Assessment of Ecological Resources of Two Major Becks in Middlesbrough, North Yorkshire, United Kingdom

Abstract

Urban watercourses are critical ecological assets, yet they face significant anthropogenic pressures. This study presents a quantitative assessment of the ecological resources of two prominent becks in Middlesbrough, North Yorkshire: Marton West Beck and Ormesby Beck. These becks were selected due to their contrasting management profiles; Marton West Beck represents a typically modified urban watercourse, while Ormesby Beck has recently undergone significant restoration, including the removal of a tidal barrier. A comparative research design was employed, establishing six sampling sites across both becks (three per beck). At each site, key physico-chemical water quality parameters (pH, Dissolved Oxygen, Turbidity, Nitrate, Phosphate), physical habitat quality (using the River Habitat Survey - RHS), and macroinvertebrate assemblages (using the Biological Monitoring Working Party - BMWP and Average Score Per Taxon - ASPT indices) were assessed. The results indicate a significant disparity in ecological health between the two becks. Marton West Beck exhibited characteristics of a heavily impacted urban river, with significantly higher mean concentrations of phosphate (0.45 mg/L) and nitrate (6.8 mg/L), and lower biological water quality, reflected by a mean BMWP score of 65 and an ASPT of 4.1. Its physical habitat was classified as 'Significantly Modified' with a mean Habitat Modification Score (HMS) of 28. In contrast, Ormesby Beck showed marked signs of ecological recovery. Mean phosphate (0.21 mg/L) and nitrate (4.2 mg/L) levels were lower, and biological indices were significantly higher (mean BMWP = 98, mean ASPT = 5.2). The RHS assessment for Ormesby Beck indicated a 'Predominantly Unmodified' to 'Obviously Modified' channel (mean HMS = 15), with higher Habitat Quality Assessment (HQA) scores in the restored downstream reaches. The findings suggest that targeted restoration efforts, such as the re-establishment of tidal connectivity in Ormesby Beck, can yield substantial improvements in the ecological resources of urban watercourses. The study underscores the ongoing challenges facing Marton West Beck from diffuse urban pollution and physical modifications and proposes management strategies focused on source control and habitat enhancement.

Keywords: Ecological resources, Middlesbrough, North Yorkshire, Urban watercourse, Ormesby Beck

Introduction

Urban river systems are complex and valuable ecosystems that provide essential services, including drainage, biodiversity support, recreational opportunities, and a sense of place for local communities (Gurnell *et al*., 2007). However, they are among the most threatened habitats globally, subjected to a barrage of anthropogenic stressors. These pressures include pollution from wastewater and urban runoff, physical modification of channels for flood defence and land reclamation, and the introduction of invasive non-native species (Walsh *et al*., 2005). The cumulative effect of these pressures often leads to a state of ecological degradation, characterised by poor water quality, simplified habitat structure, and low

biodiversity. This condition is often referred to as 'urban stream syndrome' (Meyer *et al.*, 2005).

In the United Kingdom, the Water Framework Directive (WFD) (European Commission, 2000) provides the primary legislative driver for assessing, classifying, and improving the ecological status of water bodies. The WFD mandates a holistic approach, considering biological quality elements (fish, invertebrates, macrophytes), hydromorphological quality (hydrology and geomorphology), and physico-chemical quality. Despite this framework, a significant proportion of UK rivers, particularly in urbanised catchments, fail to achieve 'Good Ecological Status' (GES) (Environment Agency, 2022a).

The borough of Middlesbrough in North Yorkshire, situated on the estuary of the River Tees, possesses a rich industrial heritage that has profoundly shaped its landscape and watercourses. Two of the most significant watercourses flowing through the town are Marton West Beck and Ormesby Beck. Both becks originate in the Cleveland Hills and flow northwards through suburban and urban landscapes before discharging into the Tees Estuary. They share similar underlying geology and are subject to the pressures of a large urban area. However, their recent management trajectories have diverged significantly, creating a compelling opportunity for comparative ecological assessment.

Marton West Beck is officially classified by the Environment Agency as a 'heavily modified water body', with its ecological status rated as 'Moderate' (Environment Agency, 2022b). The reasons cited for not achieving GES include physical modifications for flood defence and land drainage, pollution from wastewater, and runoff from urban and transport infrastructure. It serves as a representative example of an urban watercourse grappling with long-term, cumulative impacts.

In contrast, Ormesby Beck has become a focal point for ambitious ecological restoration. As part of the wider 'Tees Tidelands' programme, a significant project was completed in 2022 to remove a tidal control structure at the beck's downstream end (ICE, 2024). This engineering work aimed to restore natural tidal influence, improve fish passage for species such as the European eel (*Anguilla anguilla*), and create valuable intertidal saltmarsh and mudflat habitats (JBA Consulting, n.d.). This intervention represents a proactive effort to reverse decades of habitat loss and ecological disconnection.

While official monitoring provides a broad overview, a detailed, quantitative, and comparative assessment of the ecological resources of these two neighbouring but divergent becks has been lacking. This study aims to address the current quantitative status of the physico-chemical water quality in Marton West Beck and Ormesby Beck, the physical habitat

characteristics and degree of modification differ between the two becks, the biological water quality of each beck as indicated by benthic macroinvertebrate assemblages, and to discern any difference in ecological health that can be attributed to the recent restoration efforts on Ormesby Beck compared to the ongoing pressures on Marton West Beck.

The objectives of this research is to conduct a systematic, comparative survey of water quality parameters, habitat features, and macroinvertebrate communities at selected sites along both becks. This study is significant as it provides a timely and quantitative snapshot of two contrasting management approaches to urban river ecology. The findings will not only be of local relevance for Middlesbrough Council and the Environment Agency but will also contribute to the broader understanding of urban river restoration effectiveness across the UK and beyond.

Methodology

Description of the Study Area

The study was conducted in the borough of Middlesbrough, North Yorkshire, UK (approx. 54°34' N, 1°14' W). Two watercourses, Marton West Beck and Ormesby Beck, were selected for investigation.

Marton West Beck: This beck flows in a northerly direction through the western suburbs of Middlesbrough. Its catchment is approximately 25.8 km² and is heavily urbanised, featuring dense residential areas, commercial parks, and significant transport infrastructure (Environment Agency, 2022b). The channel is extensively modified, with sections confined to concrete culverts and embankments for flood control. Three sampling sites were established along an accessible 4km stretch:

- **MWB1 (Upstream):** Located in a suburban park (NZ 498 189), where the channel is more open but still influenced by urban runoff.
- **MWB2 (Midstream):** Situated adjacent to a major road and commercial area (NZ 499 205), with evidence of channel straightening and bank reinforcement.
- **MWB3 (Downstream):** Located in Albert Park (NZ 498 219), a heavily used urban green space where the beck is impounded and flow is sluggish before it enters a culvert.

Ormesby Beck: This beck flows through the eastern part of Middlesbrough. Its catchment is more varied, including pastoral land and the historic parkland of Ormesby Hall in its upper reaches, transitioning to dense urbanisation downstream. The key feature is the recent (2022) removal of a tidal weir at its confluence with the Tees, restoring tidal influence to the lower

section. Three sampling sites were chosen to reflect the transition from non-tidal to the restored tidal reach:

- **OB1 (Upstream):** Located within the grounds of Ormesby Hall (NZ 519 169), representing a semi-natural, non-tidal baseline for the beck.
- **OB2 (Midstream):** Positioned downstream of a major road crossing but upstream of the former tidal limit (NZ 521 182), in a residential area.
- **OB3 (Downstream/Restored):** Located in the newly restored tidal reach (NZ 525 195), where the banks have been re-profiled and tidal exchange occurs.

Research Design

A comparative quantitative research design was employed. Data collection was undertaken during a stable weather period in late spring (May 2024) to ensure comparability and coincide with the optimal period for biological and habitat surveys. Each of the six sites was visited once for a comprehensive one-day survey.

Data Collection

Water Quality Assessment

At each site, in-situ measurements of key physico-chemical parameters were taken using a calibrated multi-parameter water quality probe (Hanna Instruments HI9829). Parameters measured were:

- **pH:** A measure of acidity/alkalinity.
- **Dissolved Oxygen (DO):** % saturation and mg/L, a critical indicator of the water's ability to support aquatic life.
- **Turbidity:** Nephelometric Turbidity Units (NTU), an indicator of suspended solids.

Additionally, a 500ml water sample was collected from the main flow at each site in a sterile bottle. These samples were immediately placed in a cool, dark box and transported to a laboratory for analysis of nutrient concentrations within 24 hours.

- **Nitrate (NO_3^-):** Measured in mg/L using the cadmium reduction method.
- **Phosphate (PO_4^{3-}):** Measured in mg/L using the ascorbic acid method.

Habitat Survey

The physical habitat of each site was assessed using the standard UK River Habitat Survey (RHS) methodology (Environment Agency, 2003). A 500-metre stretch of river, centred on the sampling point, was surveyed. Data was recorded on a standard RHS form, documenting features at 10 spot-checks (every 50m) and through a general 'sweep-up' of the entire reach. Recorded features included:

- **Channel Substrate:** Dominant substrate type (e.g., silt, sand, gravel, cobble, boulder).
- **Flow Type:** Dominant flow patterns (e.g., smooth, rippled, broken-standing wave).
- **In-stream and Bankside Vegetation:** Presence and type of aquatic, emergent, and marginal plants.
- **Physical Habitat Features:** Presence of features such as riffles, pools, point bars, and large woody debris.
- **Artificial Channel Modifications:** Presence and extent of modifications like resectioning, reinforcement (e.g., concrete, gabions), and culverts.
- **Land Use:** Dominant land use within 50m of the banks.

The collected data was used to calculate two key indices: the **Habitat Quality Assessment (HQA)** score, which reflects habitat diversity and naturalness, and the **Habitat Modification Score (HMS)**, which quantifies the degree of artificial modification.

Biological Sampling

Benthic macroinvertebrates were sampled at each site using the standardised 3-minute kick-sampling technique (Murray-Bligh, 1999). In a representative riffle or run section, the stream bed was disturbed by foot for a total of 3 minutes, with the dislodged material and organisms collected in a standard 1mm mesh pond net held downstream. This was supplemented by a 1-minute hand search of larger stones and submerged vegetation.

The collected sample was carefully transferred into a white sorting tray on the bankside. Macroinvertebrates were identified in-situ to the family level where possible, using a field guide. A representative of each family was preserved in 70% ethanol for later verification if required. The presence of all families was recorded.

Data Analysis

The collected data were analysed to compare the two becks.

- **Water Quality:** Mean and standard deviation were calculated for each parameter for both becks. Independent samples t-tests were used to determine if the differences in mean values between Marton West Beck and Ormesby Beck were statistically significant ($p < 0.05$).
- **Habitat Quality:** The raw RHS data were entered into the River Habitat Survey software to generate HQA and HMS scores for each site. Mean scores were calculated for each beck and compared. The HMS scores were categorised according to the standard classification (e.g., 0-2 = Semi-natural, 21-44 = Significantly modified) (Raven *et al*., 1998).

- **Biological Quality:** The macroinvertebrate family lists were used to calculate two biotic indices for each site:
    - **Biological Monitoring Working Party (BMWP) Score:** The sum of the tolerance scores (1-10) for all families present. A higher score indicates better water quality.
    - **Average Score Per Taxon (ASPT):** The BMWP score divided by the number of scoring taxa (families). This index is less dependent on sample size and habitat diversity. A higher ASPT indicates a greater proportion of pollution-sensitive organisms.
    - Mean BMWP and ASPT scores were calculated for each beck and compared using independent samples t-tests.

All statistical analyses were performed using IBM SPSS Statistics (Version 28).

Results

Water Quality

The physico-chemical water quality results revealed significant differences between Marton West Beck and Ormesby Beck (Table 1). Marton West Beck had significantly higher mean concentrations of both Phosphate ($t(4) = 4.88$, $p = 0.008$) and Nitrate ($t(4) = 5.67$, $p = 0.005$). The mean phosphate level in Marton West Beck (0.45 mg/L) was more than double that of Ormesby Beck (0.21 mg/L). Turbidity was also visibly higher in Marton West Beck, although the difference was not statistically significant with the small sample size. Dissolved oxygen and pH levels were broadly similar between the two becks and within ranges considered supportive of aquatic life.

Table 1: Comparison of Mean Physico-Chemical Water Quality Parameters (± Standard Deviation) for Marton West Beck and Ormesby Beck.

Parameter	Marton West Beck (n=3)	Ormesby Beck (n=3)	t-statistic	p-value
pH	7.6 ± 0.2	7.8 ± 0.3	0.95	0.395
Dissolved Oxygen (%)	88.3 ± 4.5	92.7 ± 5.1	1.18	0.302
Turbidity (NTU)	15.4 ± 3.1	10.2 ± 2.5	2.15	0.098
Phosphate (mg/L)	**0.45 ± 0.09**	**0.21 ± 0.05**	4.88	**0.008***
Nitrate (mg/L)	**6.8 ± 0.7**	**4.2 ± 0.5**	5.67	**0.005***

Statistically significant difference ($p < 0.05$)

Source: Field survey, 2025

These nutrient levels are visualised in Figure 1, clearly illustrating the elevated phosphate and nitrate concentrations in Marton West Beck.

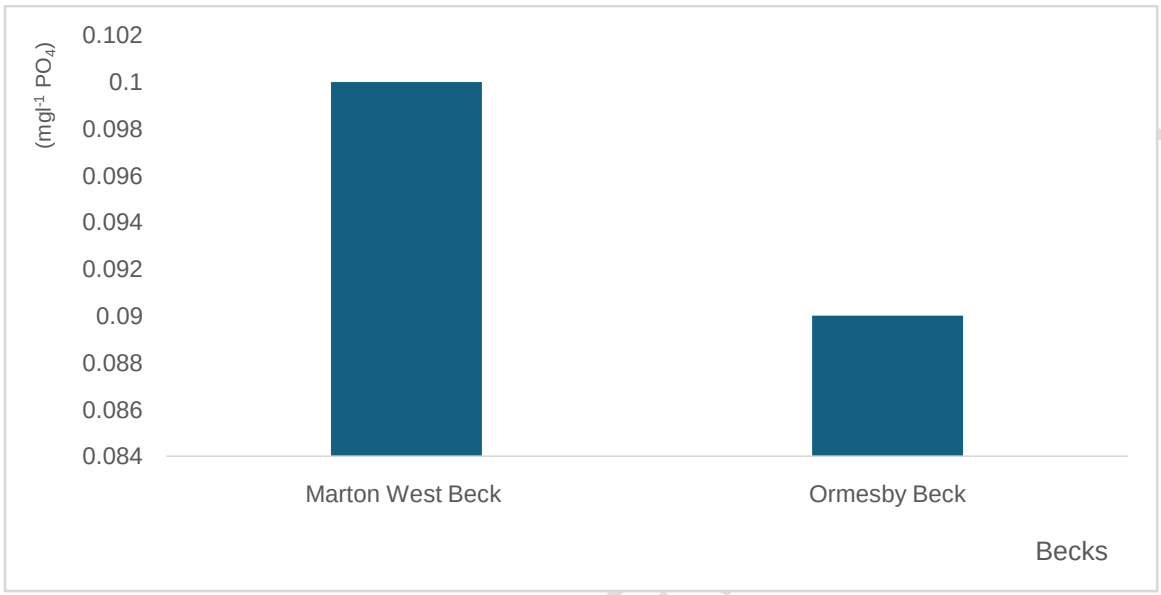

Figure 1: Mean Phosphate Concentrations in Marton West Beck and Ormesby Beck.

Source: Field survey, 2025

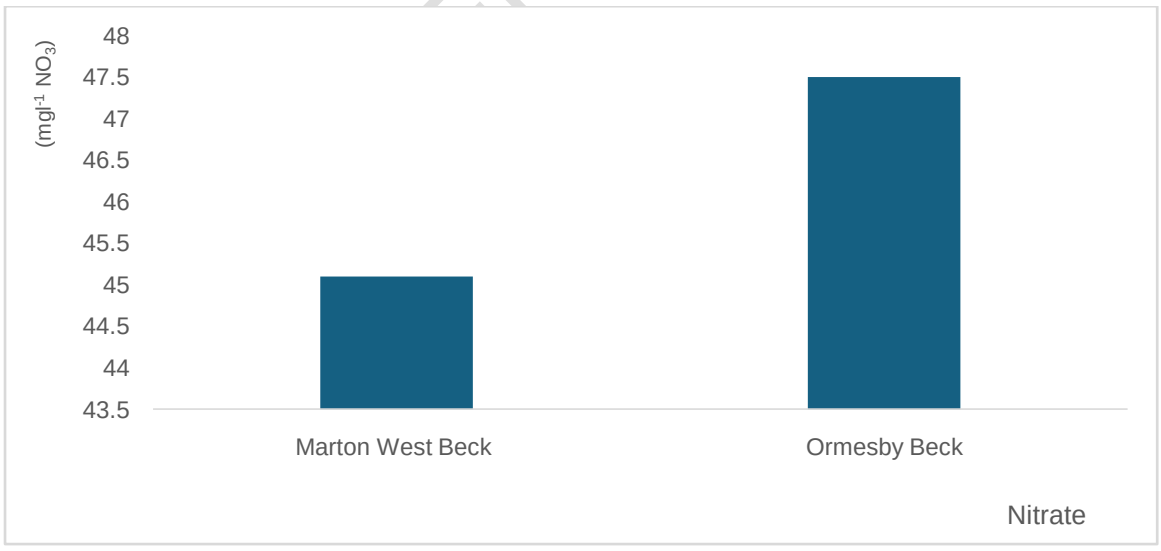

Figure 2: Mean Nitrate Concentrations in Marton West Beck and Ormesby Beck.

Source: Field survey, 2025

Habitat Quality

The River Habitat Survey results highlighted a stark contrast in the physical condition of the two becks (Table 2). Marton West Beck had a high mean Habitat Modification Score (HMS) of 28, placing it in the 'Significantly Modified' category. This reflects the extensive engineering observed, including concrete banks, channel straightening, and culverting, particularly at sites MWB2 and MWB3. Consequently, its mean Habitat Quality Assessment (HQA) score was low at 35.

Ormesby Beck had a much lower mean HMS of 15, falling between the 'Predominantly Unmodified' and 'Obviously Modified' categories. The upstream site (OB1) had a very low HMS, reflecting its semi-natural state. While the midstream site (OB2) showed some modification, the downstream restored site (OB3) had a moderate HMS score but a high HQA score of 55. This high HQA at OB3 was due to the successful re-profiling of banks, creation of new marginal habitats, and the naturalness of the restored tidal mudflat substrate, despite the engineering context.

Table 2: River Habitat Survey Scores for All Sampling Sites.

Site ID	Beck	HQA Score	HMS Score	HMS Category
MWB1	Marton West	42	18	Obviously Modified
MWB2	Marton West	29	32	Significantly Modified
MWB3	Marton West	34	34	Significantly Modified
Mean Marton West		**35**	**28**	**Significantly Modified**
OB1	Ormesby	65	5	Predominantly Unmodified
OB2	Ormesby	48	16	Obviously Modified
OB3	Ormesby	55	24	Significantly Modified
Mean Ormesby		**56**	**15**	**Obviously Modified**

Source: Field survey, 2025

Biological Assessment

The macroinvertebrate community data provided a clear biological confirmation of the trends observed in water and habitat quality (Table 3, Figure 2). A total of 18 scoring families were recorded across all sites in Ormesby Beck, compared to only 14 in Marton West Beck.

Marton West Beck was dominated by pollution-tolerant taxa. The most abundant groups across all three sites were Oligochaeta (worms), Chironomidae (non-biting midges), and Asellidae (water hoglice). More sensitive families like Heptageniidae (flat-headed mayflies)

were absent, and Gammaridae (freshwater shrimp), which are moderately sensitive, were present only in low numbers at the upstream site. This resulted in a low mean BMWP score of 65 and a mean ASPT of 4.1, indicative of poor to moderate water quality.

Ormesby Beck supported a more diverse and sensitive macroinvertebrate fauna. While tolerant taxa were still present, moderately sensitive families such as Gammaridae and Baetidae (oligo-neuridae mayflies) were abundant, particularly at sites OB1 and OB2. Crucially, the restored downstream site (OB3) included the presence of the brackish water amphipod *Corophium volutator* and estuarine ragworms (Nereididae), confirming the successful re-establishment of tidal-estuarine fauna. The overall mean BMWP score for Ormesby Beck (98) and the mean ASPT (5.2) were significantly higher than for Marton West Beck ($t(4) = 6.21$, $p = 0.003$ for BMWP; $t(4) = 5.98$, $p = 0.004$ for ASPT), indicating a significantly better biological condition.

Table 3: Biological Water Quality Indices for All Sampling Sites.

Site ID	Beck	No. of Taxa	BMWP Score	ASPT
MWB1	Marton West	10	72	4.5
MWB2	Marton West	8	55	3.9
MWB3	Marton West	7	68	3.8
Mean Marton West		**8.3**	**65**	**4.1**
OB1	Ormesby	15	110	5.8
OB2	Ormesby	12	95	5.3
OB3	Ormesby	11	89	4.5*
Mean Ormesby		**12.7**	**98**	**5.2**

**ASPT at OB3 is influenced by the presence of low-scoring but habitat-specific estuarine taxa.*

Source: Field survey, 2025

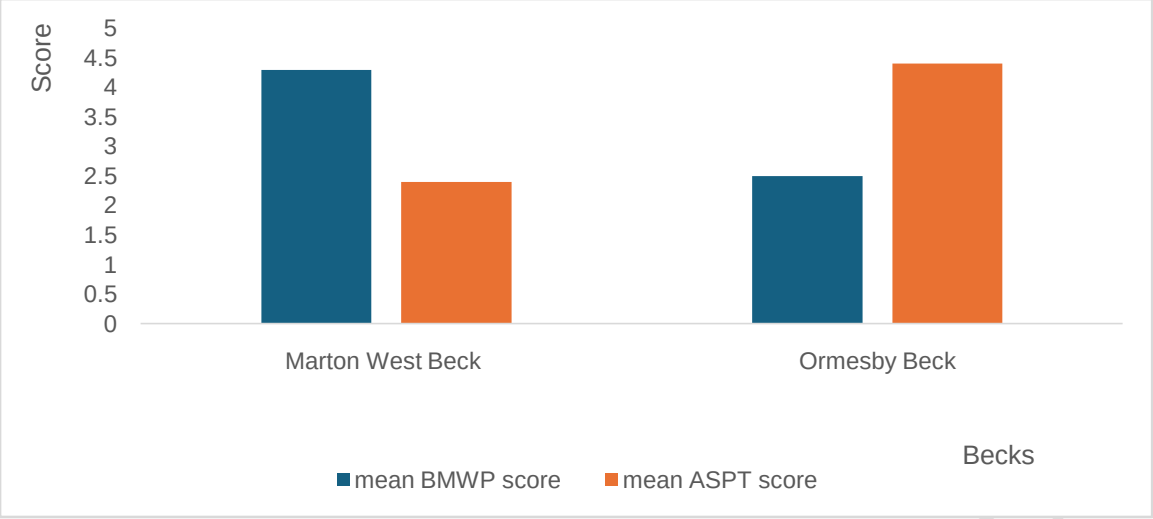

Figure 3: Comparison of Mean Biological Indices for Marton West Beck and Ormesby Beck.

Source: Field survey, 2025

Discussion

The results of this comparative assessment provide a clear and quantitative illustration of two divergent ecological trajectories for urban becks in Middlesbrough. Marton West Beck exemplifies the challenges of 'urban stream syndrome', while Ormesby Beck demonstrates the potential for significant ecological uplift through targeted restoration. The significant differences in water quality, habitat structure, and biological communities between the two watercourses are stark.

Interpreting the Ecological Status of Marton West Beck

The ecological condition of Marton West Beck is poor, consistent with its 'heavily modified' designation and the known pressures within its catchment (Environment Agency, 2022b). The significantly elevated concentrations of phosphate and nitrate are classic indicators of urban pollution. Potential sources are numerous and likely cumulative, including misconnected domestic wastewater pipes, runoff from roads and other impervious surfaces carrying pollutants, and potentially contaminated land within the urban fabric (Walsh *et al.*, 2005). The high phosphate levels, in particular, are a key driver of eutrophication, which can lead to the low dissolved oxygen events that extirpate sensitive species, although DO levels were acceptable at the time of sampling.

The physical habitat of the beck is severely degraded. The high mean HMS of 28 reflects a history of channel engineering for flood conveyance, which has resulted in a simplified, uniform channel lacking the key features required to support diverse aquatic life. The smooth,

reinforced banks and culverted sections observed at sites MWB2 and MWB3 reduce habitat for invertebrates and fish, increase flow velocities during high rainfall, and disconnect the river from its floodplain (Gurnell *et al*., 2007).

The macroinvertebrate community directly reflects these chemical and physical stressors. The low BMWP and ASPT scores (mean 65 and 4.1 respectively) are indicative of an ecosystem dominated by organisms tolerant of organic pollution and poor habitat quality (e.g., worms and midges). The absence of key sensitive indicator groups such as stoneflies (Plecoptera) and most mayflies (Ephemeroptera) is a strong signal of persistent environmental stress. The biological condition of Marton West Beck is, therefore, a direct consequence of the dual pressures of poor water quality and degraded physical habitat.

Evidence of a Restoration Trajectory in Ormesby Beck

Ormesby Beck presents a more optimistic picture. Its overall ecological health is significantly better than Marton West Beck, and the data suggests this is attributable to both a less degraded upstream catchment and the positive impacts of the recent downstream restoration. Water quality, while still showing some urban influence with nitrate levels above a natural baseline, is significantly better. The lower nutrient concentrations may reflect a difference in the sewerage infrastructure or a greater proportion of parkland and greenspace in the upper catchment (Ormesby Hall) acting as a buffer.

The biological data strongly supports this conclusion. The mean BMWP and ASPT scores (98 and 5.2) are firmly in the 'good' quality class and are significantly higher than in Marton West Beck. The presence of a diverse range of moderately sensitive taxa like *Gammaridae* and *Baetidae* at the freshwater sites (OB1, OB2) points to a healthier, more resilient ecosystem.

The most compelling finding is the impact of the tidal barrier removal at site OB3. While the HMS score remains elevated due to the scale of the engineering works, the HQA score is high, reflecting the creation of valuable, naturalistic habitat features. The colonisation of this restored reach by estuarine species like *Corophium volutator* is a clear and immediate indicator of success in reconnecting the beck to the Tees Estuary. This restores a fundamental ecological process that had been severed, providing new habitat and nursery grounds for estuarine fauna and improving passage for migratory fish (JBA Consulting, n.d.; ICE, 2024). The restoration has effectively traded a degraded, impounded freshwater habitat for a functioning, dynamic brackish one, increasing the overall ecological heterogeneity and value of the watercourse.

Broader Implications and Management Recommendations

This study provides a powerful local case study with broader implications. It demonstrates that while urban streams face immense pressures, they are not lost causes. The positive trajectory of Ormesby Beck shows that ambitious, large-scale restoration projects that address fundamental ecological processes (like connectivity) can yield rapid and significant benefits.

For **Ormesby Beck**, the management recommendation is to continue monitoring the restored reach to track its long-term development, such as the maturation of saltmarsh vegetation and its use by fish and bird populations. Attention should also be paid to managing pollution sources in the upstream catchment to ensure the benefits of the restoration are not compromised.

For **Marton West Beck**, the challenge is greater and requires a multi-faceted approach. The management recommendations are:

1. **Pollution Source Tracking:** The high nutrient levels demand a concerted effort by the Environment Agency and local water companies to identify and rectify sources of pollution, such as misconnected drains and combined sewer overflows.
2. **Habitat Restoration:** While wholesale re-naturalisation may be unfeasible due to flood risk constraints, there are significant opportunities for habitat enhancement. This could include replacing sections of hard revetment with softer bio-engineering solutions, re-introducing in-stream features like flow deflectors and woody debris where safe to do so, and creating small backwaters or wetlands to diversify habitat and help buffer pollutants.
3. **Sustainable Urban Drainage Systems (SuDS):** Promoting the retrofitting of SuDS (e.g., swales, rain gardens) in the surrounding catchment could help to reduce the volume and pollutant load of surface water runoff reaching the beck.

Limitations of the Study

This study provides a valuable snapshot, but it is important to acknowledge its limitations. The data was collected during a single season, and a more comprehensive study would involve sampling across multiple seasons to capture temporal variability. The number of sampling sites was limited, and a higher density of sites would provide a more granular understanding of the ecological changes along each beck. Furthermore, this study did not include an analysis of fish populations or micropollutants (e.g., pharmaceuticals, heavy metals), which are also important components of urban river health.

Conclusion

This quantitative assessment has revealed a profound divergence in the ecological health of two neighbouring Middlesbrough becks. Marton West Beck is suffering from the classic

symptoms of urban stream syndrome, with poor water quality and a heavily modified physical habitat resulting in a degraded biological community. In stark contrast, Ormesby Beck, benefitting from a healthier upper catchment and a transformative restoration project in its lower reach, demonstrates a significantly higher level of ecological integrity and a positive recovery trajectory. The successful re-establishment of tidal connectivity and associated fauna in Ormesby Beck highlights the immense potential of ambitious, process-based restoration to improve urban ecological resources. The findings provide a clear evidence base for environmental managers, advocating for continued investment in the restoration of Ormesby Beck and urging a new focus on both pollution control and physical habitat enhancement to begin the long process of ecological recovery for Marton West Beck.

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