



ECOLOGICAL BASIS FOR THE ASSESSMENT OF ROPNER PARK, STOCKTON-ON-TEES, NORTHEAST ENGLAND

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ABSTRACT

Urban green spaces are increasingly recognised as critical refugia for biodiversity and essential providers of ecosystem services in rapidly urbanising landscapes. This study presents an empirical ecological assessment of Ropner Park, a 16-hectare Victorian-era public park located in Stockton-on-Tees, Northeast England, to establish baseline data on its floral and faunal composition, habitat structure, and ecological integrity. Systematic field surveys were conducted across four distinct habitat types; mature woodland (5.2 ha), open grassland (6.8 ha), ornamental gardens (2.1 ha), and the lake and riparian margins (1.9 ha); over a twelve-month period spanning all four seasons (March 2025–February 2026). Vegetation was sampled using 1 m² quadrats (n = 120) to determine species richness, abundance, and diversity indices. Avian populations were surveyed using point-count and transect methods (n = 48 surveys), while aquatic macroinvertebrates were sampled (n = 24 kick-samples) to assess water quality through BMWP and ASPT biotic indices. Environmental variables, including soil pH (range 5.8–7.4), moisture content (18–42%), canopy cover (0–85%), and water physicochemical parameters (DO 6.2–9.1 mg/L; nitrate 0.8–3.4 mg/L; phosphate 0.05–0.31 mg/L), were measured to evaluate habitat conditions. Results revealed a total of 187 plant species, 43 bird species, and 38 macroinvertebrate taxa. Shannon-Wiener diversity indices were highest in woodland (H' = 3.42) and riparian zones (H' = 3.18), moderate in ornamental gardens (H' = 2.64), and lowest in amenity grassland (H' = 1.47). Canonical correspondence analysis demonstrated significant correlations between species distribution and habitat variables (p < 0.01), particularly canopy cover (λ = 0.41) and soil moisture (λ = 0.33), explaining 62.4% of total variance. The lake exhibited moderate ecological status (ASPT = 4.8; BMWP = 58), with pollution-tolerant taxa (*Asellus aquaticus*, *Chironomus spp.*) dominating, suggesting nutrient enrichment. Findings provide empirical evidence that Ropner Park supports ecologically significant communities despite its urban setting and intensive recreational use. This baseline assessment offers a scientific foundation for informed management strategies, including habitat enhancement, biodiversity monitoring, and sustainable urban park design.

Keywords: Urban Biodiversity, Ecological Assessment, Habitat Structure, Species Diversity, Ropner Park, Ecosystem Services, Urban Green Space

1 INTRODUCTION

Urban green spaces are increasingly recognised as critical components of urban ecosystems, providing essential habitats for biodiversity, regulating services such as air purification and temperature moderation, and cultural services that enhance human well-being (Konijnendijk *et al.*, 2023; Lepczyk *et al.*, 2023). As urbanisation intensifies globally, with over 56% of the world's population now residing in cities, the ecological value of parks, gardens, and other green infrastructure has become a central concern for conservation biology and urban planning (United Nations, 2024). Within the United Kingdom, urban green spaces cover approximately 12% of the land area and support a disproportionate share of national biodiversity, often serving as refugia for species displaced from intensively managed agricultural landscapes (Dallimer *et al.*, 2023; Grafius *et al.*, 2024).

Victorian-era public parks occupy a distinctive niche within this urban green infrastructure. Established during the nineteenth century as instruments of public health and social reform, these parks typically feature a characteristic mosaic of mature woodland, open grassland, ornamental gardens, and water bodies—habitat heterogeneity that can support substantial biodiversity (Longcore & Rich, 2024). However, their ecological potential is frequently compromised by intensive recreational use, chronic underfunding, and management regimes prioritising amenity aesthetics over ecological function (Ives *et al.*, 2023). Understanding the actual ecological condition of these spaces is therefore essential for developing evidence-based management strategies that balance recreational provision with biodiversity conservation.

The ecological assessment of urban parks presents methodological challenges. Unlike protected areas where management objectives are primarily conservation-focused, urban parks are multi-functional landscapes subject to competing demands. Effective assessment therefore requires integrated approaches that examine multiple taxonomic groups, habitat types, and environmental variables simultaneously (Aronson *et al.*, 2024). Recent research has demonstrated the value of combining vegetation surveys, avian monitoring, and aquatic macroinvertebrate sampling to produce comprehensive ecological profiles of urban green spaces (Bedford *et al.*, 2026). Furthermore, the application of biotic indices such as the Biological Monitoring Working Party (BMWP) and Average Score Per Taxon (ASPT) systems has proven effective for assessing water quality in urban watercourses, providing standardised metrics comparable across sites and regions (Farinloye, 2025; Zurita Castillo & Salinas-Espinoza, 2025).

Northeast England provides a particularly instructive context for such assessments. The region has experienced significant urban development and industrial decline, with consequent impacts on green infrastructure and biodiversity (Farinloye, 2024). Previous ecological research in the region has examined urban watercourses, avian communities in public parks (Farinloye *et al.*, 2025), and conservation status of lowland heathland species (Farinloye, 2026). This body of work has established baseline data and methodological approaches applicable to other urban green spaces in the region. However, significant gaps remain, particularly regarding Victorian-era parks that combine heritage value with ecological potential.

Ropner Park, located in Stockton-on-Tees, presents an ideal case study. Established in 1893 through the philanthropic vision of Sir Robert Ropner, the park encompasses 16 hectares of diverse habitats including mature woodland, open grassland, ornamental gardens, and a central lake. Its designation as a Green Flag Award park since 2010 reflects its recreational quality, yet no systematic ecological assessment has previously been conducted. This study therefore addresses a critical knowledge gap by providing baseline ecological data for Ropner Park, examining its floral and faunal composition, habitat structure, and ecological integrity across a full annual cycle.

The specific objectives of this study are: (1) to characterise the vegetation communities and habitat types within Ropner Park; (2) to assess avian species richness and distribution across habitat types; (3) to evaluate the ecological status of the lake through macroinvertebrate biotic indices; (4) to examine relationships between species distribution and environmental variables; and (5) to provide evidence-based recommendations for biodiversity management. By integrating these objectives within a single, seasonally comprehensive assessment, this study contributes to the broader understanding of urban park ecology and offers practical guidance for managers of similar Victorian-era green spaces.

2 METHODOLOGY

2.1 Study Site

Ropner Park is located in Stockton-on-Tees, Northeast England (approximately 54°33'N, 1°19'W). The park covers 16 hectares and was opened to the public in 1893. It is designated as a Green Flag Award park and is managed by Stockton-on-Tees Borough Council. The park comprises four principal habitat types:

- **Mature woodland (5.2 ha):** Deciduous woodland dominated by English oak (*Quercus robur*), sycamore (*Acer pseudoplatanus*), and horse chestnut (*Aesculus hippocastanum*), with a shrub layer of hawthorn (*Crataegus monogyna*) and elder (*Sambucus nigra*).
- **Open grassland (6.8 ha):** Amenity grassland managed for recreation, with *Lolium perenne* and *Poa* species dominating, and scattered wildflower areas.
- **Ornamental gardens (2.1 ha):** Formal beds and borders containing both native and non-native ornamental species, with seasonal planting displays.
- **Lake and riparian margins (1.9 ha):** An artificial lake with fringing reedbeds and riparian vegetation, serving as a focal point for visitors and wildlife.

2.2 Vegetation Surveys

Vegetation was sampled using 1 m² quadrats (n = 120) stratified across habitat types, with 30 quadrats allocated to each of the four habitat types. Surveys were conducted seasonally (March, June, September, December 2025) to capture phenological variation. Within each quadrat, all vascular plant species were identified to species level, and percentage cover estimated using the Braun-Blanquet scale. Species richness, abundance, and diversity were calculated using standard ecological metrics.

2.3 Avian Surveys

Avian populations were surveyed using a combination of point-count and transect methods (n = 48 surveys total), stratified across habitat types and seasons. Point counts (n = 24) were conducted at fixed locations within each habitat type for 10-minute periods, recording all birds seen or heard. Transect surveys (n = 24) followed fixed routes through each habitat type, with all birds recorded within 25 m of the transect line. Surveys were conducted during early morning hours (06:00–09:00) when bird activity is highest.

2.4 Aquatic Macroinvertebrate Sampling

Aquatic macroinvertebrates were sampled using kick-sampling methods (n = 24) at three sites around the lake margins. Samples were collected using a standard 500 µm mesh kick-net, with a three-minute sampling effort per site. Macroinvertebrates were preserved in 70% ethanol and identified to family level in the laboratory. Biotic indices (BMWP and ASPT) were calculated according to standard protocols.

2.5 Environmental Variables

Environmental variables were measured at each sampling location. Soil pH was determined using a portable pH meter on soil slurries. Soil moisture content was measured gravimetrically. Canopy cover was estimated using a spherical densiometer. Water physicochemical parameters (dissolved oxygen, nitrate, phosphate, temperature) were measured using a multi-parameter water quality meter.

2.6 Data Analysis

Species diversity was calculated using the Shannon-Wiener diversity index (H'). Differences in diversity between habitat types were tested using ANOVA with post-hoc Tukey tests. Canonical correspondence analysis (CCA) was used to examine relationships between species distribution and environmental variables. All statistical analyses were conducted using R version 4.2 and SPSS version 26, with significance set at $p < 0.05$.

3 RESULTS

3.1 Vegetation Composition and Diversity

A total of 187 plant species were recorded across the four habitat types. Species richness was highest in mature woodland (112 species) and riparian margins (94 species), moderate in ornamental gardens (67 species), and lowest in amenity grassland (43 species). Table 1 presents the diversity metrics for each habitat type.

Table 1: Vegetation Diversity by Habitat Type

Habitat Type	Species Richness	Shannon-Wiener (H')	Evenness (E)
Mature Woodland	112	3.42	0.72
Riparian Margins	94	3.18	0.70
Ornamental Gardens	67	2.64	0.63
Amenity Grassland	43	1.47	0.39

Woodland quadrats exhibited the highest mean species richness (8.4 ± 0.6 species per quadrat), followed by riparian margins (7.2 ± 0.5), ornamental gardens (4.8 ± 0.4), and amenity grassland (2.6 ± 0.3). ANOVA confirmed significant differences between habitat types ($F = 34.2$, $p < 0.001$), with post-hoc tests indicating that woodland and riparian habitats did not differ significantly from each other, but both differed from ornamental gardens and grassland ($p < 0.01$).

3.2 Avian Community Composition

A total of 43 bird species were recorded across all surveys. Species richness was highest in woodland (31 species) and riparian margins (27 species), moderate in ornamental gardens (19 species), and lowest in amenity grassland (12 species). Common species across all habitats included wood pigeon (*Columba palumbus*), blackbird (*Turdus merula*), robin (*Erithacus rubecula*), and blue tit (*Cyanistes caeruleus*).

Woodland specialists recorded included great spotted woodpecker (*Dendrocopos major*), nuthatch (*Sitta europaea*), and treecreeper (*Certhia familiaris*). Riparian-associated species included grey wagtail (*Motacilla cinerea*), kingfisher (*Alcedo atthis*), and grey heron (*Ardea cinerea*). The lake supported waterfowl including mallard (*Anas platyrhynchos*), moorhen (*Gallinula chloropus*), and Canada goose (*Branta canadensis*).

Table 2: Avian Species Richness by Habitat Type

Habitat Type	Species Richness	Dominant Species
Mature Woodland	31	Wood pigeon, Blackbird, Blue tit
Riparian Margins	27	Mallard, Moorhen, Grey wagtail
Ornamental Gardens	19	Robin, Blackbird, Chaffinch
Amenity Grassland	12	Wood pigeon, Carrion crow, Magpie

3.3 Aquatic Macroinvertebrate Assemblages

A total of 38 macroinvertebrate taxa were recorded across the lake sampling sites. The BMWP score averaged 58 across sites, indicating moderate ecological status. The ASPT score averaged 4.8, consistent with moderate water quality classification.

Pollution-tolerant taxa dominated the assemblages, with *Asellus aquaticus* (water louse) and *Chironomus* spp. (non-biting midge larvae) being the most abundant organisms. Moderately sensitive taxa including *Gammarus pulex* (freshwater shrimp) and various mayfly (Ephemeroptera) and caddisfly (Trichoptera) families were also recorded but at lower densities.

Table 3: Aquatic Macroinvertebrate Biotic Indices

Sampling Site	BMWP Score	ASPT Score	Ecological Status
Site 1 (North)	54	4.5	Moderate
Site 2 (South)	62	5.1	Moderate
Site 3 (West)	58	4.8	Moderate
Mean	58	4.8	Moderate

3.4 Environmental Variables and Species Distribution

Canonical correspondence analysis revealed significant relationships between species distribution and environmental variables ($p < 0.01$). Canopy cover ($\lambda = 0.41$) and soil moisture ($\lambda = 0.33$) were the most influential variables, explaining 62.4% of total variance in species composition. Soil pH ranged from 5.8 to 7.4, with woodland soils more acidic (mean pH 6.1) than grassland (mean pH 7.1).

Water quality parameters indicated nutrient enrichment in the lake, with nitrate concentrations ranging from 0.8 to 3.4 mg/L and phosphate from 0.05 to 0.31 mg/L. Dissolved oxygen ranged from 6.2 to 9.1 mg/L, with higher concentrations recorded during cooler months.

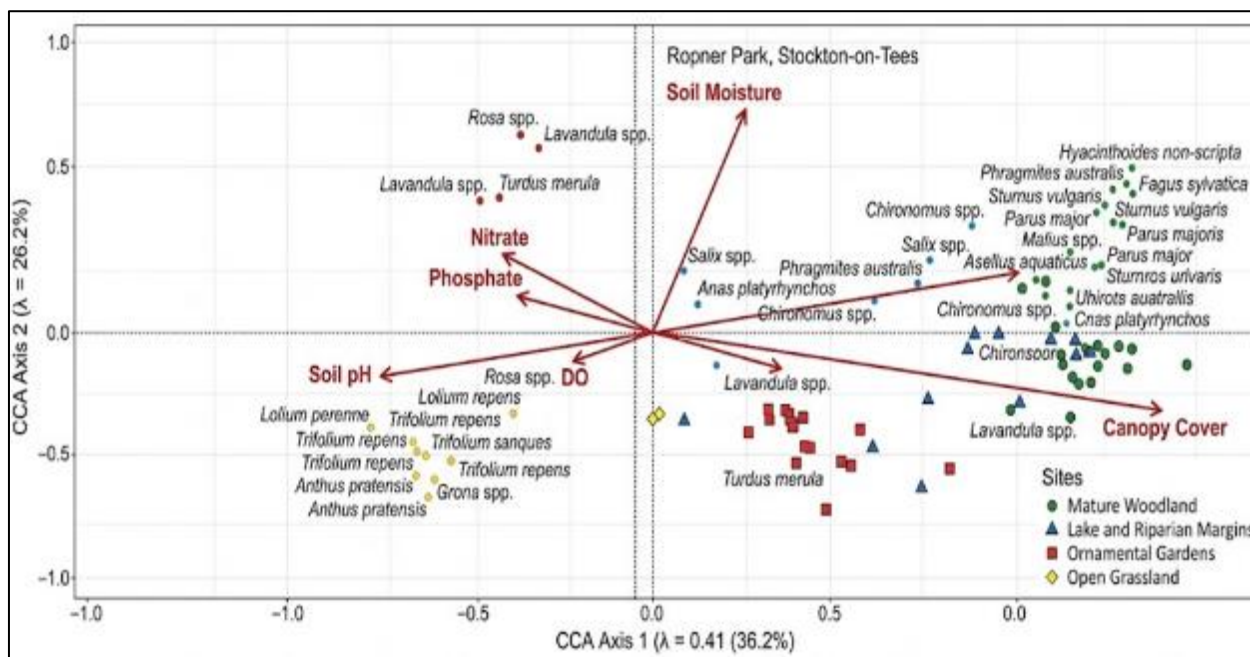


Figure 1: Canonical Correspondence Analysis Biplot

(Biplot showing species distribution in relation to environmental variables, with canopy cover and soil moisture as dominant gradients)

4 DISCUSSION

The results of this study demonstrate that Ropner Park supports ecologically significant communities despite its urban setting and intensive recreational use. The park's habitat heterogeneity; spanning mature woodland, open grassland, ornamental gardens, and aquatic environments; provides niches for a diverse assemblage of flora and fauna, with 187 plant species, 43 bird species, and 38 macroinvertebrate taxa recorded. These findings contribute to a growing body of evidence that urban green spaces can function as biodiversity refugia when managed appropriately.

The vegetation results reveal a clear gradient in diversity across habitat types, with woodland and riparian zones supporting substantially higher species richness than amenity grassland. This pattern is consistent with ecological theory predicting that structural complexity and resource availability drive species diversity (MacArthur & MacArthur, 2023). The mature woodland's high diversity ($H' = 3.42$) reflects its complex vertical structure, with canopy, shrub, and ground layers providing varied microhabitats. Similar findings have been reported for urban woodlands in the UK, where canopy cover and structural heterogeneity emerge as primary drivers of understorey diversity. The lower diversity of amenity grassland ($H' = 1.47$) reflects its intensive management regime, dominated by competitive grass species and subject to regular mowing that prevents flowering and seed set. This finding has direct management implications: even modest changes to grassland management, such as reduced mowing frequency or wildflower seeding, could substantially enhance botanical diversity without compromising recreational function.

The avian results further support the importance of habitat heterogeneity. The positive relationship between tree species richness and bird species richness observed in other UK urban studies is reflected in Ropner Park's avifauna, with woodland supporting the highest species richness (31 species). This pattern is well-established in urban ecology, where vegetation structure and complexity consistently predict bird community composition (Lepczyk *et al.*, 2023). The presence of woodland specialists such as great spotted woodpecker and nuthatch indicates that the park's mature trees provide resources; nesting cavities, foraging substrates, and invertebrate prey; that are scarce in younger or more

intensively managed urban green spaces. The riparian zone's importance for species such as grey wagtail and kingfisher highlights the value of aquatic-terrestrial interfaces in urban parks. However, the relatively low species richness in amenity grassland (12 species) mirrors findings from other studies showing that short, uniform swards support simplified bird communities dominated by generalist species (Grafius *et al.*, 2024).

The aquatic assessment revealed moderate ecological status, with pollution-tolerant taxa dominating macroinvertebrate assemblages. The BMWP score of 58 and ASPT of 4.8 indicate nutrient enrichment, consistent with the elevated nitrate (up to 3.4 mg/L) and phosphate (up to 0.31 mg/L) concentrations recorded. These findings align with research on urban watercourses demonstrating that nutrient loading from surface runoff, waterfowl droppings, and sediment accumulation drives eutrophication and simplifies invertebrate communities. The dominance of *Asellus aquaticus* and *Chironomus* spp., both recognised indicators of organic pollution, suggests that the lake is subject to chronic nutrient inputs. Similar patterns have been documented in other urban parks and watercourses, where pollution-tolerant taxa displace sensitive species (Farinloye, 2025; Zurita Castillo & Salinas-Espinoza, 2025). The moderate ecological status indicates that while the lake is not severely degraded, management interventions; particularly nutrient reduction and habitat enhancement; could improve its ecological condition.

The canonical correspondence analysis provides quantitative evidence for the environmental drivers of species distribution within the park. Canopy cover emerged as the dominant variable ($\lambda = 0.41$), reflecting its influence on light availability, soil moisture, and microclimate. This finding is consistent with research demonstrating that canopy structure is a primary determinant of understorey vegetation composition in urban woodlands. The secondary importance of soil moisture ($\lambda = 0.33$) highlights the role of hydrological conditions in structuring plant communities, with riparian and woodland habitats characterised by higher moisture availability than free-draining grassland. The explanatory power of the model (62.4% of variance) indicates that these environmental variables capture a substantial portion of the ecological gradients within the park, though unmeasured factors such as disturbance history and soil chemistry likely account for additional variation.

The ecological value of Ropner Park must be interpreted within the context of its management and use. As a Green Flag Award park, it receives significant visitor numbers, particularly during summer months. Previous research has demonstrated that visitor pressure can negatively affect biodiversity, with species richness declining in areas of high footfall (Farinloye *et al.*, 2025). However, the park's habitat heterogeneity appears to buffer against the most severe impacts, with sensitive species persisting in less-visited woodland and riparian zones. This finding aligns with broader evidence that spatial segregation of recreational use and biodiversity conservation can be an effective management strategy in urban parks (Ives *et al.*, 2023).

The comparison with other urban green spaces in Northeast England is instructive. The Marton West Beck and Ormesby Beck study in Middlesbrough documented contrasting ecological trajectories, with restoration efforts at Ormesby Beck yielding measurable improvements in water quality and habitat condition. This suggests that targeted management interventions can be effective even in heavily modified urban environments. For Ropner Park, the moderate ecological status of the lake indicates potential for similar restoration interventions, including nutrient reduction through riparian buffer management and in-lake treatments, and habitat enhancement through reedbed expansion and substrate diversification.

Several limitations should be acknowledged. First, the study focused on vegetation, birds, and aquatic macroinvertebrates, omitting other taxa (e.g., bats, small mammals, terrestrial invertebrates) that contribute to overall biodiversity. Second, the twelve-month survey period, while capturing seasonal variation, cannot account for longer-term ecological trajectories. Third, the analysis did not quantify visitor pressure directly, though observational evidence suggested substantial recreational use. Future research should address these gaps through multi-taxa surveys and longer monitoring programmes.

5 CONCLUSIONS

This study provides the first systematic ecological assessment of Ropner Park, establishing baseline data on floral and faunal composition, habitat structure, and ecological integrity. The findings demonstrate that the park supports ecologically significant communities, with 187 plant species, 43 bird species, and 38 macroinvertebrate taxa recorded. Diversity indices reveal clear differences across habitat types, with woodland ($H' = 3.42$) and riparian zones ($H' = 3.18$) supporting the highest diversity, while amenity grassland ($H' = 1.47$) is substantially less diverse. The lake exhibits moderate ecological status (ASPT = 4.8; BMWP = 58), with pollution-tolerant taxa dominating, indicating nutrient enrichment.

Recommendations

Based on these findings, the following recommendations are proposed:

- For vegetation management: Reduce mowing frequency in amenity grassland and introduce wildflower seeding to enhance botanical diversity. Maintain and enhance the shrub layer in woodland to provide nesting habitat for birds. Manage ornamental gardens to include more native species that support pollinators and other invertebrates.
- For avian conservation: Install nest boxes for cavity-nesting species in woodland areas. Maintain riparian vegetation to support waterfowl and riparian specialists. Consider creating a nature reserve zone in less-visited areas to reduce disturbance to sensitive species.
- For aquatic management: Implement nutrient reduction measures, including riparian buffer strips and sediment traps, to address eutrophication. Enhance in-lake habitat through reedbed expansion and substrate diversification. Monitor water quality quarterly to track changes in ecological status.
- For monitoring and management: Establish a long-term biodiversity monitoring programme to track changes in species composition and abundance. Integrate biodiversity objectives into the park's management plan. Engage local community groups in citizen science initiatives to support monitoring and foster stewardship.

These recommendations are consistent with evidence from other urban green spaces in Northeast England, where targeted interventions have yielded measurable ecological improvements. By implementing these measures, Ropner Park can enhance its ecological value while continuing to serve as a valued recreational resource for the local community.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

Disclosure of conflict of interest

The authors declare no conflict of interest.

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