bar-tailed Godwit | | | | | | 355 | | 1250 | 970 | 40 | 59 | | |
| 18 | | <i>Tringa totanus</i> | Common Redshank | 310 | 155 | 89 | 370 | 645 | 1850 | 1235 | 2150 | 950 | 350 | 561 | 357 | |
| 19 | | <i>Tringa guttifer</i> | Nordmann's Greenshank | | | | | | | | 48 | | | 127 | | |
| 20 | | <i>Xenus cinereus</i> | Terek Sandpiper | 17 | | | 17 | 382 | | 525 | 793 | 452 | 11 | 63 | 5 | |
| 21 | | <i>Actitis hypoleucos</i> | Common Sandpiper | | | | | 2 | 6 | 2 | 3 | 5 | | | 1 | |
| 22 | | <i>Arenaria interpres</i> | Ruddy Turnstone | | | | | | | 17 | 69 | 7 | | | | |
| 23 | | <i>Limnodromus semipalmatus</i> | Asian Dowitcher | | | | | 459 | 355 | 658 | 1959 | 564 | 30 | 476 | | |
| 24 | | <i>Calidris tenuirostris</i> | Great Knot | | | | | | | 815 | 672 | 340 | | 619 | | |
| 25 | | <i>Calidris canutus</i> | Red Knot | | | | | | | | | | 37 | 338 | | |
| 26 | | <i>Calidris alba</i> | Sanderling | | | | | | | | 39 | 5 | | | | |
| 27 | | <i>Calidris ruficollis</i> | Rufous-necked Stint | 32 | | | | 54 | | 36 | 457 | 155 | | | | |
| 28 | | <i>Calidris ferruginea</i> | Curlew Sandpiper | 7 | | | | 313 | 238 | 118 | 280 | 250 | 26 | 152 | | |
| 29 | | <i>Calidris falcinellus</i> | Broad-billed Sandpiper | | | | | 49 | 61 | 11 | 75 | 215 | 3 | 72 | | |
| 30 | | <i>Calidris pugnax</i> | Ruff | | | | | | | | 1 | | | | | |
| 31 | Laridae | <i>Chlidonias hybridus</i> | Whiskered Tern | 20 | | 18 | 125 | 188 | 54 | 25 | 255 | 111 | 31 | 212 | 21 | |
| 32 | | <i>Chlidonias leucopterus</i> | White-winged Tern | 78 | 126 | 34 | 211 | 144 | 67 | 50 | 257 | 300 | 55 | 162 | 87 | |
| 33 | | <i>Gelochelidon nilotica</i> | Gull-billed Tern | | 5 | | 35 | 59 | 43 | 14 | 89 | 145 | 4 | 67 | | |
| 34 | | <i>Sterna hirundo</i> | Common Tern | 12 | | 7 | 9 | 28 | | 5 | 44 | | 1 | 39 | | |
| 35 | | <i>Sterna albifrons</i> | Little Tern | 22 | 14 | 48 | 15 | | 5 | 8 | 9 | 45 | 3 | 27 | 7 | |
| 36 | | <i>Sterna bengalensis</i> | Lesser Crested Tern | | | | | | | | 4 | | 1 | | | |
| 37 | | <i>Sterna bergii</i> | Great crested Tern | | | | | | | 7 | | | 2 | | | |
| | | Un Id Shorebirds | Un Id Shorebirds | | | | | | | | | | 500 | | | |
| Total All Waterbirds | | | | 653 | 366 | 239 | 1050 | 3766 | 6178 | 4786 | 13920 | 11101 | 2232 | 3899 | 698 | |
| Total Shorebirds | | | | 465 | 171 | 89 | 571 | 3208 | 5937 | 4664 | 12956 | 10403 | 1592 | 3356 | 529 | |

Based on **Table 2**, the highest total number of each shorebirds species at Sejarah in one year was 14,603 birds from 22 species. The top three dominant species were the Black-tailed Godwit, Asian Dowitcher, and Common Redshank. The Common Redshank was present every month, assuming that first-year individuals did not return to their breeding grounds. In contrast, only one Ruff was recorded, along with eight Grey-headed Lapwings and eighteen Grey Plovers, all in December 2023. Additionally, two rare species were recorded in high numbers: 338 Red Knots and 127 Nordmann's Greenshanks in March 2024.



Table 3. The list of waterbird species and their population numbers at Kresek Beach.

| No. | Family | Scientific Names | Year | 2023/2024 | | | | | | | | | | | | |
|-----------------------------|-------------------|----------------------------------|------------------------|--------------|------------|------------|------------|-------------|-------------|-------------|--------------|--------------|-------------|-------------|------------|-----|
| | | | | Month | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr |
| | | | | Common Names | | | | | | | | | | | | |
| 1 | Phalacrocoracidae | <i>Phalacrocorax niger</i> | Little Black Cormorant | 7 | | 15 | 4 | | 41 | 11 | 3 | | 2 | 10 | | |
| 2 | Ardeidae | <i>Ardea cinerea</i> | Grey Heron | 4 | 1 | | 5 | | 12 | | 2 | 2 | | 7 | | |
| 3 | | <i>Ardea purpurea</i> | Purple Heron | | | 2 | | 1 | 3 | | | | 1 | | | |
| 4 | | <i>Ardea alba</i> | Great Egret | 6 | 49 | | 157 | 65 | 12 | 211 | 54 | 77 | 10 | 41 | | |
| 5 | | <i>Egretta intermedia</i> | Yellow-billed Egret | | | | 8 | | | | 6 | 2 | | | | |
| 6 | | <i>Egretta garzetta</i> | Little Egret | 53 | | 26 | | 3 | | | 112 | 42 | | 10 | | |
| 7 | | <i>Butorides striata</i> | Striated Heron | | 3 | 2 | 2 | 1 | 3 | | 1 | 4 | 1 | 2 | | |
| 8 | Ciconiidae | <i>Mycteria cinerea</i> | Milky Stork | 48 | 35 | 24 | 31 | 8 | 92 | 112 | 81 | 138 | 56 | 78 | | |
| 9 | Charadriidae | <i>Vanellus cinereus</i> | Grey-headed Lapwing | | | | | | 27 | | 45 | 31 | | | | |
| 10 | | <i>Pluvialis squatarola</i> | Grey Plover | | | | | 6 | 2 | 41 | 38 | 102 | | 4 | | |
| 11 | | <i>Pluvialis fulva</i> | Pacific Golden Plover | 47 | | | | | 1125 | 564 | 689 | 868 | 45 | 116 | | |
| 12 | | <i>Anarhynchus atrifrons</i> | Tibetan Sand Plover | 19 | 36 | | 112 | | 456 | 311 | 1515 | 870 | 79 | 31 | | |
| 13 | | <i>Anarhynchus leschenaultii</i> | Greater Sand Plover | | | | | | 23 | | | 79 | 7 | | | |
| 14 | Scolopacidae | <i>Numenius phaeopus</i> | Whimbrel | | 8 | | 26 | 17 | 44 | 97 | 570 | 322 | 450 | | | |
| 15 | | <i>Numenius arquata</i> | Eurasian Curlew | 78 | | | | | 367 | | 1590 | 540 | 237 | 125 | | |
| 16 | | <i>Limosa limosa</i> | Black-tailed Godwit | | | | | 167 | 650 | 346 | 2875 | 1850 | | | | |
| 17 | | <i>Limosa lapponica</i> | Bar-tailed Godwit | 9 | 43 | | | 458 | | 317 | 942 | 1238 | | | | |
| 18 | | <i>Tringa totanus</i> | Common Redshank | 210 | | 156 | 312 | 320 | 855 | 450 | 2117 | 1560 | 887 | 254 | | |
| 19 | | <i>Tringa nebularia</i> | Common Greenshank | | | | | | | 2 | | 1 | | | | |
| 20 | | <i>Tringa guttifer</i> | Nordmann's Greenshank | | | | | | | 11 | | 36 | | 51 | | |
| 21 | | <i>Xenus cinereus</i> | Terek Sandpiper | | | | 32 | | 110 | 33 | 653 | 345 | | 56 | | |
| 22 | | <i>Actitis hypoleucos</i> | Common Sandpiper | 2 | 1 | | | 1 | 4 | | 7 | 6 | 1 | 2 | | |
| 23 | | <i>Arenaria interpres</i> | Ruddy Turnstone | | | | | | 5 | | 41 | 58 | | 12 | | |
| 24 | | <i>Limnodromus semipalmatus</i> | Asian Dowitcher | | | | | | 476 | 115 | 918 | 1386 | 311 | 428 | | |
| 25 | | <i>Calidris tenuirostris</i> | Great Knot | | | | | | | 448 | 1670 | 1245 | 47 | 375 | | |
| 26 | | <i>Calidris canutus</i> | Red Knot | | | | | | | | | 12 | 32 | | | |
| 27 | | <i>Calidris alba</i> | Sanderling | | | | | | | 12 | | | 5 | | | |
| 28 | | <i>Calidris ruficollis</i> | Rufous-necked Stint | | | | | | | | 211 | 89 | 459 | | | |
| 29 | | <i>Calidris ferruginea</i> | Curlew Sandpiper | | | | | | 285 | 35 | 78 | 512 | 357 | | | |
| 30 | | <i>Calidris falcinellus</i> | Broad-billed Sandpiper | | | | | | | | 17 | 142 | | 48 | | |
| 31 | Laridae | <i>Chlidonias hybridus</i> | Whiskered Tern | 115 | 38 | 21 | | 59 | 216 | | 568 | 219 | 445 | 54 | | |
| 32 | | <i>Chlidonias leucopterus</i> | White-winged Tern | 25 | 319 | | 67 | | 21 | 43 | 350 | 742 | | 36 | | |
| 33 | | <i>Gelochelidon nilotica</i> | Gull-billed Tern | 47 | | | 15 | | | 217 | 21 | 63 | | 5 | | |
| 34 | | <i>Sterna hirundo</i> | Common Tern | 2 | 5 | | | | 58 | 26 | | 91 | | 12 | | |
| 35 | | <i>Sterna albifrons</i> | Little Tern | 34 | 21 | | | | | 310 | 46 | 195 | | 50 | | |
| | | Un Id Shorebirds | Un Id Shorebirds | | | | | | 450 | | | | 2100 | | | |
| Total All Waterbirds | | | | 706 | 559 | 246 | 771 | 1106 | 5337 | 3712 | 15220 | 12867 | 5532 | 1623 | 827 | |
| Total Shorebirds | | | | 365 | 88 | 156 | 482 | 969 | 4429 | 2782 | 13976 | 11292 | 2917 | 1377 | 648 | |

Based on **Table 3**, the highest total number of each shorebirds species at Kresek in one year was 16,240 birds from 22 species. The top three dominant species are the Black-tailed Godwit, Common Redshank, and Great Knot. Similar to another two sites, Common Redshank were present almost every month. Sanderling and Common Greenshank were recorded in small numbers, ranging from 1 to 12 individuals; Red Knot, Grey-headed Lapwing and Ruddy Turnstone ranging from 12 to 58 individuals. In March 2024, we recorded 51 Nordmann's Greenshank.



The importance of Sujono Intertidal Landscape and their significance at the flyway level

We recorded ten shorebird species that represented more than 1% of the population criteria at the EAA Flyway (**Table 4**). The Tibetan Sand Plover, Black-tailed Godwit, Bar-tailed Godwit, Common Redshank, Nordmann's Greenshank, and Asian Dowitcher were significantly recorded at all observation sites. Notable counts included 127 Nordmann's Greenshanks (12.70%) in March 2024 and 1,959 Asian Dowitchers (7.00%) in December 2023, both recorded at Sejarah.

The total distance between the three locations is approximately 22.7 km, with 4.4 km from Kresek to Sujono and about 18.3 km from Sujono to Sejarah. We assume that the shorebirds at these sites are interconnected, using intertidal mudflats alternately according to tidal conditions and human presence. In all three locations, people were observed collecting shellfish and oysters from the mudflats, while fishermen with small boats were seen fishing in the shallow waters near the tidal areas.

Table 4. List of Shorebirds species that meet 1% population criteria at the East Asian-Australasian Flyway.

| Name of species | 1% Threshold | Highest Count | | |
|-----------------------|--------------|---------------|-------------|-------------|
| | | Sujono | Sejarah | Kresek |
| Pacific Golden Plover | 1200 | 1430 (1.19) | - | - |
| Tibetan Sand Plover | 1300 | 2124 (1.63) | 1650 (1.27) | 1515 (1.17) |
| Whimbrel | 650 | 782 (1.20) | - | - |
| Black-tailed Godwit | 1600 | 3122 (1.95) | 2660 (1.66) | 2875 (1.80) |
| Bar-tailed Godwit | 1200 | 1275 (1.06) | 1250 (1.04) | 1238 (1.03) |
| Common Redshank | 1000 | 1292 (1.29) | 1870 (1.87) | 2117 (2.12) |
| Nordmann's Greenshank | 10 | 16 (1.60) | 127 (12.70) | 51 (5.10) |
| Asian Dowitcher | 280 | 687 (2.45) | 1959 (7.00) | 1386 (4.95) |
| Terek Sandpiper | 500 | - | 793 (1.59) | 653 (1.31) |
| Eurasian Curlew | 1000 | - | - | 1590 (1.59) |

Note; 1% criteria followed Wetlands International (2024) "Waterbird Populations Portal". Accessed 30 Jun 2024 at: wpe.wetlands.org

Comparison with previous surveys -

Comparing our survey results from 2018-2019 with those from 2023-2024, we found significant differences in the number of shorebirds recorded at various locations. At Sujono Beach in December 2018, we counted a total of 8,390 shorebirds across 25 species. This included 37 Nordmann's Greenshanks, 1,006 Black-tailed Godwits, 1,655 Great Knots, and 542 Broad-billed Sandpipers.

At Kresek Beach in January 2019, we recorded a total of 21,617 birds across 22 species. Notably, this included 3,800 Black-tailed Godwits, 1,900 Bar-tailed Godwits, 1,500 Common Redshanks, 1,865 Tibetan Sand Plovers, 1,170 Eurasian Curlews, 1,150 Terek Sandpipers, 410 Ruddy Turnstones, 2,250 Asian Dowitchers, 1,376 Curlew Sandpipers, and 487 Broad-billed Sandpipers.

At Sejarah Beach, we counted a total of 858 birds across 5 species in February 2018 and 182 birds across 9 species in January 2019. Our surveys from both 2023-2024 and 2018-2019 demonstrate that all the sites support at least ten species that meet the >1% population criteria in the East Asian-Australasian Flyway.

The Conservation status of all waterbirds species which found at the three observation sites.

Out of the 42 waterbird species we observed, fifteen are protected under Indonesian legislation (Ministry of Forest, P.106/MENLHK/KUM.1/12/2018; see **Table 5**). These include the Great Egret, Milky Stork, Whimbrel, Eurasian Curlew, Far Eastern Curlew, Asian Dowitcher, Nordmann's Greenshank, Whiskered Tern, White-winged Tern, Little Tern, and Common Tern. According to the IUCN Red List, four species—Nordmann's Greenshank, Far Eastern Curlew, Great Knot, and Milky Stork—are categorized as Endangered. Additionally, eight species—Curlew Sandpiper, Rufous-necked Stint, Black-tailed Godwit, Bar-tailed Godwit, Eurasian Curlew, Asian Dowitcher, Red Knot, and Grey-tailed Tattler—are classified as Near Threatened.

Table 5. The conservation status of waterbirds at the three observation sites.

| No. | Family | Scientific names | Common Names | Conservation Status | | |
|-----|-------------------|----------------------------------|------------------------|---------------------|--------|-----------------|
| | | | | IUCN | Cites | Ind-Legislation |
| 1 | Anatidae | <i>Anas bahamensis</i> | White-cheeked Fintail | LC | | UP |
| 2 | Phalacrocoracidae | <i>Microcarbo niger</i> | Little Cormorant | LC | | UP |
| 3 | Ardeidae | <i>Ardea cinerea</i> | Grey Heron | LC | | UP |
| 4 | | <i>Ardea purpurea</i> | Purple Heron | LC | | UP |
| 5 | | <i>Ardea alba</i> | Great Egret | LC | | P |
| 6 | | <i>Ardea intermedia</i> | Yellow-billed Egret | LC | | UP |
| 7 | | <i>Egretta garzetta</i> | Little Egret | LC | | UP |
| 8 | | <i>Butorides striatus</i> | Striated Heron | LC | | UP |
| 9 | Ciconiidae | <i>Mycteria cinerea</i> | Milky Stork | EN | App. I | P |
| 10 | Charadriidae | <i>Vanellus cinereus</i> | Grey-headed Lapwing | LC | | P |
| 11 | | <i>Pluvialis squatarola</i> | Grey Plover | LC | | UP |
| 12 | | <i>Pluvialis fulva</i> | Pacific Golden Plover | LC | | UP |
| 13 | | <i>Anarhynchus dealbatus</i> | White-faced Plover | LC | | UP |
| 14 | | <i>Anarhynchus mongolus</i> | Lesser Sand Plover | LC | | UP |
| 15 | | <i>Anarhynchus leschenaultii</i> | Greater Sand Plover | LC | | UP |
| 16 | Scolopacidae | <i>Numenius phaeopus</i> | Whimbrel | LC | | P |
| 17 | | <i>Numenius arquata</i> | Eurasian Curlew | NT | | P |
| 18 | | <i>Numenius madagascariensis</i> | Far Eastern Curlew | EN | | P |
| 19 | | <i>Limosa limosa</i> | Black-tailed Godwit | NT | | UP |
| 20 | | <i>Limosa lapponica</i> | Bar-tailed Godwit | NT | | UP |
| 21 | | <i>Tringa totanus</i> | Common Redshank | LC | | UP |
| 22 | | <i>Tringa nebularia</i> | Common Greenshank | LC | | UP |
| 23 | | <i>Tringa guttifer</i> | Nordmann's Greenshank | EN | App. I | P |
| 24 | | <i>Xenus cinereus</i> | Terek Sandpiper | LC | | UP |
| 25 | | <i>Actitis hypoleucos</i> | Common Sandpiper | LC | | UP |
| 26 | | <i>Arenaria interpres</i> | Ruddy Turnstone | LC | | UP |
| 27 | | <i>Limnodromus semipalmatus</i> | Asian Dowitcher | NT | | P |
| 28 | | <i>Calidris tenuirostris</i> | Great Knot | EN | | UP |
| 29 | | <i>Calidris canutus</i> | Red Knot | NT | | UP |
| 30 | | <i>Calidris alba</i> | Sanderling | LC | | UP |
| 31 | | <i>Calidris ruficollis</i> | Rufous-necked Stint | NT | | UP |
| 32 | | <i>Calidris ferruginea</i> | Curlew Sandpiper | NT | | UP |
| 33 | | <i>Calidris falcinellus</i> | Broad-billed Sandpiper | LC | | UP |
| 34 | | <i>Calidris pugnax</i> | Ruff | LC | | UP |
| 35 | | <i>Tringa brevipes</i> | Grey-tailed Tattler | NT | | UP |
| 36 | Laridae | <i>Chlidonias hybridus</i> | Whiskered Tern | LC | | P |
| 37 | | <i>Chlidonias leucopterus</i> | White-winged Tern | LC | | P |
| 38 | | <i>Gelochelidon nilotica</i> | Gull-billed Tern | LC | | P |
| 39 | | <i>Sterna albifrons</i> | Little Tern | LC | | P |
| 40 | | <i>Sterna hirundo</i> | Common Tern | LC | | P |
| 41 | | <i>Sterna bengalensis</i> | Lesser Crested Tern | LC | | P |
| 42 | | <i>Sterna bergii</i> | Great crested Tern | LC | | P |

Note ; Red list IUCN criteria (2019); EN= Endangered, NT= Near Threatened, LC= Least Concern, CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora); Appendix I= species threatened with extinction. Trade in specimens of these species is permitted only in exceptional circumstances. Appendix II= species not necessarily threatened with extinction, but in which trade must be controlled in order to avoid utilization incompatible with their survival. Indonesia Legislations (Ministry of Forest, P.106/MENLHK/SETJEN/KUM.1/12/2018, concerning the Protection of Flora and Fauna); UP= Un-Protected, P= Protected.

The status of the intertidal mudflat and mangrove forest around shorebird sites.

Based on the map of mangrove forest function areas (SK MENHUT NO.579/MENHUT-II/2014), Sujono Beach is located in Lalang Village, and the area is classified as a non-forest estate. Kresek Beach spans the coastline of three villages: Durian, Pematang Nibung, and Nenas Siam, where the mangrove forests are designated as protected areas. Sejarah Beach covers two villages, Gambus Laut and Perupuk, and the mangrove areas there are also protected (**Figure 3**).

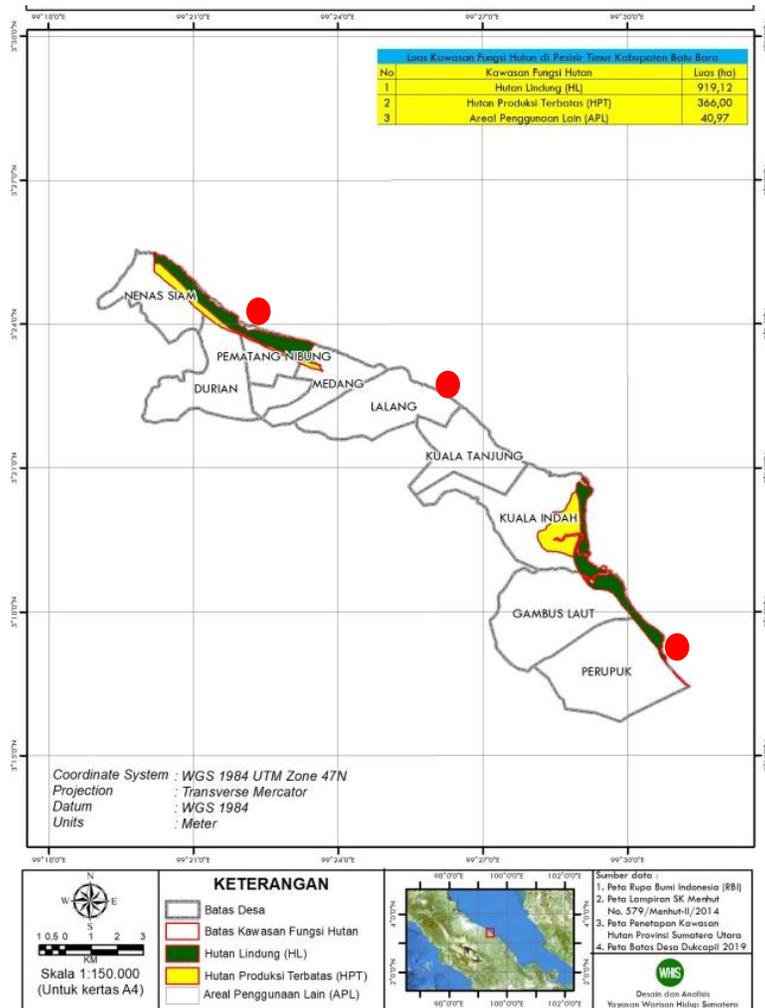


Figure 3. The Map of mangrove forest function at the three observation sites. Green Polygon = Protected forest, Yellow Polygon = Limited production forest, Red dot = observation sites.

B. Diversity and Abundance of Macrozoobenthos Species at the three sample sites.

The diversity of macrozoobenthos species across the three beaches encompasses three Phyla, six Classes, and a total of 28 species. Detailed species and individual counts for each location are presented in **Table 6**.

Table 6. Diversity and Abundance of Macrozoobenthos at Sujono Beach, Sejarah Beach, and Kresek Beach in Batu Bara Regency.

| Phylum | Class | Species | Number of Species | | |
|--------------------------------------|-------------------------------|---------------------------------|-------------------|---------------|--------------|
| | | | Sujono Beach | Sejarah Beach | Kresek Beach |
| Annelida | <i>Polychaeta</i> | <i>Glycera</i> sp. | 9 | 15 | 17 |
| | <i>Polychaeta</i> | <i>Nephtys</i> sp. | 35 | 63 | 47 |
| | <i>Polychaeta</i> | <i>Nereis</i> sp. | 153 | 129 | 88 |
| Arthropoda | <i>Crustacea</i> | <i>Pinnotheres</i> sp. | 7 | 5 | 5 |
| | <i>Malacostraca</i> | <i>Asellidae</i> sp. (larvae) | 17 | - | - |
| | <i>Malacostraca</i> | <i>Litopenaeus</i> sp. (larvae) | 23 | - | - |
| | <i>Malacostraca</i> | <i>Macrophthalmus</i> sp. | 11 | 8 | 13 |
| | <i>Malacostraca</i> | <i>Paguridae</i> sp. | 7 | 5 | 5 |
| | <i>Thecostraca</i> | <i>Chthamalus</i> sp. | 3 | 7 | 7 |
| | <i>Bivalvia</i> | <i>Anadara granosa</i> | 55 | 37 | 33 |
| <i>Bivalvia</i> | <i>Anadara gubernaculum</i> | 3 | 6 | 9 | |
| <i>Bivalvia</i> | <i>Callista lilacina</i> | 19 | 37 | 154 | |
| <i>Bivalvia</i> | <i>Donax trunculus</i> | 2 | 9 | 4 | |
| <i>Bivalvia</i> | <i>Mactra grandis</i> | 56 | 31 | 27 | |
| <i>Bivalvia</i> | <i>Mytilus platensis</i> | 207 | 39 | 47 | |
| <i>Bivalvia</i> | <i>Orbicularia orbiculata</i> | 5 | 3 | 1 | |
| <i>Bivalvia</i> | <i>Unio</i> sp. | - | 1 | - | |
| Molusca | <i>Gastropoda</i> | <i>Cerithideopsis</i> sp. | 18 | 7 | 5 |
| | <i>Gastropoda</i> | <i>Clypeomorus</i> sp. | 2 | 3 | 1 |
| | <i>Gastropoda</i> | <i>Littoraria</i> sp. | 1 | 1 | - |
| | <i>Gastropoda</i> | <i>Nassarius elegantissimus</i> | 10 | 3 | 2 |
| | <i>Gastropoda</i> | <i>Nassarius margaritifer</i> | 7 | - | - |
| | <i>Gastropoda</i> | <i>Nassarius reeveanus</i> | 8 | - | - |
| | <i>Gastropoda</i> | <i>Natica tigrina</i> | 1 | 2 | 2 |
| | <i>Gastropoda</i> | <i>Orania xuthedra</i> | 1 | - | - |
| | <i>Gastropoda</i> | <i>Peringia ulvae</i> | 1 | - | - |
| | <i>Gastropoda</i> | <i>Pomaceae</i> sp. | 1 | - | - |
| | <i>Gastropoda</i> | <i>Turritella terebra</i> | 2 | 1 | 1 |
| Total | | | 664 | 412 | 329 |
| Abundance (ind/m³) | | | 2,459 | 1,525 | 1,218 |

Based on **Table 6**, the phylum Annelida, class Polychaeta, comprises three species: *Glycera* sp., *Nephtys* sp., and *Nereis* sp. Polychaeta, known for its ability to thrive in mud and sand substrates for nutrient acquisition and survival, includes *Nereis* sp., which exhibits strong adaptability to diverse and challenging environments. In the phylum Arthropoda, the

class Crustacea features *Pinnotheres* sp., while the class Malacostraca includes *Asellidae* sp. and *Litopenaeus* sp. at the larva form, alongside the class Theostraca represented by *Chthamalus* sp. Within the phylum Mollusca, Bivalvia and Gastropoda are represented by various species, with *Mytillus platensis* dominating Bivalvia and *Cerithideopsisilla* sp. showing the highest individual count across all sampling locations. The greatest individual abundance was recorded at Sujono with 2,459 ind/m³, followed by Sejarah with 1,525 ind/m³, and Kresek with 1,218 ind/m³. The high numbers at Sujono are attributed to organic substrate from nearby mangroves and river-borne organic waste at all three sites. Additionally, the significant macrozoobenthos population is influenced by environmental factors and a balanced ecological dynamic involving predators, competitors, and parasites.

Indeks of Species richness, diversity, evenness and dominance of three sampel sites.

Sujono, Sejarah, and Kresek beaches each demonstrate distinct characteristics in macrozoobenthos diversity and evenness. Sujono Beach boasts the highest species richness index at 4.155, followed by Sejarah at 3.322 and Kresek at 3.106 (Figure 4), indicating moderate richness across all three beaches. This suggests that each beach provides suitable habitats for diverse macrozoobenthos species. Kresek Beach shows the highest Shannon-Wiener diversity index at 2.306, followed by Sejarah at 2.266 and Sujono at 2.197, placing all three beaches within the moderate range of macrozoobenthos diversity. The diversity index serves as a vital parameter for assessing community stability, reflecting habitat suitability and the impact of environmental factors on species persistence. Moderate diversity typically indicates stable ecosystems with consistent species distribution and evenness.

Sejarah Beach exhibits the highest evenness index for macrozoobenthos at 0.744, followed closely by Kresek at 0.742 and Sujono at 0.659, categorizing all three beaches within the high range of evenness. Similar evenness index values between Sejarah and Kresek beaches can be attributed to their comparable loam habitats, promoting a similar species distribution across these environments. Conversely, Sujono Beach demonstrates the highest Simpson dominance index at 0.172, followed by Sejarah at 0.156 and Kresek at 0.138, indicating no dominant species among the macrozoobenthos communities at these beaches.

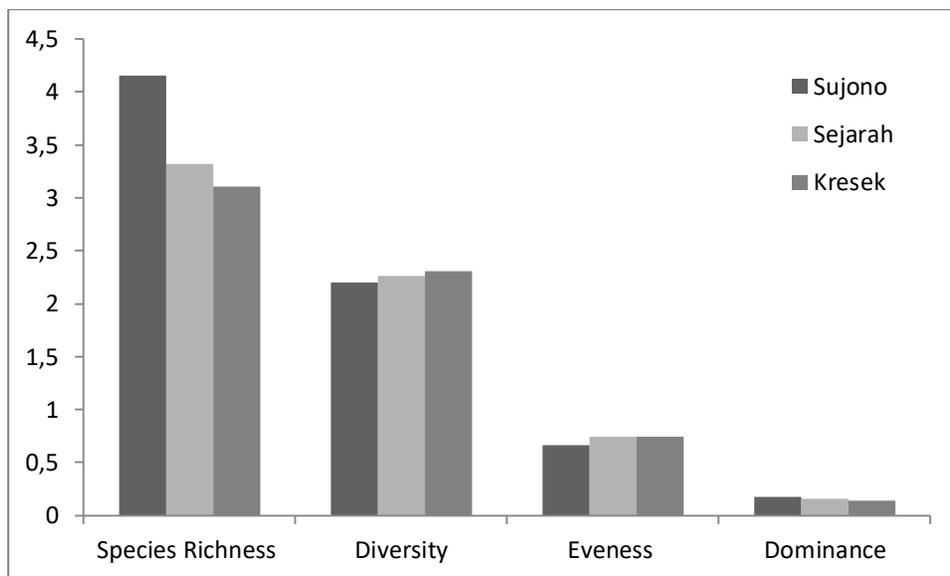


Figure 4. Indeks of Species Richness, Diversity, Evenness and Dominance of Makrozoobenthos in Sujono Beach, Sejarah Beach and Kresek Beach.



C. Environmental Physical Factors and Characteristics of Substrate Texture at the Research Site

The physical factors and substrate characteristics at Sujono Beach, Sejarah Beach, and Kresek Beach in Batu Bara Regency are present in **Table 7**. Based on Table 2, the temperature across all three beaches ranges similarly from 29 to 30°C. However, significant variations are noted in pH levels, with Sujono Beach showing a neutral pH of 6.8, while Sejarah Beach and Kresek Beach exhibit acidity with pH values of 4.5. pH levels indicate the balance of hydrogen ions (H⁺) and hydroxide ions (OH⁻) in the substrate, influencing nutrient availability and absorption efficiency by plants. Neutral pH facilitates optimal nutrient uptake, whereas acidic conditions may limit nutrient absorption and can indicate potential toxicity from elements like aluminum, which binds essential nutrients like phosphorus crucial for plant growth.

Table 7. Environmental Physical Factors and Characteristics of Substrate Texture at the Research Site.

| No | Sample Sites | Environmental Physical Factors | | Characteristics of Substrate Texture | | | | |
|----|---------------|--------------------------------|-----|--------------------------------------|----------|----------|---------------|----------------|
| | | Temperature | pH | Sand (%) | Silt (%) | Clay (%) | Organic C (%) | Texture (USDA) |
| 1 | Sujono Beach | 29 | 6,8 | 64 | 28 | 8 | 4,71 | Sandy loam |
| 2 | Sejarah Beach | 30 | 6,5 | 30 | 62 | 8 | 4,19 | Loam |
| 3 | Kresek Beach | 30 | 6,5 | 30 | 62 | 8 | 3,97 | Loam |

Regarding substrate characteristics, Sujono Beach features sandy loam texture, predominantly sand (64%), with 28% dust and 8% clay content. In contrast, Sejarah Beach and Kresek Beach have loam texture, dominated by silt (62%), with 30% sand and 8% clay content. Substrate texture affects physical and chemical properties such as water retention, aeration, and fertility, with clay textures retaining more water due to their higher adsorptive capacity compared to sand.

Organic carbon (C-organic) content is consistent across all beaches, ranging from 3.97% to 4.71%, with Sujono Beach having the highest at 4.71%, followed by Sejarah Beach at 4.19%, and Kresek Beach at 3.97%. Organic carbon enhances nutrient availability and water retention in substrates, potentially improving soil fertility and supporting plant growth that may important for makrozoobenthos.



1.4 RECOMMENDATIONS

How might the outcome of your project be applied in future research.

Discuss how this project contributes to the implementation of the [EAAFP Strategic Plan 2019-2028](#).

We assume that the three observation locations are interconnected and mutually supportive. To validate this assumption, conducting local movement studies is essential. Using satellite tracking technology for these studies allows us to observe how shorebirds utilize each location during winter. Additionally, we can identify high-tide roosts when intertidal mudflats are unavailable during high tide. This knowledge is crucial for conserving the important habitats that shorebirds rely on during wintering

The project contributes to **the EAAFP Strategic Plan of Partnership Objective 1**: developing the Flyway Network of internationally significant sites for the conservation of migratory waterbirds. This effort builds on the achievements of the Asia-Pacific Migratory Waterbird Conservation Strategy, aiming to establish a sufficient and efficient network of sustainably managed sites.

KRA 1.1: Sujono Intertidal Landscape is not yet part of the Flyway Network. However, based on records from 2018-2020 (Putra *et al.*, 2019) showing the presence of numerous migratory shorebirds and significant populations of species like Nordmann's Greenshank (Putra *et al.*, 2021), along with the results from our 2023-2024 survey, the importance of Sujono Intertidal Landscape in Sumatra at the flyway level is evident. Our survey work in this area may assist with EAAFP's future site assessments and contribute to the inclusion of new Flyway Network Sites in Indonesia. Our next objective is to promote Sujono Intertidal Landscape and Ulee Matang Site as Flyway Network Sites or Ramsar Sites.

Section 2. BUDGET REPORT

| Item | Total Cost |
|---|------------------|
| Food allowances (during 12 month) | 1038,5 USD |
| Rent a car, Gasoline and e-toll (during 12 month) | 2683,2 USD |
| Rent boat | 260,9 USD |
| Accommodation for 3-4 person (during 12 month) | 521,7 USD |
| Makrozoobenthos sampling tools (Surber net, GPS, cool box, Alcohol 96%, Plastic sample, sample bottle, sieve (size <1mm), stationary, etc). | 779,5 USD |
| Substrat assessment tools (pH Tester, Temperature tester, plastix sample, etc) | 217,4 USD |
| Benthos identification and substrate assessment in laboratory | 447,2 USD |
| Total | 5,949 USD |

Note:

- It is compulsory that recipients of the 2023 EAAFP Small Grant Fund for WG/TFs submit a final report along with a web article within 3 months of the completion of the project.

Appendix 1. Documentation during shorebird monitoring activities.



Shorebirds monitoring on October 2023 with Fion and Nemo from WWF Hong Kong at Sejarah Beach.



Shorebirds monitoring on September at Sujono beach.

Appendix 2. Shorebird photos.



Mix flock of Black-tailed Godwit and Asian Dowitcher at Sejarah Beach on December 2023.



Mix flock of Tibetan Sand Plover, Pacific Golden Plover, Curlew Sandpiper, Terek Sandpiper and Black-tailed Godwit.



Two Far Eastern Curlew and four Eurasian Curlew at Sujono Mudflat on December 2023.



Three Nordmann's Greenshank resting on the mudflat area of Sejarah Beach on December 2023.



Asian Dowitcher Eating Polychaeta.



Tibetan Sand Plover eating small Crustacea.

Appendix 3. Documentation during Makrozoobenthos collecting activities.



Appendix 4. The photos of macrozoobenthos that we found at observation areas.



Mytilus platensis



Callista lilacina



Donax trunculus



Anadara granosa



Unio pictorum



Orbicularia orbiculata



Mactra grandis



Anadara gubernaculum



Chthamalus sp



Clypeomorus moniliferus



Nassarius reeveanus



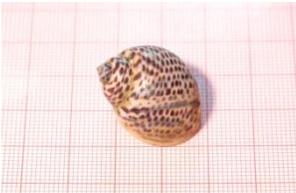
Cerithideopsisilla alata



Pomaceae sp



Nassarius elegantissimus



Natica tigrina



Littoraria scabra



Nassarius margaritifer



Turritella terebra



Orania xuthedra



Pinnotheres pisum



Macrophthalmus depressus



Litopenaeus vannamei



Asellidae rafinesque



Glycera lamarck



Nereis sp.



Nepthys sp.



Peringia ulvae



Paguridae latreille

Appendix 5. The result of subtrat texture characteristics.



UNIVERSITAS SUMATERA UTARA
 FAKULTAS PERTANIAN
 LABORATORIUM RISET
 Jalan. Prof. A. Sofyan. No. 03.Kampus USU
 Medan – 20155

HASIL ANALISIS

Pemilik : Muammar
 Nim : 4182220011
 Unit/Prog studi : UMSU / Biologi
 JenisSampel : Substrat/ Lumpur
 Jumlah : 3 sampel

| Parameter | Satuan | Sampel | | |
|-----------|--------|-----------|-----------|-----------|
| | | Lokasi. 1 | Lokasi. 2 | Lokasi. 3 |
| Pasir | % | 64 | 30 | 30 |
| Debu | % | 28 | 62 | 62 |
| Liat | % | 8 | 8 | 8 |
| Tekstur | USDA | Lp | Ld | Ld |
| C-organik | % | 4.71 | 419 | 3.97 |

Keterangan :
 Lp : Lempung berpasir
 Ld : Lempung berdebu

