



Baseline terrestrial and aquatic biodiversity for a peri-urban residential development

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ABSTRACT

Background: Peri-urban residential development can replace agricultural and ruderal habitats, simplify ecological structure, and alter adjacent freshwater communities. Baseline studies are often presented descriptively without checking taxonomic or arithmetic consistency. This study evaluated terrestrial and aquatic biological conditions at the proposed Sunville Residence site and the connected Tamangapa Canal in Gowa Regency, Indonesia. **Methods:** The 2025 baseline dataset included count-based inventories of herb and shrub vegetation, direct observations and community information for terrestrial fauna and nekton, and phytoplankton observations at two canal stations. Shannon diversity, Pielou evenness, and Simpson concentration were independently recalculated from the tabulated abundances. A planning-level biomass estimate used the reported 29.67 ha conversion area, a crop-biomass assumption of 12 t/ha, and an urban-tree biomass equivalence of 35 t/ha. **Findings:** The source listed 50 herb records and 51 shrub records. Herb counts summed to 1,938, rather than the reported 1,926, and produced $H' = 3.103$; the reported $H' = 3.116$ was reproduced only when the lower denominator was used. Shrub counts summed consistently to 6,473, but recalculation produced $H' = 3.452$, compared with the reported 3.1162. The faunal survey recorded two mammals, three birds, one amphibian, two reptiles, one annelid group, six arthropod groups, and three fish taxa, with several identifications requiring taxonomic verification. Phytoplankton diversity was moderate at the upstream station ($H' = 1.364$) and downstream station ($H' = 1.197$); both communities were uneven and dominated numerically by Navicula and Oscillatoria records. According to the source classification table, these values indicate moderate rather than light pollution. The biomass assumptions yielded 356.04 t of existing biomass and an equivalent tree-based green-space area of 10.17 ha. **Conclusion:** The site retains diverse but disturbance-associated vegetation, limited observed vertebrate richness, and a canal plankton community that warrants physicochemical and seasonal verification. Development approval should be linked to riparian avoidance, taxonomic confirmation, functionally diverse green infrastructure, invasive-species control, and repeated post-construction monitoring. **Novelty/Originality of this article:** The study combines terrestrial and aquatic baseline evidence with an explicit audit of biodiversity indices, totals, pollution interpretation, and biomass calculations, then converts the corrected evidence into measurable biodiversity-management actions for a peri-urban housing project.

KEYWORDS: aquatic biodiversity; biodiversity baseline audit; environmental monitoring; peri-urban residential development; terrestrial biodiversity.

1. Introduction

Urban expansion converts agricultural, wetland, and informal green areas into built environments, altering habitat area, hydrology, edge conditions, disturbance, and species movement. These changes can reduce local abundance and reshape community composition, although effects depend on development intensity, landscape context, and

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organism traits (Grimm et al., 2008; Newbold et al., 2015; Li et al., 2022; Hahs et al., 2023). Because urban ecological responses are dynamic, a biological baseline should serve as a reproducible reference for subsequent change rather than as a fixed description (Alberti, 2015; Cardinale et al., 2012).

Peri-urban areas can still support native, non-native, and disturbance-tolerant species, but numerical richness alone does not demonstrate ecological integrity. Habitat size, vegetation complexity, connectivity, management intensity, native status, and specialization are more informative for conservation value (Aronson et al., 2014; Beninde et al., 2015; Ives et al., 2016; Lepczyk et al., 2017). Disturbed habitats may contain many ruderal taxa and may also promote biotic homogenization (McKinney, 2006, 2008; Kowarik, 2011). Environmental impact assessment therefore requires a defensible baseline that documents observations, sampling effort, identification, abundance, and calculations. Diversity indices can conceal taxonomic uncertainty, duplicate records, and unequal sampling; more robust comparisons require raw data and replicated sampling (Gotelli & Colwell, 2001; Jost, 2006; Chao et al., 2014; Morris et al., 2014).

Freshwater components are equally important because canals and creeks connect development sites to wider catchments and receive sediment, nutrients, hydrocarbons, litter, and thermal loads. Such pressures can alter water quality and aquatic communities (Dudgeon et al., 2006; Reid et al., 2019; Tickner et al., 2020; Albert et al., 2021; Birk et al., 2020). Phytoplankton can provide useful biological signals, but Shannon diversity alone is not a universal pollution scale; interpretation should consider dominance, physicochemical conditions, and repeated sampling (Reynolds et al., 2002; Padisák et al., 2009; Salmaso et al., 2015; Stevenson, 2014).

Green infrastructure can reduce residual biodiversity loss when it provides connected, structurally diverse, and well-maintained vegetation rather than simply maximizing planted stems. Species selection, canopy structure, rooting space, continuity, resilience, and invasiveness should therefore guide design (Alvey, 2006; Roy et al., 2012; Livesley et al., 2016; Endreny et al., 2017; Kendal et al., 2014; Sjöman et al., 2016). The source environmental document for the proposed Sunville Residence described a peri-urban mosaic of herb-shrub cover and rice-growing land and reported vegetation, fauna, plankton, biomass loss, and recommended tree species. Several totals, formulas, taxonomic labels, and interpretations were internally inconsistent, however, creating uncertainty for mitigation areas, monitoring thresholds, and ecological-condition claims.

Accordingly, the study asks four questions; (1) What terrestrial and aquatic conditions are represented in the 2025 baseline? (2) Are the reported abundance totals, biodiversity indices, plankton pollution classifications, and biomass calculations internally consistent and reproducible? (3) How should the audited findings be interpreted in light of ecological evidence, sampling limitations, and Indonesian environmental policy? (4) What mitigation and monitoring actions follow from the audited baseline? These questions position the study as an audit-based environmental assessment rather than a complete biodiversity census.

2. Methods

2.1 Analytical framework

The analysis follows four steps corresponding to the research questions: description of the 2025 terrestrial and aquatic records; independent checking of totals, biodiversity metrics, pollution categories, and biomass calculations; ecological interpretation; and development of a testable mitigation and monitoring framework. The source dataset is treated as a screening-level baseline rather than a complete biodiversity census.

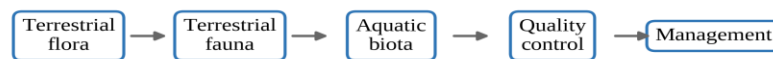


Fig. 1. Audit framework linking terrestrial flora and fauna, aquatic biota, quality-control checks, and management actions

2.2 Study area and source dataset

The study concerned the proposed Sunville Residence development in Paccinongang, Somba Opu District, Gowa Regency, South Sulawesi, Indonesia. The planned conversion area was reported as 296,739 m², equivalent to 29.6739 ha. Terrestrial observations were associated with the project footprint and its immediate surroundings. Aquatic observations were associated with the connected Tamangapa Canal. The upstream plankton station was located at S 05°11'12.402", E 119°28'28.661", and the downstream station at S 05°10'58.992", E 119°28'32.352". The analysis used the 2025 biological-component report and its field and laboratory tables (PT Bumi Surya Persada, 2025), which contained counts for 50 herb-layer and 51 shrub-layer records, qualitative terrestrial-fauna observations, three nekton records, phytoplankton counts from two stations, one downstream zooplankton record, and biomass-replacement assumptions.

Available documentation allows the original procedures to be reconstructed only broadly: vegetation was recorded as count-based herb- and shrub-layer inventories; terrestrial fauna combined direct observations with local information; nekton comprised three fish occurrence records; and plankton was recorded at one upstream (T1) and one downstream (T2) station. Standardized effort cannot be reconstructed because the report omits plot dimensions and arrangement, transect length, survey duration and timing, observer number, repeat visits, detection distance, fauna gear, plankton sample volume and depth, collection device, replication, preservation, counting chamber, microscope effort, and taxonomic keys. The manuscript therefore uses a descriptive case-study design, preserves source observations, distinguishes reported from recalculated values, and avoids inferential statistics unsupported by the sampling design. Detection probability, sampling completeness, confidence intervals, population density, temporal trends, and cross-component richness comparisons are not estimated.

2.3 Vegetation inventory and diversity audit

Each vegetation record contained a local name, a source scientific-name label, and an individual count. Plant nomenclature was checked against Plants of the World Online (2026). Unambiguous orthographic errors were corrected, whereas labels that could not be resolved confidently were retained at the lowest defensible taxonomic rank. Duplicate source rows were not synonymized or merged because the biodiversity audit must remain reproducible from the original abundance table. Nomenclatural standardization does not constitute voucher-based confirmation of field identity.

The source reported Shannon-Wiener diversity for each vegetation stratum. The audit recalculated Shannon diversity from the tabulated counts using natural logarithms.

$$H' = -\sum(p_i \ln p_i) \quad (\text{Eq. 1})$$

where p_i is the proportion of individuals assigned to record i . Pielou evenness was calculated as H' divided by $\ln S$, where S is the number of positive-abundance records. Simpson concentration was calculated as the sum of squared proportions. Lower Simpson concentration indicates less numerical dominance.

$$J' = H' / \ln(S) \quad (\text{Eq. 2})$$

$$D = \sum p_i^2 \quad (\text{Eq. 3})$$

The audit compared row-level totals with printed totals and tested whether the reported H' values could be reproduced. Taxonomic standardization was applied only to nomenclature and presentation; duplicate or uncertain source rows were not merged. Consequently, recalculated metrics remain directly reproducible from the tabulated source records rather than from a retrospectively consolidated species list.

2.4 Fauna and nekton assessment

Terrestrial fauna records came from direct observation and information supplied by local residents. Taxonomic labels were standardized conservatively using Mammal Diversity Database v2.5 (Mammal Diversity Database, 2026), Amphibian Species of the World v6.2 (Frost, 2026), The Reptile Database (Uetz et al., 2026), and IOC World Bird List v15.2 (Gill et al., 2026). Source identifications lacking diagnostic evidence were not upgraded to species level; ambiguous amphibian and skink labels were reduced to family level where genus assignment could not be defended. No abundance or standardized effort data were available, so richness and diversity indices were not calculated.

Nekton observations consisted of three fish records from the watercourse within or near the project area. The analysis retained the reported scientific names but flags the suckermouth catfish identification for verification because this common name can refer to several loricariid taxa. The absence of a protected species in the source report was not interpreted as proof of absence because the survey had limited temporal replication and several organisms were identified only to genus, order, or informal group.

2.5 Plankton analysis and water-quality interpretation

Phytoplankton abundance was tabulated at the upstream station T1 and downstream station T2. The T2 dataset also included 300 *Paramecium* sp. records classified as zooplankton. The source diversity, evenness, and dominance values at T2 were calculated from phytoplankton only, excluding *Paramecium* sp. The audit followed that convention to allow direct comparison. Shannon diversity, Pielou evenness, and Simpson concentration were independently recalculated. The source evenness values were also checked and found to equal H' divided by species count rather than the conventional Pielou formula.

The source supplied a four-class water-quality interpretation based on Shannon diversity: H' greater than 2.0 as unpolluted, 1.6 to 2.0 as lightly polluted, 1.0 to 1.6 as moderately polluted, and less than 1.0 as heavily polluted. This scheme was evaluated for internal consistency but was not treated as a stand-alone regulatory diagnosis. Plankton community data were interpreted together with the limitations of one-time sampling and the need for physicochemical corroboration.

2.6 Biomass and green-space equivalence

The source treated the conversion area as rice-dominated land and adopted a planning biomass density of 12 t/ha. It then assumed that tree-dominated green open space could provide 35 t/ha of biomass. These are generalized planning coefficients rather than site measurements. The audit corrected the units and arithmetic as follows,

$$B_0 = A \times b_0 \quad (\text{Eq. 4})$$

$$A_{RTH} = B_0 / b_{RTH} \quad (\text{Eq. 5})$$

Here, B_0 is estimated existing biomass in tonnes, A is site area in hectares, b_0 is assumed existing biomass density, A_{RTH} is the area of tree-based green open space required to

reach numerical biomass equivalence, and b_{RTH} is the assumed tree-biomass density. The calculation does not estimate carbon stock, soil organic carbon, annual sequestration, habitat quality, or the time needed for planted trees to reach the assumed biomass.

2.7 Quality-control rules and limitations

Quality control compared printed totals with row-level sums, reproduced reported indices from listed abundances, checked calculation units, and compared ecological categories with the thresholds stated in the source. Where discrepancies occurred, both reported and audited values are retained. Limitations include incomplete sampling metadata, single-year observations, uncertain or duplicated taxonomic labels, lack of linked vouchers or photographs, non-standardized fauna effort, and only two plankton stations. These constraints preclude effort-standardized richness, reliable rarefaction or coverage comparisons, inference of true absence, seasonal trends, population size, complete inventories, or causal effects of development. The dataset remains suitable for preliminary screening, numerical auditing, and mitigation design.

3. Results and Discussion

3.1 Vegetation composition and numerical structure

The inventory listed 50 herb-layer records. Their row-level counts summed to 1,938 individuals, which is 12 more than the printed total of 1,926. The four most abundant records were *Grona triflora* with 408 individuals, *Cynodon dactylon* with 205, *Mimosa pudica* with 185, and *Axonopus compressus* with 142. Together they represented 48.5% of the audited total. The remaining records formed a long tail of moderate and low abundances. This structure explains why the community can have a Shannon value above three even though one record contributes more than one fifth of all individuals.

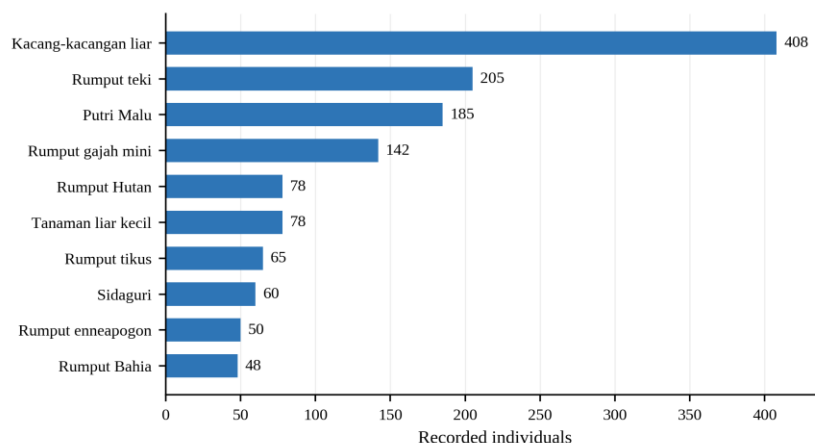


Fig. 2. 10 most abundant herb-layer records in the 2025 source inventory. Bars show the recorded number of individuals

Several herb records also contain duplicate source rows, including *Praxelis clematidea* and *Centrosema pubescens*. Both names are currently accepted in Plants of the World Online, but their duplicated rows were retained because merging them would alter the auditable source structure. Other unresolved labels were handled conservatively rather than assigned to a species without voucher evidence.

The shrub table contained 51 records and a consistent total of 6,473 individuals. *Mimosa pudica* was most abundant with 627 individuals, followed by *Calopogonium mucunoides* with 469, the unresolved source record standardized conservatively as *Cyperus* sp. with 422, *Ischaemum rugosum* with 361, and *Sporobolus africanus* with 349. The top five

accounted for 34.4% of all shrub-layer individuals. Numerical dominance was therefore distributed across several records rather than concentrated in one taxon.

Table 1. Dominant herb-layer records

Common-name label	Audited taxonomic label	Count	Share (%)
Kacang-kacangan liar	<i>Grona triflora</i>	408	21.1
Rumput teki	<i>Cynodon dactylon</i>	205	10.6
Putri Malu	<i>Mimosa pudica</i>	185	9.5
Rumput gajah mini	<i>Axonopus compressus</i>	142	7.3
Rumput Hutan	<i>Brachypodium sylvaticum</i>	78	4.0
Tanaman liar kecil	Unresolved vascular plant	78	4.0
Rumput tikus	<i>Festuca myuros</i>	65	3.4
Sidaguri	<i>Sida acuta</i>	60	3.1
Rumput enneapogon	<i>Eriochloa procera</i>	50	2.6
Rumput Bahia	<i>Eragrostis</i> sp.	48	2.5

Taxonomic note: source spellings were standardized to *Cynodon dactylon*, *Brachypodium sylvaticum*, *Sida acuta* and *Eriochloa procera*. The labels “*Clyptocercus ciliatus*” and “*eragrostis ballirieri*” could not be resolved confidently and are therefore presented as an unresolved vascular plant and *Eragrostis* sp., respectively. These changes standardize nomenclature but do not verify field identity.

The flora is consistent with a disturbed, open, seasonally wet peri-urban environment dominated by grasses, sedges, legumes, and other disturbance-tolerant taxa. Because the source alternately describes the land as herb-shrub cover and rice fields but provides no vegetation map or plot coordinates, the relative extent of active paddy, fallow vegetation, wet depressions, canal margins, compacted ground, and woody cover remains unresolved.

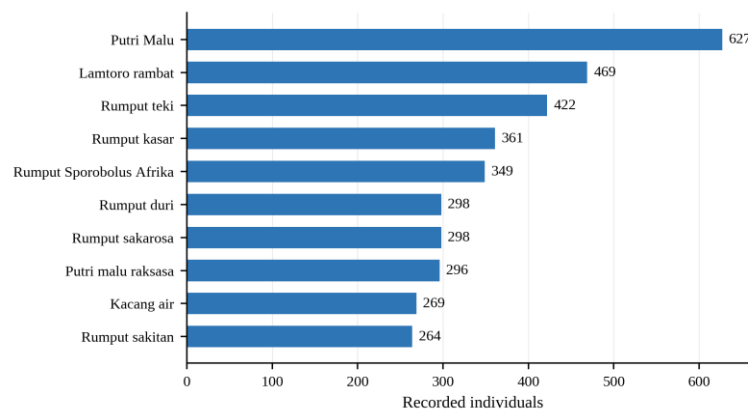


Fig. 3. 10 most abundant shrub-layer records in the 2025 source inventory. Bars show the recorded number of individuals

High ruderal richness should not be equated with ecological integrity because conservation value also depends on native status, habitat specialization, structural complexity, and connectivity (McKinney, 2006; Kowarik, 2011; Aronson et al., 2014). This interpretation is consistent with Makassar studies linking urban bird diversity to green-space area, vegetation structure, disturbance, habitat quality, and connectivity (Mannan & Malik, 2025, 2026). Although their diversity indices are not directly comparable with the present vegetation data, both lines of evidence support retaining connected canal margins, wet depressions, and woody cover rather than relying on isolated ornamental planting.

Table 2. Dominant shrub-layer records

Common-name label	Audited taxonomic label	Count	Share (%)
Putri Malu	<i>Mimosa pudica</i>	627	9.7
Lamtoro rambat	<i>Calopogonium mucunoides</i>	469	7.2
Rumput teki	<i>Cyperus</i> sp.	422	6.5
Rumput kasar	<i>Ischaemum rugosum</i>	361	5.6

<i>Rumput Sporobolus Afrika</i>	<i>Sporobolus africanus</i>	349	5.4
<i>Rumput duri</i>	<i>Cenchrus setosus</i>	298	4.6
<i>Rumput sakarosa</i>	<i>Panicum virgatum</i>	298	4.6
<i>Putri malu raksasa</i>	<i>Mimosa diplotricha</i>	296	4.6
<i>Kacang air</i>	<i>Aeschynomene americana</i>	269	4.2
<i>Rumput sakitan</i>	<i>Panicum virgatum</i>	264	4.1

Taxonomic note: source spellings were standardized to *Sporobolus africanus*, *Cenchrus setosus* and *Mimosa diplotricha*. "*Cyperus compectus*" could not be resolved confidently and is retained only as *Cyperus* sp. The two *Panicum virgatum* rows remain separate because the audit preserves the original row-level structure.

3.2 Diversity-index audit

For the herb layer, the reported $H' = 3.116$ is reproduced only with the printed total of 1,926, although row-level counts sum to 1,938. Using the internally consistent denominator gives $H' = 3.103$, $J' = 0.793$, and $D = 0.081$. The ecological interpretation changes little, but proportions must sum to one.

The shrub discrepancy remains unresolved. The 51 listed counts sum to the reported 6,473 but yield $H' = 3.452$, $J' = 0.878$, and $D = 0.042$ rather than $H' = 3.1162$. No simple denominator change or obvious subset reproduces the reported value, and the original workbook and formulas were unavailable. The manuscript therefore identifies $H' = 3.1162$ as non-reproducible from the available table, uses $H' = 3.452$ for interpretation, and retains the reported value transparently pending verification.

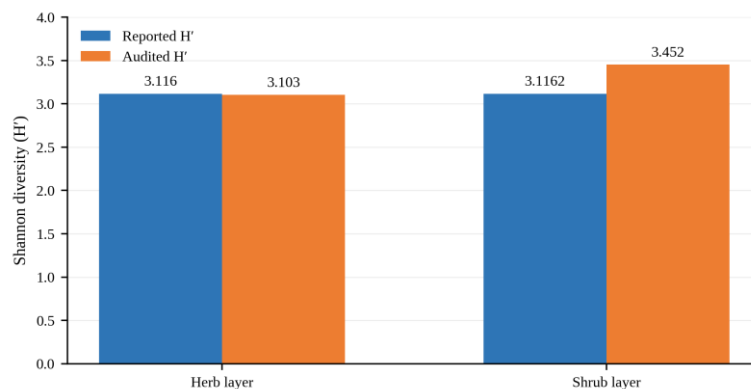


Fig. 4. Reported and independently recalculated Shannon diversity (H') for the herb and shrub layers. Values above bars show H'

Shannon diversity above three is often labelled high in applied environmental reports, but a fixed threshold has limited ecological meaning across different sampling designs. H' increases with richness and evenness and depends on taxonomic resolution. Comparing H' between the herb and shrub strata is only valid if field effort, area, counting rules, and identification standards are comparable. The source did not document these conditions. International reporting should therefore present the metric, the formula, the log base, the underlying sample size, and the sampling design rather than relying on the word high as the primary result (Jost, 2006; Chao et al., 2014; Morris et al., 2014).

Table 3. Audit of vegetation abundance totals and diversity metrics

Stratum	Records (S)	Printed total	Summed total	Reported H'	Audited H'	Pielou J'	Simpson D
Herb	50	1,926	1,938	3.116	3.103	0.793	0.081
Shrub	51	6,473	6,473	3.1162	3.452	0.878	0.042

3.3 Terrestrial fauna and the limits of occurrence data

The terrestrial survey recorded two mammals, three birds, one amphibian, two reptiles, one annelid group, and six arthropod groups, mostly taxa associated with human-modified, agricultural, wetland-edge, or open habitats. These few vertebrate records should not be interpreted as complete poverty or absence because survey effort was not standardized and detectability varies among taxa. Repeated point counts, camera traps, acoustic monitoring, cover boards, pitfall traps, and habitat measurements can better separate non-detection from true absence (Lepczyk et al., 2017; Nilon et al., 2017; Mainwaring et al., 2024).

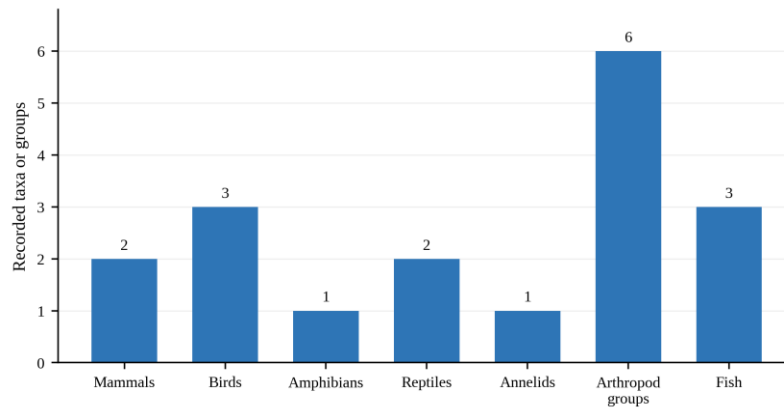


Fig. 5. Faunal records by broad taxonomic group in the 2025 source survey. Bars represent the number of recorded taxa or higher-level groups

The source statement that no protected fauna were found should be limited to no protected fauna were identified during the available survey. Several records remain above species level, so legal status requires taxonomic verification and comparison with the protected-species list under Minister of Environment and Forestry Regulation No. P.20/2018 and its amendments, consistent with Indonesia's conservation framework under Law No. 32 of 2024. Pre-construction verification should include standardized effort, coordinates, seasonal replication, and photographs or vouchers where appropriate.

Table 4. Terrestrial fauna records after taxonomic standardization

Group	Common name	Audited taxonomic label	Evidence or taxonomic note
Mammal	Rat	<i>Rattus</i> sp.	Source label " <i>Rattus axulans</i> " unresolved; genus retained
Mammal	Domestic dog	<i>Canis familiaris</i>	Community information; current MDD species name
Bird	House sparrow	<i>Passer domesticus</i>	Direct observation; IOC name retained
Bird	Scaly-breasted munia	<i>Lonchura punctulata</i>	Direct observation; IOC name retained
Bird	Javan pond heron	<i>Ardeola speciosa</i>	Direct observation; IOC name retained
Amphibian	Toad	<i>Bufo</i> sp.	Source label " <i>Bufo</i> sp."; genus unresolved
Reptile	Monitor lizard	<i>Varanus</i> sp.	Direct observation; genus retained
Reptile	Skink	<i>Scincidae</i>	Source Mabuya/ <i>Eutropis</i> label; genus unresolved
Annelid	Leech	<i>Hirudinea</i>	Community information; higher taxon retained

Arthropod	Grasshopper	<i>Caelifera</i>	Higher-level field record
Arthropod	Dragonfly	<i>Anisoptera</i>	Higher-level field record
Arthropod	Butterfly	<i>Lepidoptera</i>	Source " <i>Rhopalocera</i> "; standardized to formal order
Arthropod	Spider	<i>Araneae</i>	Higher-level field record
Arthropod	Red ant	<i>Solenopsis</i> sp.	Genus-level field record
Arthropod	Black ant	<i>Lasius</i> sp.	Source species label not voucher-verified; genus retained

Taxonomic note: *Canis familiaris* follows Mammal Diversity Database v2.5. The source amphibian and skink labels were reduced to *Bufo* and *Scincidae* because genus-level identifications cannot be verified from the available evidence. "*Rhopalocera*" was standardized to the formal order *Lepidoptera*. Genus-level *Rattus*, *Varanus*, *Solenopsis*, and *Lasius* records were retained without unsupported species assignment.

Future fauna surveys should pair observations with vegetation structure, including canopy cover, vegetation height, shrub density, ground cover, and wetland proximity. Remote-sensing measures can support, but not replace, species-level field observations (Fairbairn et al., 2025; Hernandez-Santin et al., 2025). Three fish taxa were reported. Their presence indicates continuing aquatic habitat function, but abundance, size structure, recruitment, and connectivity were not measured, and the suckermouth catfish identification requires species-level confirmation. Future nekton monitoring should use standardized gear and effort.

3.4 Plankton community and biological indication of canal condition

At T1, 7,500 phytoplankton units were counted across seven records; *Navicula* sp. (48.6%) and *Oscillatoria* sp. (29.2%) dominated. Audited metrics were $H' = 1.3641$, $J' = 0.7010$, and $D = 0.3348$. The source prose matches $H' = 1.3641$, while the table value of 1.3541 appears to be a transcription inconsistency.

At T2, 1,590 phytoplankton units occurred across eight records, dominated by *Navicula* sp. 1 (47.2%) and *Oscillatoria* sp. (39.6%). Audited values were $H' = 1.1965$, $J' = 0.5754$, and $D = 0.3839$. The reported H' is reproduced when 300 *Paramecium* sp. records are excluded, confirming that the index refers to phytoplankton only.

Most plankton discrepancies are therefore explainable: T1 differs by transcription, the source evenness values use H'/S rather than Pielou's $H'/\ln S$, and T2 depends on excluding *Paramecium* sp. The shrub-layer Shannon value remains the only major biodiversity-index discrepancy that cannot be reproduced from the available source materials.

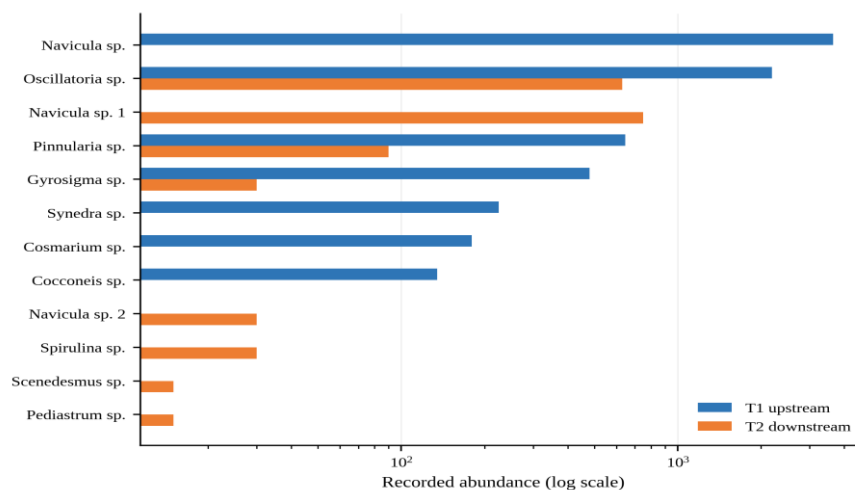


Fig. 6. Recorded phytoplankton abundance at upstream (T1) and downstream (T2) Tamangapa Canal stations. The abundance axis is logarithmic; taxa not recorded at a station have no bar

Under the source's own classification, both H' values fall within the moderately polluted range (1.0–1.6), not the lightly polluted category stated in the report. This is a biological screening result rather than a regulatory water-quality diagnosis. Consistent with Government Regulation No. 22 of 2021, it should be corroborated with physicochemical monitoring and repeated upstream, site-adjacent, and downstream sampling.

Table 5. Audit of plankton metrics at the two canal stations

Metric	T1 upstream	T2 downstream	Interpretation
Phytoplankton records (S)	7	8	Different taxonomic composition
Total phytoplankton count	7,500	1,590	Lower source count at T2
Reported Shannon H'	1.3641 in prose; 1.3541 in table	1.1965	T1 table contains a transcription inconsistency
Audited Shannon H'	1.3641	1.1965	Moderate diversity under the source thresholds
Reported evenness	0.1949	0.1496	Calculated as H'/S , not Pielou evenness
Audited Pielou J'	0.7010	0.5754	Both communities are uneven
Audited Simpson D	0.3348	0.3839	No single record exceeds $D=0.5$, but two taxa dominate numerically
Zooplankton record	None	<i>Paramecium sp.</i> , 300	Excluded from T2 phytoplankton indices

The dominance of *Navicula* and *Oscillatoria* warrants follow-up but cannot identify a specific stressor at genus level. Future monitoring should pair plankton with temperature, pH, dissolved oxygen, conductivity, turbidity, suspended solids, nutrients, chlorophyll-a, discharge, antecedent rainfall, and standardized field/laboratory metadata, with wet- and dry-season replication. A before-after-control-impact design would better distinguish development effects from hydrological and seasonal variation (Reynolds et al., 2002; Padiśák et al., 2009; Salmaso et al., 2015; Barberoux et al., 2025).

3.5 Biomass estimate and green-open-space requirement

The source applied 12 t/ha to 29.6739 ha. The correct product is 356.1 t, not 356.1 ha. Biomass is a mass, so the hectare unit in the original result is incorrect. Dividing 356.1 t by the assumed tree-based biomass density of 35 t/ha gives 10.17 ha. The source printed 10.75 ha, but the stated inputs yield 10.17 ha. The corrected numerical equivalence represents 34.3% of the project area.

29.67 ha

Project area

356.1 t

Estimated existing
biomass

10.17 ha

Equivalent tree-based
green-space area

Fig. 7. Planning-level values derived from the source assumptions: project area, estimated existing biomass, and equivalent tree-based green-space area. Values use different units and are therefore presented separately

The 10.17 ha value is a numerical biomass equivalence, not an ecological offset. Seasonal rice biomass and maturing tree biomass differ in turnover, habitat structure, hydrological function, food-production value, and ecosystem services; tonnes per hectare

therefore compare mass rather than ecological equivalence. Green-space design should prioritize connected riparian vegetation, street-tree corridors, retention areas, and multi-layer planting. A diverse palette, preferably dominated by native or verified non-invasive species, should consider invasiveness, rooting and crown traits, flood and drought tolerance, utility conflicts, and maintenance. Shrubs, herbs, floral resources, and reduced mowing can further increase structural and functional habitat diversity (Alvey, 2006; Livesley et al., 2016; Endreny et al., 2017; Kendal et al., 2014; Sjöman et al., 2016; Baldock et al., 2019; Threlfall et al., 2017).

Monitoring should emphasize survival and canopy development rather than planting numbers alone. Survival, canopy diameter, height, stem condition, replacement, irrigation, and damage should be tracked, with biomass reassessed at years 1, 3, 5, and 10 using measured tree dimensions. This functional approach is consistent with IBSAP 2025–2045 and Minister of Agrarian Affairs and Spatial Planning/National Land Agency Regulation No. 14 of 2022, which emphasize measurable biodiversity outcomes and ecological functions of green open space (National Development Planning Agency, 2024). The 10.17 ha figure should therefore remain a planning benchmark, not a sufficient compensation target.

3.6 Integrated mitigation and monitoring framework

The mitigation hierarchy begins with avoidance and minimization. Canal margins, wet depressions, and remaining woody vegetation should be mapped and protected before earthworks; stockpiles, fuel, concrete washout, and vehicle maintenance should remain outside riparian protection zones. Clearing should be staged, preceded by fauna inspection, and supported by erosion control, directed lighting, and careful chemical use. Restoration should begin during construction using multiple functional plant groups, mortality-replacement obligations, hydrological design, habitat connectivity, and measurable canopy targets. The corrected 10.17 ha biomass-equivalence value can inform planning but should not replace statutory or ecological green-space requirements.

Table 6. Proposed biodiversity mitigation and monitoring framework

Hierarchy	Component	Required action	Performance indicator
Avoid	Canal and wet habitats	Map and fence a riparian no-disturbance zone before clearing	No unauthorized clearing, stockpiling, or discharge
Minimize	Vegetation and fauna	Stage clearing and conduct pre-clearance fauna inspection	Inspection records and incident-free fauna handling
Restore	Green infrastructure	Establish connected multi-layer vegetation during construction	Permanent area, survival, canopy cover, and native-species share
Control	Invasive species	Verify high-risk taxa and remove new invasive outbreaks early	No expanding invasive population in permanent plots
Monitor	Terrestrial biodiversity	Repeat standardized surveys in wet and dry seasons	Comparable effort, coordinates, photographs, and verified taxonomy
Monitor	Aquatic condition	Sample upstream, adjacent, and downstream stations with chemistry and biota	No persistent deterioration beyond baseline variability
Audit	Biomass and canopy	Measure planted trees at years 1, 3, 5, and 10	Observed biomass and canopy trajectory toward approved targets
Disclose	Data quality	Maintain raw sheets, calculation files, and taxonomic evidence	All reported totals and indices reproducible

Monitoring requires explicit indicators and triggers. Permanent vegetation plots should track richness, abundance, cover, native status, survival, and canopy development; fauna surveys should use standardized wet- and dry-season effort; and canal monitoring should combine biota with physicochemical parameters. Persistent sediment, low dissolved

oxygen, canopy loss, invasive expansion, or marked departures from baseline conditions should trigger corrective action.

The framework in Table 6 integrates evidence that urban biodiversity depends on space, connectivity, structural complexity, and management quality with Indonesian policy emphasizing measurable conservation and monitoring outcomes (Beninde et al., 2015; Aronson et al., 2017; Lepczyk et al., 2017; Spotswood et al., 2021). Its practical contribution is a reproducible chain from field data to decision: raw totals and indices are auditable, taxonomic uncertainty is disclosed, and management indicators can be repeated through construction and operation.

4. Conclusions

The audited 2025 baseline indicates disturbance-associated herb and shrub vegetation, limited and incompletely standardized fauna records, and a canal phytoplankton community requiring further verification. Recalculation produced herb $H'=3.103$ from 1,938 individuals and shrub $H'=3.452$ from 6,473 individuals; the latter remains inconsistent with the reported value. Canal H' values of 1.364 upstream and 1.197 downstream fall within the source's moderate-pollution category but require physicochemical and seasonal confirmation. The corrected biomass estimate is 356.1 t, equivalent to 10.17 ha of tree-based green space under the stated coefficients, but this is not an ecological offset. Management should therefore prioritize riparian and wet-area protection, verified taxonomy, connected multi-layer green infrastructure, invasive-species control, and reproducible wet- and dry-season monitoring.

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Author Contribution

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Not available. The study analyzed environmental field observations and did not involve experimental research on humans or captive vertebrate animals. Any future fauna handling must follow applicable permits and animal-welfare procedures.

Informed Consent Statement

Not available.

Data Availability Statement

The row-level vegetation and plankton data analyzed in this article are summarized in the manuscript tables. Original field sheets, photographs, specimens, laboratory worksheets, and geospatial layers are held by the project environmental-study team and may be available from the corresponding author subject to authorization.

Conflicts of Interest

The authors declare no conflict of interest.

Declaration of Generative AI Use

During the preparation of this work, the authors used OpenAI ChatGPT to assist with English-language editing, manuscript restructuring, numerical consistency checks, visualization, and formatting to the journal template. The authors reviewed the content, verified calculations against the source tables, and take full responsibility for the publication.

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