A method for monitoring constructed wetlands with community scientists

June 2025

Please note: This guidance document should be used in conjunction with the Constructed Wetland Monitoring Training Presentation.

ACKNOWLEDGEMENTS

SUPPORTED BY

MAYOR OF LONDON

With thanks to the Greater London Authority, the Riverfly Partnership, Thames21, Friends of Chinbrook Meadows, Friends of Headstone Manor Park, Citizen Crane and all the citizen scientists involved in this project.

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1 INTRODUCTION

Biological monitoring of freshwater habitats like rivers and ponds is a well-established practice in the UK, providing key insights into ecosystem health that chemical testing alone cannot provide. Rivers have long been monitored by statutory bodies using macroinvertebrate surveys, with tools such as the Biological Monitoring Working Party (BMWP) scoring system assessing pollution sensitivity at the invertebrate family level. The Riverfly Monitoring Initiative (RMI) was developed, based on systems already used by professionals, to fill gaps in statutory monitoring and give citizen scientists the skills to monitor their rivers themselves and track river health using simplified but robust methods. Similarly, the Freshwater Habitats Trust developed PSYM (the Predictive SYstem for Multimetrics) to provide a means of systematically assessing the quality of ponds/small lakes in England and Wales. PSYM combines habitat data and biological surveys (mainly of aquatic invertebrates and plants) to generate a "biological quality score".

As urbanisation increases, constructed wetland systems are becoming more common in towns and cities, built as nature-based solutions for purposes such as flood control, pollution mitigation, and habitat creation. However, comparable and standardised methodologies have not been developed for assessing constructed wetland systems. Urban constructed wetland invertebrate communities typically contain a mixture of species that inhabit standing and flowing waters which are not encompassed by existing methods and biotic scoring systems. Applying similar citizen science-led and professional monitoring frameworks to urban wetlands is essential to understand their ecological function, track their effectiveness over time, and ensure they provide real biodiversity benefits alongside their engineered roles.

1.1 What do invertebrates tell us about water quality?

Aquatic macroinvertebrates have long been recognised and widely used as indicators of waterbody health. The advantages of monitoring water body health using macroinvertebrates include the following:

- Macroinvertebrate species show a wide variation in sensitivity to pollution. The presence or absence of sensitive or tolerant species within communities can be used as a proxy for water quality.
- Macroinvertebrates are ubiquitous, abundant, and relatively easy to collect.
- Unlike fish, they are relatively sedentary and thereby representative of local conditions.
- Macroinvertebrates can live in water for extended periods and thereby reflect long-term environmental conditions (unlike chemical testing which can often only provide a snapshot of water quality).

Monitoring invertebrate assemblages on a regular basis can therefore act as an effective way to identify fluctuations in water quality. Changes in invertebrate community composition, and diversity can reveal pollution, nutrient enrichment, habitat degradation, or other stresses.

1.2 Principles of the Constructed Wetland Monitoring Method

Monitoring the function of the constructed wetland requires volunteers to take two, one-minute samples during each survey. One sample at the inlet and the other at the outlet of the constructed wetland. Samples are sorted on the banks of the wetland and the numbers of the indicator groups of invertebrates (shown on page 10 and 11) are counted to derive a score for each sample. The scoring system is shown on page 8. Once both samples have been completed the score at the inlet and outlet are compared.

In a normally functioning constructed urban wetland, water quality typically improves along a natural gradient from the inlet to the outlet. Runoff entering at the inlet often contains high levels of nutrients, sediments, and urban pollutants. As water moves slowly through the system, processes such as sedimentation, filtration through vegetation, microbial activity, and plant uptake help remove contaminants. By the outlet, the water is usually cleaner and more oxygenated, supporting a greater presence of pollution-sensitive aquatic invertebrates like mayflies and caddisflies. In contrast, more pollution-tolerant species are commonly found near the inlet.

When a constructed wetland is not functioning properly, this improvement in water quality may be limited or absent. Poor design, lack of maintenance, blockages, sparse vegetation, or high pollutant loads can impact treatment capacity. Pollutants such as nutrients, sediments, heavy metals, and hydrocarbons may remain elevated across the wetland cells, often resulting in low oxygen levels, algal buildup, or contamination. Invertebrate communities in such systems are typically dominated by tolerant species such as fly larvae, worms, and leeches, with few or no sensitive taxa, indicating poor ecological condition and ineffective water quality improvement.

Figure 1: Images of visible pollution in the inlet cells of (left to right) Headstone Manor Park, Chinbrook Meadow and Newton Park wetlands).

2 METHODS

2.1 Health and Safety

Wetlands cells are often designed to have steep and deep sides and bed substrates are often unstable, soft, slippery and hard to see due to turbid waters. The following key health and safety protocols must be always followed:

- Surveying should only be carried out by trained volunteers that have been briefed on the key risks associated with this monitoring activity and how to conduct monitoring safely.
- Because of the nature and design of constructed urban wetland systems, unlike RMI monitoring, all wetland monitoring should be carried out from the bank and volunteers should not enter the water.
- A site risk assessment must be carried out during the site selection process and all volunteers must be briefed on monitoring and site-specific risks prior to training/sampling.
- Sampling should be carried out in pairs as a minimum.
- Appropriate health and safety equipment must be worn/present at the time of sampling, including: first aid kits, buoyancy aids, antibacterial hand sanitiser, nitrile gloves, telephone. In addition, suitable clothing should be worn for monitoring including: suitable footwear, warm clothing during winter months and hats/suncream during warmer months.
- Constructed wetlands can often contain high levels of contamination and bacteria. It is advised that volunteers wear gloves whilst sampling to reduce the risk of waterborne diseases such as Leptospirosis. Cuts should be covered with a waterproof dressing and gloves prior to sampling.
- Volunteers will not sample if conditions are unsafe prior to sampling and will abort sampling if conditions change and become unsafe during their monitoring (e.g. heavy rainfall causing banks to become slippery or water levels to rise rapidly).
- After sampling, hands will be washed thoroughly with warm soapy water.

2.2 Site Selection

When selecting sampling locations within a constructed wetland for invertebrate monitoring, it is essential to assess each site for potential risks or hazards, including deep water, unstable banks, dense vegetation, or nearby infrastructure. Sampling should be carried out only from safe, accessible points on the banks of the wetland. Choose one site at both the inlet and outlet cells that can be safely reached and that are broadly representative of the physical and biological characteristics of each cell, including typical vegetation, bed material, and flow conditions. These sites should reflect the habitat types present in their respective areas (and be chosen with potential seasonal changes to the site in mind) to ensure reliable and comparable invertebrate data over time.

2.3 Equipment Checklist

- ☐ Risk assessment and dynamic risk assessment
- ☐ Safety equipment including:
    - First aid kit
    - Buoyancy aid
    - Anti-bacterial hand sanitiser
    - Nitrile gloves
    - Telephone
- ☐ Wellington boots or waders
- ☐ Standard sampling net (1.5m handle, 25cm wide frame)
- ☐ Invertebrate sorting equipment including:
    - Large pipette/turkey baster
    - Small pipette
    - Plastic spoons
    - Hand lens
    - Large plastic bucket (x2)
    - Large white plastic tray (x2)
    - Sectioned tray (x2)
- ☐ Data recording sheets
- ☐ Clipboard or weather writer
- ☐ Identification guide
- ☐ Hanna Checkers (ammonia and phosphate)

2.4 Sample Collection

The **bank-side** sample collection is a **one-minute hand netting** of **vegetation and bed material** around the **wetland perimeter** at a suitable location as near to the wetland **inlet and outlet** as safely possible.

1. Once a safe location has been established at the wetland inlet and outlet perimeter, this will remain fixed for each month. Changes in flow, vegetation and habitat may change seasonally/over time which may impact access. If this is the case, sample as near to the fixed location as safe as possible.
2. If you are carrying out fixed point photography and water quality sampling (Hanna checkers or strip test sampling) as part of your monitoring, this should be carried out before you start sampling invertebrates.

3. To collect your invertebrate sample, gently disturb the bed substrate such as gravels or organic debris (leaves and twigs) with the base of the net using a scooping and sweeping motion. Split sampling time between any patches of different vegetation or bed substrates (e.g. submerged, floating, emergent vegetation) according to the proportion of different habitats/vegetation present.
4. During sampling, if the net collects lots of sediment or plant material, the sample can be decanted into the sampling bucket between the sampling of different habitats. The timer can be paused while doing this.

2.5 Sample Processing

1. Before you start processing your sample, you can remove any unwanted debris or sediment. Sediment can be rinsed by holding the net over one of the large buckets and passing clean water through the sample while gently disturbing the contents to dislodge any silt, mud or sediment. This step can be repeated multiple times until the sample is clear enough to start processing. Large sticks or vegetation can also be carefully removed by rinsing into the bucket before discarding - being mindful not to lose any of the required invertebrates that may be attached.
2. Once the sample has been cleaned in the bucket it can be placed into the large white tray half-filled with clean water for processing. Depending on how much material has been collected in the net, the sample can be split into sub-samples for ease of processing. If processing as subsamples, please ensure there is enough water in the bucket for the other invertebrates while you are processing what is in the tray.
3. Using the large and small pipettes or spoons you can start sorting invertebrates into the segmented tray (along with some water in each segment) to assist with counting. Not all invertebrates need to be transferred into the segmented tray, for example, if there is a high abundance of freshwater shrimp, it can be easier to estimate counts directly from the tray.
4. Once sorted, estimate total counts which can then be grouped into abundance categories: **1-9**, **10-99**, **100-999** and **>1000**. See table below.
5. Record site data (date, time, surveyor name, location, conditions) estimated counts, abundance categories and totals to the recording form.
6. You can note down any additional invertebrates or species of interest. For example, if you see an abundance of snails or fish, this can be added to the ‘additional notes’ section of the form.
7. Once all data has been recorded, carefully tip the contents of the trays back into the bucket and then carefully return into the wetland sample site.

Wetland Invertebrate Scoring Table:

Taxa	Abundance			
	1-9	10-99	100-999	1000+
Mayfly (*Ephemeroptera*)	**1**	**2**	**3**	**4**
Caddisflies (*Trichoptera*)	**1**	**2**	**3**	**4**
Dragonflies & Damselflies *(Odonata)* - Dragonfly (*Aeshnidae*) - Damselfly (*Coenagrionidae*)	**1**	**2**	**3**	**4**
Freshwater Shrimp *(Gammarus)*	**1**	**2**	**3**	**2**
Freshwater Hoglouse *(Aseliidae)*	**1**	**1**	**0**	**-2**
Leeches *(Hirudinea)*	**1**	**1**	**0**	**-2**
Fly Larvae (*Diptera*) - Non-Biting Midge Larvae *(Chironomidae)* - Mosquito larvae *(Culicidae)* - Drone fly larvae *(Syrphidae)*	**1**	**1**	**0**	**-3**
Worms *(Oligochaeta)*	**1**	**1**	**0**	**-3**

Please note: The presence of target invertebrates may vary between wetlands, inlet and outlet, and seasonally throughout the year so, it is likely that not all target taxa will be present in every sample.

2.6 Data Recording and Uploading

Volunteers should enter data to a shared online spreadsheet (e.g. Google Sheets, EpiCollect or preferred alternative) and upload any corresponding water quality data and site photographs. A project Padlet page can be a useful space to store this data in one place as it does not require volunteers to register with an email address and notifications can be tailored. Volunteers should be encouraged to take a photograph and safely store their paper data sheets as a backup.

2.7 What will the monitoring achieve?

Systematically monitoring constructed wetlands using new invertebrate sampling methods, supported by citizen scientists, will generate vital baseline and long-term data on wetland health. By comparing monthly invertebrate data over time, we can track seasonal and ecological changes, offering insight into how well these systems are functioning. When combined with other water quality monitoring datasets, such as nutrient levels or turbidity, this approach provides a more complete picture of wetland performance. This is particularly valuable as many new constructed wetlands are being built across the UK as nature-based solutions for urban water management - yet currently, there is limited ecological data available to assess their effectiveness. This monitoring will help fill that gap, guide maintenance needs, and inform the design and management of future wetlands.

How to get started?

These constructed wetland invertebrate monitoring methods were developed following a successful pilot study carried out with support from the Riverfly Partnership. The pilot and subsequent methods were developed following an in depth investigation 'Evidencing the Impact of Constructed Wetlands: Headstone Manor Park' led by ZSL and the publication of 'The Urban Wetland Design Guide', collaboratively developed by ZSL and the London Borough of Enfield which offers concise, practical advice for planning, designing and maintaining constructed surface-flow wetlands specifically aimed at reducing urban diffuse pollution.

The aim now is to make these methods widely accessible to organisations looking to work with community groups, local communities and conservation volunteers interested in monitoring constructed urban wetland systems.

If you are part of a group looking to start monitoring, you can contact ZSL for advice, training resources, and guidance on applying these methods to your local wetland. To learn more, you can read a detailed report on how the methods were used during the London pilot study **here** or watch a short introductory video **here**.

Identification Key (adapted from Anglers' Riverfly Monitoring Initiative (ARMI) guide)

Mayfly (*Ephemeroptera*)

- 3 tails and 3 pairs of legs
- Feathery or small leaf like gills may be present along body.
- Antenna often visible

***Avoid confusing with:**

- damselfly larvae: both have 3 tails/gills projecting from end of body but damselfly much more robust

Caddisflies (*Trichoptera*)

With a case

- No visible antenna
- Body enclosed within a case.
- Case made of small stones, sand grains, plant material or shells.
- Case may be round, square, or flat in cross section.
- One or more of the 3 pairs of legs may be visible when moving

Without a case

- No visible antenna
- 3 pairs of legs visible
- 2 posterior hooks and anal proleg with terminal brush of long seta and tufted gills on abdominal segment
- May be inside web.

***Avoid confusing with:**

Chironomid midge larvae - have no legs.

Beetle larvae - no hooks on the posterior appendages

Dragonflies and Damselflies (*Odonata*)

Dragonfly *(Anisoptera)*

- Gills are located inside the rectum (unlike damselflies, which extend from body like 3 leaflike tails)
- Stout body, no tails (5 short spines at the end of the body
- Large eyes

Damselfly *(Zygoptera)*

- Three fin-like gills projecting from end and body slender/elongated.
- 3 sets of long legs
- Large eyes
- Range in colour from green to brown
- Slow crawling/climbing movement

Freshwater Shrimp (*Gammarus*)

- Body always curved and flattened side to side
- Swims on side
- More than 3 pairs of legs plus other appendages on the underside of body

Freshwater Hoglouse (*Aseliidae*)

- Looks like a woodlouse.
- Slow crawling movement
- Body dorsally flattened

Leeches (*Hirudinea*)

- No legs
- Dorsally flattened
- Sucker present at each end of the body (uses these to move in looping motion)
- Often stuck to rocks – check tray and bucket as you empty
- Variety of shapes and colours

Worms (*Oligochaeta)*

- Wiggle movement
- No legs with a long, thin, cylindrical body (15+) segments

***Avoid confusing with:**

Terrestrial worms: aquatic worms are a lot thinner and smaller. The head is indistinct and unlike terrestrial worms they lack a clitellum (raised band).

Non-biting midge larvae.

Fly Larvae (*Diptera*)

Mosquito Larvae (*Culicidae*)

- Fast wriggling movement
- Tend to remain at the surface of the water.
- Tube/siphon on end of body as well as anal segment with gills sometimes visible
- Large/bulbous head and thorax

Non-Biting Midge Larvae *(Chironomidae)*

- Worm-like segmented shape,
- Distinctly separate head which is often darker than the rest of the body.
- Colouring can be tan, light green or clear, but some are red.

Dronefly Larvae *(Syrphidae)*

- Long thin breathing tube (tail-like)
- Greyish, green, or pale brown in colour
- Slow moving

DATA RECORDING FORM

Date	
Time	
Surveyor name	
Location	
Conditions	

Additional Notes:
Inlet: Outlet:

	Abundance			
Taxa	1-9	10-99	100-999	1000+
Mayfly (Ephemeroptera)	1	2	3	4
Caddisflies (Trichoptera)	1	2	3	4
Dragonflies and Damselflies (Odonata) - Dragonfly (Aeshnidae) - Damselfly (Coenagrionidae)	1	2	3	4
Freshwater Shrimp (Gammarus)	1	2	3	2
Freshwater Hoglouse (Aseliidae)	1	1	0	-2
Leeches (Hirudinea)	1	1	0	-2
Fly Larvae (Diptera) - Non-Biting Midge Larvae (Chironomidae) - Mosquito larvae (Culicidae) - Drone fly larvae (Syrphidae)	1	1	0	-3
Worms (Oligochaeta)	1	1	0	-3

Taxa	Inlet		Outlet	
	Estimated Count	Score	Estimated Count	Score
Mayfly (*Ephemeroptera*)				
Caddisflies (*Trichoptera*)				
Dragonfly & Damselfly (*Odonata)*				
Freshwater Shrimp *(Gammarus)*				
Freshwater Hoglouse *(Aseliidae)*				
Leeches *(Hirudinea)*				
Fly Larvae (*Diptera*) • Midge Larvae *(Chironomidae)* • Mosquito Larvae *(Culicidae)* • Drone Fly Larvae *(Syrphidae)*				

Worms *(Oligochaeta)*				
	Total INLET score =		**Total OUTLET score =**	

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