



Insects of the Royal Canal in Phibsboro

Prepared for: Phibsboro Village Tidy Towns

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Cover Image: Water stick insect (*Ranatra linearis*)

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1. INTRODUCTION

1.1. Study Sites

1.1.1. History and Management

The Royal Canal runs between the River Liffey in Dublin and the River Shannon in Longford. It was built between 1790 and 1817 primarily for freight and passenger transportation. From 1845, railway transport started to replace it until 1961 when the canal was officially closed. The Royal Canal Amenity Group (RCAG) was formed in 1974 to maintain the canal as a public amenity and prevent it from being converted into a motorway. The canal was finally reopened for navigation in 2010.

The Royal Canal represents a 145-kilometre-long waterway and landscape in which biodiversity is supported but is also at risk of negative impacts. For instance, the part of the canal going through urban Dublin has suffered from heavy litter pollution in the past, which reduces water quality, is particularly harmful if ingested by wildlife, and can ultimately flow into and accumulate in marine systems (Davey, 2021). Fortunately, the situation has improved since the 1990s when community members began to take care of the banks and walkways. The Royal Canal is also vulnerable to pollution from storm drain overflow, which has the potential to harm aquatic invertebrates and fish (Thomas, 2016).

The Royal Canal, Grand Canal, and Dublin's rivers are recognised by Waterways Ireland as ecological corridors that facilitate the safe migration of a large variety of flora and fauna between the different habitats in which they find food, mates, breeding sites, and shelter. Thus, it is important to maintain the health of this habitat along its full length (Dalby, 2022).



Fig. 1. The Royal Canal in Dublin (left and right) and Leixlip (centre).

The canal passes through Phibsboro, also known as Phibsborough, an urban area just north of Dublin's city centre. Between 2019 and 2021, Phibsboro' Village Tidy Towns commissioned research to develop a Biodiversity Action Plan (BAP) to protect and increase the diversity of green spaces in the area. The results of the fieldwork highlighted some specific areas of biodiversity interest, including the canal. The fieldwork in Phibsboro recorded the presence of 94 native plants (and 28 non-natives) growing in the wild and 30 different bird species (Tubridy, 2021).

The Royal Canal has social and educational importance, revealing the diversity and importance of nature to people living in urban areas. The Biodiversity Action Plan delivers an expert evaluation of the biodiversity value in the region and shows the path to implementing actions that will protect it and raise local awareness on the matter.

1.1.2. Importance for Biodiversity

The WWF (2022) reports that there has been an average decline of 69% in species populations around the planet since 1970. Ireland's biodiversity has not been spared from this loss. While only about 10% of Ireland's known 31,000 species have been assessed, we know that one-fifth of those assessed are threatened with extinction. This includes many insect species, as the following examples highlight.

One-third of Ireland's bee species and more than half of our bumblebee species are threatened with extinction, and 45% of our solitary bee species are in decline (Fitzpatrick et al., 2006). Four of our 24 species of damselfly and dragonfly have been IUCN Red List assessed as Threatened, and one as Near Threatened, due to habitat loss and the alteration of hydrology and nutrient levels in wetlands (Nelson et al., 2011). 37% of Europe's hoverfly species are threatened with extinction due to changes in farming approaches, urban development, pesticides, unsustainable forestry methods, and climate change (International Union for Conservation of Nature, 2022).

Insect populations are negatively impacted by global changes, and the systematic use of pesticides as well as environmental pollution are responsible for impacts on their population dynamics, distribution, abundance, intensity, and feeding behaviour (Khaliq et al., 2014; Alstad et al., 1982). Habitat fragmentation is a major issue for urban biodiversity. Many species use more than one type of habitat during their life cycle or at different seasons. Development and land use change are dividing large habitats into smaller, more isolated, and lower-quality fragments where species may not have access to all the resources they need.

The banks of Dublin's canals provide important habitat. The habitats can be divided into three zones: the open water, which supports aquatic fauna and waterweeds; the banks, which host emergent vegetation, semi-aquatic invertebrates, nesting and sleeping ducks and swans, and small mammals; and the drier verges along the towpath, which support a completely different community of plants and invertebrates (Dalby, 2022).

The slow flow and relatively unpolluted waters of the canals have allowed the establishment of extensive benthic vegetation communities, including the protected Opposite-leaved Pondweed, the Glutinous snail, and coarse fish species, including Pike, Rudd, Bream, and Tench (Dublin City Council, 2021). The Glutinous snail (*Myxas glutinosa*) is extremely localised in central and western Ireland, common in places along the two canals but is in decline (Anderson, 2016). Protected built heritage sites can also be important for biodiversity because they are often less disturbed and managed than other sites (Dublin City Council, 2021). The stone walls along

the towpath are covered with lichens, mosses, and ferns, while outside these walls, there are patches of calcareous grassland, shrubs, and trees. Bats can also be found amongst these bushes and trees (Thomas, 2016). For these reasons, both of the canals that run into Dublin are proposed Natural Heritage Areas (NHA). Proposed NHAs are legally protected from damage.

Due to its distinctive hydrological and structural features, the Royal Canal may support aquatic insect species that are not found elsewhere in North Dublin. It also supports populations of more generalist species that are in decline due to the loss of water availability and vegetation in other locations through urban development, draining of agricultural land, and the over-tidying and paving of gardens and parks.

In 2019, Ireland declared a biodiversity crisis, and Dublin City Council followed suit shortly after. This was followed by the publication of the Dublin City Biodiversity Action Plan 2021 - 2025 (Dublin City Council, 2021). To reduce risks to the environment, the council is phasing out glyphosates and began to implement alternative methods for herbicide between 2018 and 2020. The council is also working to reverse the decline in species populations by allowing areas of parkland to grow wild and encouraging pollinator-friendly gardening (Dublin City Council, 2018). These efforts are welcomed and necessary given the scale of population decline, where scientists warn that up to 40% of all insect species are on a downward trajectory to extinction (Sanchez-Bayo and Wyckhuys, 2019).

Actions such as these can provide buffer zones around and corridors between ecologically significant habitats such as the Royal Canal. Other green spaces under the care of Phibsboro Village Tidy Towns provide essential buffer zones for protecting the site against the added pressures of its urban surroundings and bolstering populations of the insects that use the canal. As a constant presence of water and cool, sheltering vegetation, the Royal Canal is also particularly important for biodiversity as it faces the challenges of climate change.

1.1.3. Potential Threats of Developments

Three development projects are planned along the Royal Canal in Phibsboro and are likely to have an impact on local biodiversity.

The first project is the Royal Canal Greenway, which extends from Dublin's North Strand to Phibsboro. Phase 3 of the project involves the construction of a 2.1-kilometre-long pedestrian and cycle track. This track will be situated on the banks of the Royal Canal from Newcomen Bridge at the North Strand Road to Cross Guns Bridge in Phibsborough. The final planned 3.2-kilometre cycle and walking route from Phibsboro in the north of the city to the River Liffey should be achieved by 2025. The Greenway will incorporate access ramps between the canal towpath and all road crossings, a new bridge for pedestrians and cyclists across the Royal Canal, and a new community plaza (Afloat.ie Team, 2023). This project aims to reduce our carbon footprint through slow mobility such as cycling or walking. It is essential to balance the benefits of cycle tracks in reducing the carbon footprint with the conservation of biodiversity and the protection of wetland habitats, which are necessary for climate change mitigation. Dublin City Council (2021) notes that not only does the National Biodiversity Action Plan aim to prevent the loss of biodiversity but also has the objective to "promote net biodiversity gain." To maximise environmental benefits, the Royal Canal Greenway plan should take this into account.

The second project is the Cross Guns Development, the construction of an apartment building on the site of an old bakery at Cross Guns, on the banks of the Royal Canal. This project, submitted under the Strategic Housing Development (SHD) process and authorised by An Bord Pleanála, will be between five and twelve floors high, which represents 40 meters at its largest point. It has met local resistance, and the Dublin City Council has shown its opposition to the project (McCullagh, 2021). Due to the height of the building and its position on the south bank of the canal, it may overshadow the canal that borders it and have an impact on the biodiversity in the water. A new inspector's report on the planning application for the Cross Guns apartments from Bindford Ltd was made available online on May 29th (An Bord Pleanála, 2023). The application is still for a building of between four and twelve stories.

The third project is the new Glasnevin Metrolink station, which will be constructed on the premises of the Brian Boru pub and Des Kelly Interiors, among others, on Phibsborough Road. It will entail the removal of all of the hedgerow along that stretch of the north side of the canal. In the case of all three of these developments, an increase or change in street lighting has the potential to impact local wildlife, especially insects.

1.2. Choice of Study Subjects

The present survey is part of a series commissioned by Phibsboro Village Tidy Towns to inform the actions and objectives of a management plan for the green areas around Phibsboro. Phibsboro Village Tidy Towns is a group of volunteers who, through various actions, want to make a difference to the global environment and the community of Phibsboro. A Biodiversity Action Plan (BAP) for Phibsboro was prepared for Phibsboro Village Tidy Towns in 2021. It includes checklists of plant and bird species in the area, a water quality assessment of Blessington Basin, and guidelines for biodiversity management for local green areas (Tubridy, 2021). However, the BAP does not yet include a detailed analysis of insects in the area, which is why the present survey has been commissioned.

Baseline information is essential for any long-term monitoring or management program. Habitat management plans based on a single taxon (e.g., plant species) may not always be appropriate for the conservation of invertebrates (Gardner, 1991; York, 1999). Therefore, it is prudent for Phibsboro Village Tidy Towns to commission a survey of invertebrates in conjunction with those of other flora and fauna. Including multiple taxa of invertebrates is particularly useful for monitoring the effects of changes in management practices (Pedley et al., 2013).

Carabid beetles and hoverflies, in particular, can be used as bioindicators to monitor the effectiveness of a habitat management plan in maintaining the biodiversity of a site. They fit the criteria for a suitable bioindicator as summarised by Rainio and Niemälä (2003): the group must be well-known, and its ecology and distribution reasonably well-understood; it should have specialist habitat requirements; it should respond rapidly to changes in environmental factors; and it needs to be simple and inexpensive to sample.

Ground beetles respond rapidly to changes in vegetation structure, disturbance, hydrology, and other influences that can alter microclimate conditions (Darcy, 2012; Rushton et al., 1990; Vessby et al., 2002). These changes can influence the presence or absence of sensitive species, abundance, diversity, distribution, and the composition of species assemblages (Luff, 1996; New, 2010). Hoverflies can reflect similar changes both at microhabitat and landscape scales (Speight, 2008). Therefore, gathering data on these two insect

groups will provide an effective baseline with which to compare the results of any management interventions or construction developments along the Phibsboro stretch of the Royal Canal.

Aquatic beetles and aquatic bugs have been included in this survey to provide information on the water quality and condition of habitats in the canal. The other insect groups included in this study are butterflies, bumblebees, shield bugs, ladybirds, dragonflies, and damselflies. These were chosen for their popularity among the public, ease of capture and identification in the field, sensitivity to changes (dragonflies also make suitable bioindicators), evidence of their declining populations (e.g., bumblebees), and to contribute records to ongoing citizen science recording schemes.

1.3. Primary Aims

This study aims to achieve the following outcomes:

- Gather baseline data on bioindicator species to compare the outcomes of future management interventions or construction developments along the Royal Canal in Phibsboro.
- Identify any uncommon or specialist species that require protection due to essential habitat conditions provided by the site, taking into consideration the impacts of the proposed developments.
- Provide general recommendations for the conservation of insects in the green spaces and waterways of Phibsboro.
- Compile a species list of easily visible macro-invertebrates to raise awareness among Phibsboro residents about the biodiversity in their neighbourhood.

2. METHODOLOGY

2.1. Pitfall Traps

A total of six pitfall traps were set along the canal to catch ground beetles.

Three traps were placed among the vegetation along the south bank of the canal between Dakota Court Apartments, where there is a small widened wedge of canal-side vegetation, and Cross Guns Bridge. Along this stretch, there is a more gradual incline into the water than elsewhere, as well as a diversity of vegetation structure and plant species. The traps were evenly spread out along the bank, with their locations chosen to represent a range of vegetation types and structures.

Another three traps were set under the hawthorn hedgerow along the towpath verge on the north side of the canal, between Lock 5 (close to Cross Guns Bridge) and Lock 6. This location was selected because the hedgerow is due to be removed to accommodate the construction of the Glasnevin Metrolink station. It is also the only terrestrial vegetation along that stretch of the canal likely to be affected by the shadow of the proposed Cross Guns development at certain times of the day.

The traps consisted of opaque plastic 350 ml cups, yellow and light green, measuring 7 cm in diameter at the top and 5 cm at the base. They were inserted into the ground up to the rim and placed at least 10 meters apart from each other. To prevent small mammals and frogs from becoming trapped, a piece of chicken wire was placed in the mouth of each cup.

Approximately 100 ml of a mixture of propylene glycol (50%) and water (50%) was added to each cup. A 20 cm x 20 cm lid, cut from old plastic election campaign posters, was secured 5 - 10 cm above each trap using bamboo skewers. On the back of each lid, a notice was written explaining their purpose and providing contact details.



Fig. 2. Locations of pitfall traps 1 to 3 on the bank of the Royal Canal.

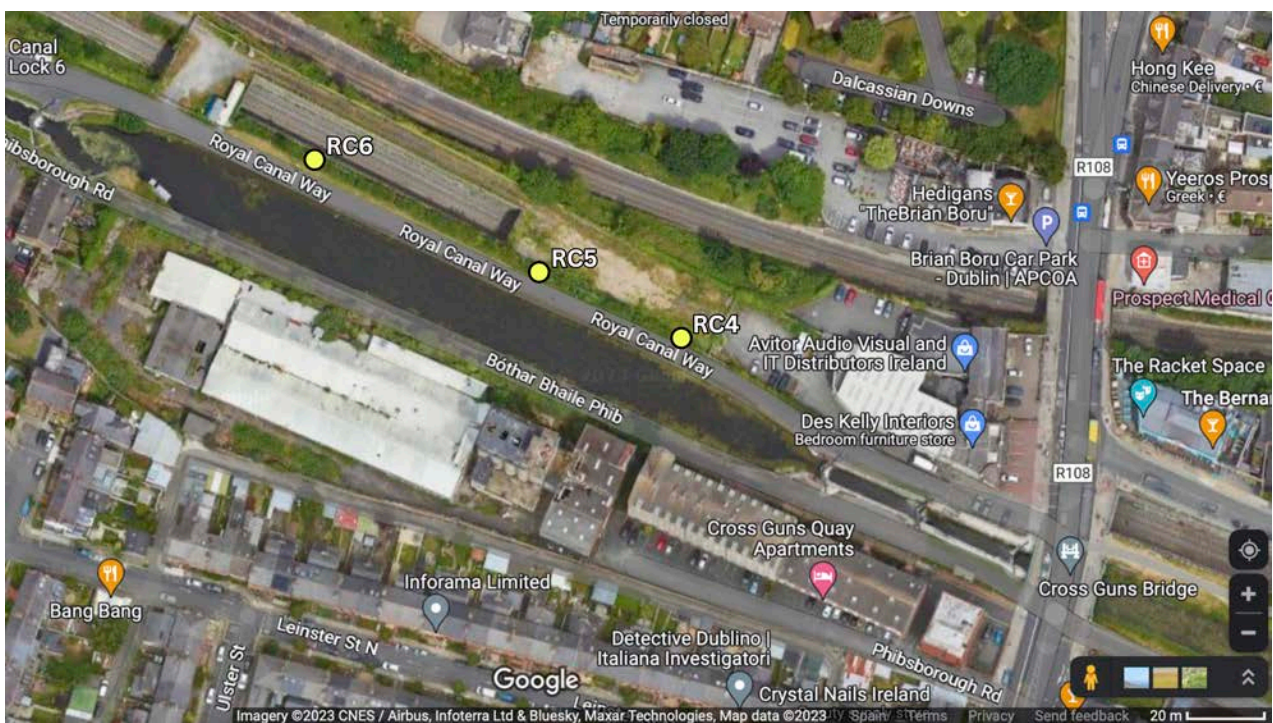


Fig. 3. Locations of pitfall traps 4 to 6 on the bank of the Royal Canal.

2.2. Transects

In order to survey butterflies, bees, and hoverflies, transects were walked along sections of the banks of the Royal Canal. The transect monitoring method was adapted from recording guidelines in the National Biodiversity Data Centre's Five Visit Monitoring Scheme for Butterflies (2022a) and their Bumblebee Monitoring Scheme (2022).

All but one of the transects were surveyed between the hours of 11:00 and 17:00. The surveys took place between the months of June and August, only when the temperature was above 13°C, and during good weather conditions. The recorder visually searched the habitat within a "box" of space measuring 2.5m on either side of the recorder and 5m in front as they walked along.

Sightings of insects from all of the survey target groups were recorded. Any chance sightings of other insects that could be easily identified in the field were also recorded, but a comprehensive survey was not conducted for these groups. They included macro moths, other beetle families, true bugs, grasshoppers, and spiders. Any insects from the target groups that could not be identified in the field were captured in sample jars and placed in a freezer overnight before being stored in alcohol.



Fig. 4. Map of transect locations for the Royal Canal insect survey.

2.3. Sweep Netting

A medium sweep net (40 cm at the widest point) was used to collect target insect groups from the vegetation alongside the transect. This was accomplished by sweeping the net back and forth twelve times within a 1 m span, taking a step forward between each sweep. The net's contents were emptied into a white dissection tray, and all insects from the survey target groups were identified and recorded, or removed for identification under the microscope. The latter were placed in the freezer overnight and then stored in alcohol.

2.4. Aquatic Sampling

A professional hand net (25 cm wide) with an aluminium handle was utilised to collect samples from different areas of the canal, encompassing varying depths, substrates, and vegetation densities. An effort was made to disturb the canal bed, banks, and vegetation to dislodge insects for collection. The net's contents were emptied into a white dissection tray filled with clear canal water, and all specimens of Coleoptera and a diverse selection of Hemiptera were gathered and stored in plastic jars. Upon returning to the laboratory, the water was drained from the jars, and the insects were placed in the freezer overnight. Subsequently, the specimens were stored in alcohol.

2.5. Identification and Ecology

The contents of each pitfall trap were emptied into a white tray and sorted by Nessa Darcy and Elias Borel. The invertebrates were divided into two categories (Coleoptera and miscellaneous) and stored in alcohol. All specimens of the target insect groups were identified by Nessa Darcy, with assistance from Elias Borel, Oisín Slator and Elijah Bahate. The insects were examined under an Optika Lab-20 stereo microscope (7x...45x magnification).

Identification and notes on ecology and conservation status are taken from the following sources for each insect group:

Bees

Field Guide to the Bees of Great Britain and Ireland (Falk, 2015).

Beetles (including Ladybirds)

The Ground Beetles of Ireland website by the National Museums Northern Ireland (2006); The Carabidae (ground beetles) of Britain and Ireland by Martin L. Luff (2007); The Ladybirds of Ireland website (National Museums Northern Ireland, 2009); Ladybirds (Coccinellidae) of Britain and Ireland (Roy et al., 2012); and the Species Profiles on the National Biodiversity Data Centre (2022b) website.

Butterflies

The Irish Butterfly Book (Harding, 2021) and the Species Profiles on the National Biodiversity Data Centre (2022b) website.

Dragonflies

Identification Guide to Ireland's Dragonflies and Damselflies (Regan and Nelson, 2013); Ireland Red List No.6: Damselflies & Dragonflies (Odonata) (Nelson et al., 2011); and Dragonfly Ireland (National Museums Northern Ireland, 2012).

Hoverflies

Britain's Hoverflies: A field guide (Ball and Morris, 2015) and Species Profiles on the National Biodiversity Data Centre (2022b) website.

Moths

Field Guide to the Moths of Great Britain and Ireland (Third Edition) (Waring et al., 2017), The Butterflies and Moths of Northern Ireland (National Museums Northern Ireland, 2022) and the Irish Moths and Butterflies website (Seawright, 2010).

True Bugs (including Shieldbugs and aquatic bugs)

British Bugs, an online identification guide to UK Hemiptera (Bantock and Botting, 2018); Shieldbugs of Ireland (Dublin Naturalists' Field Club, 2020); and The Irish Naturalist website (Beckett, 2022); Aquatic Heteroptera Recording Scheme for Britain and Ireland (Cook, n.d.).

A full list of sources can be found in the references section of this report.

3. RESULTS

3.1. Sampling Effort

Six pitfall traps were set for two time periods. The first round was from 6th June until 20th June 2022, the second was from 27th August until 15th September 2022. The weather was very dry during both periods. Traps RC1 and RC3 were reset on 8th September as their rims were found to have risen above the surface of the soil. Twelve insects from the target groups were identifiable from the pitfall trap contents.

The banks of the canal were visually surveyed in several short transects. The dates and time periods of these visual surveys are outlined in Table 1. The visual surveys along the transects resulted in a total of one hundred and thirty-nine records of invertebrates, between those identified in the field and samples collected and identified under the microscope.

| Transect | Date | Start Time | End Time |
|----------|----------------|------------|--------------------------------|
| A | 13 June 2022 | 12:04 | 14:21 (with a 34 minute break) |
| B | 27 August 2022 | 13:08 | 13:40 |
| C | 6 June 2022 | 16:50 | 18:09 |
| D | 31 August 2022 | 13:27 | 13:56 |
| E | 31 August 2022 | 14:16 | 14:33 |

Table 1. Dates and time periods when each transect was surveyed.

A total of twenty-four sweep net samples were taken along the transects on the same day as each transect was walked (Table 2), resulting in twenty-five records of insects.

| Transect | Date | Number of Sweep Samples |
|----------|----------------|-------------------------|
| A | 13 June 2022 | 11 |
| B | 27 August 2022 | 8 |
| D | 31 August 2022 | 5 |

Table 2. Dates and quantities of sweep samples taken along each transect.

Thirty-one river net samples were taken (Table 3), producing forty-three invertebrate records.

| Transect | Date | Number of River Net Samples |
|--|-------------------|-----------------------------|
| C | 15 April 2022 | 1 |
| C | 17 June 2022 | 6 |
| A | 17 June 2022 | 6 |
| D (section between Lock 6 and Phibsborough Road) | 17 June 2022 | 3 |
| C | 15 August 2022 | 3 |
| C | 15 September 2022 | 2 |
| B | 15 September 2022 | 2 |
| A | 31 August 2022 | 4 |
| D | 31 August 2022 | 4 |

Table 3. Dates and quantities of river net samples taken from the canal along each transect.

In addition to the sampling methods described above, twelve opportunistic records (random sightings of identifiable species) were made during the survey.

In total, two hundred and thirty-one individual insects were identified and recorded during the survey. The species identified from all of the sampling methods above are outlined in the following sections and tables. Several additional species were added to the list following observations by the author and pupils of Lindsay Road National School and St. Peter's National School during Heritage in Schools outings in April, May and June 2023. The outings took place along Transect D next to Shandon Park.

3.2. Bees (Apidae)

In total, four different bee species were recorded during this survey along the banks of the Royal Canal in Phibsboro (Table 4). Fifty-three of the individuals recorded were found during the monitoring of the transect, and one was recorded opportunistically at another time. This survey focused on bumblebees and honeybees, and did not include solitary bees.

While this survey was qualitative, not quantitative, it is worth noting that *Bombus pascuorum* and *Apis mellifera* were the most frequently recorded bee species during this survey, with 21 and 18 individuals respectively, while 13 individuals of the *Bombus lucorum* aggregate and only two *Bombus terrestris* individuals were recorded, both queens.

| Species | Common Name | Comments on Irish Distribution, Conservation Status and Habitat | Sampling Method |
|----------------------------|-------------------------|---|---------------------------------|
| <i>Apis mellifera</i> | Honey bee | Not evaluated in the Irish Red List, “due to the difficulty of distinguishing native populations from those imported into Ireland by beekeepers”. | Transect |
| <i>Bombus lucorum</i> agg. | White tailed bumblebee | Extremely common, Least Concern. | Transect |
| <i>Bombus pascuorum</i> | Common carder bumblebee | One of Ireland’s commonest bumblebees. Least Concern. | Transect and opportunistic find |
| <i>Bombus terrestris</i> | Buff tailed bumblebee | Common, Least Concern. | Transect |

Table 4. Bee species recorded at the Royal Canal in Phibsboro.

3.3. Ground Beetles (Carabidae)

Only two individual ground beetles were recorded from the pitfall traps (Table 5). Both of the ground beetles were caught using pitfall traps under the hawthorn hedgerow on the opposite side of the canal from the site of the proposed Cross Guns development. Both species are common and have a widespread distribution in Ireland. Common names are not listed as most ground beetles do not have one.

The pitfall traps contained seventy-two beetles of other families and other miscellaneous invertebrates. These groups were not included in the scope of this survey, but the specimens have been preserved by the author and are available to anyone who wishes to identify them. An additional ground beetle species was recorded along Transect D during a school outing on 12th June 2023.

| Ground Beetle Species | Comments on Irish Distribution, Conservation Status and Habitat | Pitfall Traps Containing This Species |
|---------------------------|---|---------------------------------------|
| <i>Nebria brevicollis</i> | Very common. | RC4 |

| Ground Beetle Species | Comments on Irish Distribution, Conservation Status and Habitat | Pitfall Traps Containing This Species |
|--------------------------------|---|---------------------------------------|
| <i>Pterostichus madidus</i> | Widespread and common. Under stones, loose bark, grass tussocks in open and shaded habitats. Lowland pasture, hay meadows, drier woodlands, dry heath, peatlands. | RC6 |
| <i>Pterostichus melanarius</i> | Common, widespread and abundant under stones, bark, grass tussocks and leaf litter in a variety of moist habitats. | Opportunistic (June 2023) |

Table 5. Ground beetle species recorded at the Royal Canal in Phibsboro.



Fig. 5. Some beetles recorded at the Royal Canal in Phibsboro: mating 22-spot ladybirds, a false blister beetle, and a pair of mating soldier beetles.

3.4. Ladybirds (Coccinellidae)

Seven of the individual ladybirds found during this survey of the banks of the Royal Canal in Phibsboro were recorded during the transects, and four were caught using a sweep net (Table 6). All are common species in Ireland. Two additional species were recorded during school outings to the canal in May and June 2023, resulting in a total of six species.

| Ladybird Species | Common Name | Comments on Irish Distribution, Conservation Status and Habitat | Sampling Method |
|--------------------------------------|--------------------|---|----------------------------|
| <i>Adalia bipunctata</i> | 2-spot ladybird | Common in houses, gardens, vegetation on wet water margins, pasture, trees (especially willow) or scrub. Feeds on aphids. Decreasing in the UK following the arrival of the harlequin ladybird. | Transect |
| <i>Adalia decempunctata</i> | 10-spot ladybird | Similar distribution to the 2-spot but slightly less common. Mainly in woodland edge habitats, on various tree species and in hedgerows, or in the herb layer of woodlands. Aphid-feeding. | Opportunistic (June 2023) |
| <i>Coccinella septempunctata</i> | 7-spot ladybird | Widespread and common, particularly on low herbage. Feeds on aphids. | Transect |
| <i>Harmonia axyridis</i> | Harlequin ladybird | Recent arrival to Ireland (2007), established and becoming more common. | Opportunistic (May 2023) |
| <i>Propylea quatuordecimpunctata</i> | 14-spot ladybird | Widely distributed and common. Decreasing in the UK. Both adults and larvae were found in the present survey. | Sweep netting and transect |
| <i>Psyllobora vigintiduopunctata</i> | 22-spot ladybird | Common and widespread. Feeds on mildew on hogweed, ragwort and other herbaceous plants. Decreasing in the UK. Both adults and larvae were found in the present survey. | Sweep netting and transect |

Table 6. Ladybird species recorded at the Royal Canal in Phibsboro.

3.5. Butterflies and Moths (Lepidoptera)

Surveying the transect, using the sweep net, and recording opportunistic finds during this survey along the banks of the Royal Canal resulted in a list of four moth species and one butterfly species. All of these were identified in the field or from photographs. All are common and well distributed in Ireland where their larval food plants are present, or where nectar sources are available, in the case of the migrant red admiral. Three additional moth species and two butterfly species were found during school outings to Transect D on 25th April and 12th June 2023. All of the moth and butterfly species are listed in Table 7.

| Butterfly/Moth Species | Common Name | Comments on Irish Distribution, Conservation Status and Habitat | Sampling Method |
|------------------------|-------------------------------|--|---------------------------|
| <i>Aglais urticae</i> | Small tortoiseshell butterfly | Common and widespread, Least Concern. Gardens, hedgerows, woodlands. | Opportunistic (June 2023) |

| Butterfly/Moth Species | Common Name | Comments on Irish Distribution, Conservation Status and Habitat | Sampling Method |
|--------------------------------|---------------------------|---|----------------------------|
| <i>Anania hortulata</i> | Small magpie moth | Common. Caterpillar feeds on common nettle, woundworts, mints, horehounds and bindweeds, from a rolled or silk-spun leaf. It spends the winter in a tough silk cocoon in a hollow stem or under bark before pupating the following May. Various habitats, including gardens, waste ground, and hedgerows. | Opportunistic (June 2023) |
| <i>Anthophila fabriciana</i> | Nettle tap moth | Widespread where its larval food plant, stinging nettle (<i>Urtica dioica</i>), is found. | Transect |
| <i>Cabera pusaria</i> | Common white wave moth | Common, widespread. Larvae eat birch and other trees and shrubs. | Opportunistic (June 2023) |
| <i>Nymphula nitidulata</i> | Beautiful China-mark moth | Common. Larvae are aquatic and feed on bur-reed (<i>Sparganium</i>) and other water plants. | Opportunistic (June 2023) |
| <i>Pararge aegeria</i> | Speckled wood butterfly | Least Concern. Woodland, hedgerow, scrub. Larvae feed on damp wild grasses. Its habitat is abundant in Ireland so it is common, but in decline. | Opportunistic (June 2023) |
| <i>Patania ruralis</i> | Mother of pearl moth | Common and widespread where its larval food plant, stinging nettle, is found. | Sweep netting |
| <i>Phlogophora meticulosa</i> | Angle shades moth | Common and widespread, larvae eat many different food plants. | Sweep netting |
| <i>Phragmatobia fuliginosa</i> | Ruby tiger moth | Widely distributed but never abundant. Mainly associated with coastal and inland heaths. Larvae eat ragworts, plantains, heathers, purple moor-grass, dock, dandelion, spindle and broom. | Opportunistic (April 2023) |
| <i>Tyria jacobaeae</i> | Cinnabar moth | Common and well distributed in Ireland. The larvae eat Common Ragwort, which is classified as a noxious weed and frequently eradicated from farmland in Ireland. Commonly found in well-drained, open, grassy areas such as waste grounds, railway banks, gardens, woodland clearings, sand dunes, and heaths. | Opportunistic find |
| <i>Vanessa atalanta</i> | Red admiral butterfly | Widespread migrant, wherever sources of nectar are available. | Opportunistic find |

Table 7. Butterfly and moth species recorded at the Royal Canal in Phibsboro.

3.6. Dragonflies and Damselflies (Odonata)

Two species of dragonfly (an adult of *Sympetrum striolatum* and two larvae and one possible adult of *Anax imperator*) and one species of damselfly (15 adult individuals of *Ischnura elegans*) were observed at the Royal Canal (Table 8) during the survey. They were identified from photographs. The emperor dragonfly was identified from photographs of its larval form. The adult was seen in flight and too distant to confirm identification. An additional damselfly species was added to the list during a school outing to Transect D on 12 June 2023.

| Dragonfly Species | Common Name | Comments on Irish Distribution, Conservation Status and Habitat | Sampling Method |
|------------------------------|-------------------------|--|---|
| <i>Anax imperator</i> | Emperor dragonfly | Larvae found, and possible adult seen in flight. Least Concern. Common and range expanding towards the north west of Ireland. “Found in areas with high volumes of pondweed, and other aquatic plants. Rarely seen far from aquatic habitats. Found in slow-moving/still water bodies e.g. lakes, ponds, canals, rivers, ditches etc.” (National Biodiversity Data Centre, 2022b) | Aquatic sampling and opportunistic find |
| <i>Enallagma cyathigerum</i> | Common blue damselfly | Very common, most widespread damselfly in Ireland. Least Concern. Breeds in a range of freshwater habitats, especially slow-flowing rivers, canals, lakes, reservoirs, large ponds. Prefers open water habitat. Can be seen away from water in grassland or woodland. | Opportunistic (June 2023) |
| <i>Ischnura elegans</i> | Blue-tailed damselfly | Least Concern. Widespread, common, in a wide range of lowland water bodies, including polluted or brackish water. Prefers well vegetated habitat. | Transect |
| <i>Sympetrum striolatum</i> | Common darter dragonfly | Least Concern. Most widespread Irish dragonfly. Population stable. Small shallow pools and sheltered lakes. Can tolerate brackish water. | Opportunistic find |

Table 8. Dragonfly and damselfly species recorded at the Royal Canal in Phibsboro.

3.7. Hoverflies (Syrphidae)

Six species of hoverfly were recorded during the present survey, on the transect and opportunistically (Table 9). The most abundant was *Episyrphus balteatus*, with eight individuals recorded, seven of which were on the transect. Only one or two individuals of the other species were recorded. An additional species was recorded during a school outing to Transect D on 12 June 2023.

| Hoverfly Species | Common Name | Comments on Irish Distribution, Conservation Status and Habitat | Sampling Method |
|-------------------------------|-------------------------------------|---|----------------------------------|
| <i>Episyrphus balteatus</i> | Marmalade hoverfly | Anthropophilic, almost ubiquitous. | Transect and opportunistic finds |
| <i>Eupeodes corollae</i> | | Widespread but not common in Ireland. More common in southern Europe. Anthropophilic. Likes open ground, hedgerows, low growing vegetation, including farmland and suburban gardens. Early spring population prefers lowland habitats near coast. Visits the margins of streams, ponds and pools to drink in hot weather. Migratory. | Transect |
| <i>Meliscaeva auricollis</i> | | Associated with forests, including oak forest, <i>Betula/Salix</i> scrub and conifer plantations. Larvae can occur in a wide range of situations and use both aphids and psyllids as food, providing this species with potential to use a variety of habitats. Anthropophilic, found more frequently in suburban gardens and conifer plantations than in wilder habitats. Overwinters as an adult, e.g. under ivy on walls. Expanding its Irish range due to the warming climate and general availability of appropriate habitat. | Transect |
| <i>Merodon equestris</i> | Large Narcissus fly | Widely distributed, almost entirely anthropophilic in Ireland, most frequently found in urban/suburban areas, because its larvae rely on certain types of bulbiferous plants such as <i>Narcissus</i> and <i>Allium</i> . Adults visit a wide range of wildflowers. | Opportunistic (June 2023) |
| <i>Platycheirus albimanus</i> | | Probably the most abundant and generally distributed hoverfly in Ireland. Common in gardens, among low foliage such as brambles, nettles, low growing flowers. | Transect |
| <i>Sphaerophoria scripta</i> | Long hoverfly/ Common twist-tail | Primarily coastal species in Ireland, in contrast to the rest of Western Europe where it is widespread. Open ground, grassland, heath, gardens, saltmarsh. Possibly a non-resident migrant here. | Transect |
| <i>Syritta pipiens</i> | Thick-legged hoverfly | Ubiquitous, anthropophilic and hygrophilous. | Transect |

Table 9. Hoverfly species recorded at the Royal Canal in Phibsboro.



Fig. 6. Dragonfly and damselfly species recorded at the Royal Canal in Phibsboro: emperor dragonfly, blue-tailed damselfly, and common darter dragonfly.

3.8. Terrestrial True Bugs (Hemiptera)

Shieldbugs were a target group of this study. Two shieldbug species were found along the banks of the Royal Canal (eight individuals of *Palomena prasina* and two *Dolycoris baccarum*) (Table 10). Both of these species were found again during a school outing on 25th April 2023. It was also possible to identify another common species of true bug (Hemiptera), *Philaenus spumarius*. “Cuckoo spit”, a frothy substance excreted by the nymphs of this species, was also present in abundance on the hawthorn hedgerows along the canal.

| True Bug Species | Common Name | Comments on Irish Distribution, Conservation Status and Habitat | Sampling Method |
|----------------------------|-------------------|--|---|
| <i>Dolycoris baccarum</i> | Hairy shield bug | Widespread and common in the southern half of Ireland, less so in the north but spreading. Dry, warm habitats including herb rich grassland, low shrubs and grassy hedgerow bases. Adults overwinter in grass tussocks and low growing evergreen vegetation (Beckett, 2023). | Sweep netting |
| <i>Palomena prasina</i> | Green shield bug | One of Ireland’s commonest shield bugs. | Sweep netting, transect, opportunistic find |
| <i>Philaenus spumarius</i> | Common froghopper | Common. | Sweep netting and transect |

Table 10. Terrestrial true bug species recorded at the Royal Canal in Phibsboro.



Fig. 7. Shieldbugs recorded at the Royal Canal: green shieldbugs and a hairy shieldbug.

3.9. Aquatic Invertebrates

Water beetles (Coleoptera) were the target group for aquatic sampling in this survey, but it was also possible to capture and identify a selection of true bugs (Hemiptera) and other aquatic invertebrates (Table 11). Fifteen individual beetles were captured and identified, along with seventeen water bugs, a dragonfly larva, multiple diving bell spiders, and a freshwater shrimp. *Asellus aquaticus* (the water hog louse) was observed in the vast majority of river net samples. At least three different species of caddisfly larvae were also observed frequently, but not identified or recorded, distinguished by differences in the construction and materials of their cases.

All of the invertebrates were captured using a river net except for the jewel reed beetles, *Plateumaris sericea*, which were found on buttercups during a school trip in May 2023, and ten individuals of aquatic Hemiptera which were recorded from pitfall trap RC1 during the second round of pitfall trapping. These included all of the *Gerris lacustris* specimens and some specimens of *Gerris odontogaster*.

| Aquatic Species | Common Name | Order | Comments on Irish Distribution, Conservation Status and Habitat |
|-------------------------|-------------------|------------|--|
| <i>Anacaena limbata</i> | A water beetle | Coleoptera | Least Concern. Well vegetated, mostly eutrophic, still waters. Irish records are mainly from the midlands. |
| <i>Anax imperator</i> | Emperor dragonfly | Odonata | Least Concern. Common and spreading from south east of Ireland to north west. Well vegetated slow-moving or still water bodies, including canals. Adults hunt over the water and tend to stay near aquatic habitats. |

| Aquatic Species | Common Name | Order | Comments on Irish Distribution, Conservation Status and Habitat |
|--|--------------------------------|------------|--|
| <i>Argyroneta aquatica</i> | Diving bell spider | Araneae | <p>Least Concern (British IUCN Red List).</p> <p>Only known species of spider in Ireland that spends almost all of its life underwater. It prefers clean freshwater habitats with vegetation, including lakes, ponds, canals, marshes, slow streams. Creates an underwater silken cell filled with air from the surface, used for consuming prey, breeding and overwintering. Abundant in suitable habitat. May be in decline in some areas due to pollution (Harvey, et al., 2002).</p> <p>Found in abundance in the Royal Canal during the present survey and subsequent school outings.</p> |
| <i>Asellus aquaticus</i> | Water hog louse or pond slater | Isopoda | Very common and widespread. Tolerates pollution and low oxygen levels. |
| <i>Gammarus</i> sp. | Freshwater shrimp | Amphipoda | Unable to identify to species level |
| <i>Gerris argentatus</i> | A water skater | Hemiptera | One of the scarcer species of water skater, although not rare. Widespread in the north of Ireland but scarce in the south. Ponds, ditches, small pools, lake edges, where there is plenty of emergent vegetation. Can tolerate brackish conditions. |
| <i>Gerris lacustris</i> | A water skater | Hemiptera | All specimens found in pitfall trap RC1. Common and widely distributed. In a range of habitats including ponds, ditches, lakes and the backwaters of rivers and streams. Preference for warmer water temperatures, abundance of emergent plants, high concentrations of calcium and magnesium. |
| <i>Gerris odontogaster</i> | A water skater | Hemiptera | Recorded from pitfall trap RC1 as well as river net sampling. Widespread in Ireland. Well vegetated lakesides, ponds and canals. Both acidic and neutral to alkaline water. Overwinters as an adult in habitats such as grass tussocks. |
| <i>Haliphus flavicollis</i> | A water beetle | Coleoptera | Least Concern. Clean and clear stagnant or very slowly running water of lakes, ditches, canals and pools with rich vegetation. (Van Vondel et al., 2017) |
| <i>Haliphus immaculatus</i> | A water beetle | Coleoptera | Least Concern. In manmade stagnant water bodies, even with pollution. |
| <i>Haliphus lineolatus</i> | The hydravore water beetle | Coleoptera | Near Threatened (IUCN Irish Red List). Genitalia examined to confirm identification. Frequent from Kerry to Ulster, in particular Lough Erne, but appears to have been lost from much of the south of Ireland, where diffuse pollution may be the cause. Browses on hydrozoans, sponges and algae in lakes and canals. |
| <i>Haliphus ruficollis</i> group (females) | A water beetle | Coleoptera | The ID of females in this group is best decided by examining the males with which they are associated. |

| Aquatic Species | Common Name | Order | Comments on Irish Distribution, Conservation Status and Habitat |
|-----------------------------------|----------------------|------------|---|
| <i>Helophorus brevipalpis</i> | A water beetle | Coleoptera | Least Concern. Common and abundant in summer. Found in almost any habitat but needs exposed muddy edges of pools and streams for breeding. Largely lowland distribution. |
| <i>Hydrometra stagnorum</i> | Water measurer | Hemiptera | Found throughout Ireland in reedy river and stream margins where the current is slow and at the edges of ponds, lakes and ditches. Recorded from Royal Canal again on 25th April 2023 at Transect D. |
| <i>Nepa cinerea</i> | Water scorpion | Hemiptera | Found throughout Ireland in a variety of aquatic habitats. Usually in shallow water among vegetation. Eggs are laid in vegetation just beneath the surface of water. Predates on small fish, fly larvae, larvae of other water bugs and other aquatic animals. Some can disperse by flying. |
| <i>Noterus crassicornis</i> | A water beetle | Coleoptera | Least Concern. Found in permanent, base-rich lakes, ponds, ditches. Patchy distribution, common in much of Ireland. |
| <i>Notonecta glauca</i> | Common backswimmer | Hemiptera | The commonest of the back swimming water boatmen. Widespread in relatively still-water habitats including ponds, lakes, canals and ditches. Eggs are laid in plant stems. Prey includes tadpoles, small fish and invertebrates. |
| <i>Plateumaris sericea</i> | Jewel reed beetle | Coleoptera | Widespread and common, Least Concern. Well vegetated wetland margins with non-acidic, still or slow flowing water. Feed on various reeds, rushes and yellow iris. Adults also eat pollen. Aquatic larvae develop among roots. |
| <i>Ranatra (Ranatra) linearis</i> | Water stick insect | Hemiptera | Recent arrival to Ireland and still uncommon. First recorded in Ireland in 2016. Expanding British range northwards in response to climate change. Lays eggs on water plants. Preys on a wide variety of small animals including tadpoles. Can disperse by flying. |
| <i>Sigara</i> sp. | Lesser water boatman | Hemiptera | The specimen resembles <i>S. Scotti</i> , female, but that species is mainly associated with acidic lakes and pools where vegetation is sparse. This does not match the habitat in the Royal Canal, but the specimen could be a vagrant. |

Table 11. Aquatic invertebrate species recorded from the Royal Canal in Phibsboro.

3.10. Miscellaneous Other Terrestrial Invertebrates

A number of records were made of other terrestrial invertebrate species which could be easily identified, but which were not in the target groups for this survey (Table 12).

| Miscellaneous Species | Common Name | Comments on Irish Distribution, Conservation Status and Habitat | Sampling Method |
|--------------------------------|--|--|----------------------------|
| <i>Araneus diadematus</i> | Common garden spider/cross spider/orb weaver | Common and widespread in a variety of habitats. | Transect |
| <i>Cantharis cryptica</i> | A soldier beetle | Various habitats. It may be found in long grass, on umbellifers, bushes and trees. Widespread. Preys on other flower-feeding insects. (NatureSpot, 2022) | Transect |
| <i>Chorthippus brunneus</i> | Common field grasshopper | Common and widespread but scarcer in the far north. Dry, grassy habitats. Common on roadside verges, parkland, waste ground. Soil disturbance can be detrimental, as females lay their eggs just below the surface of dry ground or in anthills (Jones, 2012). | Transect |
| <i>Chrysoperla carnea</i> agg. | Green lacewing | Unable to identify to species level | Opportunistic (June 2023) |
| <i>Forficula auricularia</i> | Common earwig | Common and widespread | Sweep netting |
| <i>Lilioceris lili</i> | Scarlet lily beetle | A pest on garden varieties of lilies, this individual was likely blown in from a nearby garden. Climate change may be a factor in its recent northward and westward expansion from southern counties of England. | Opportunistic (June 2023) |
| <i>Pisaura mirabilis</i> | Nursery web spider | Common and widespread in grassland, heathland, scrub. | Transect |
| <i>Porcellio scaber</i> | Common rough woodlouse | Very common, often in gardens. Under stones and logs, in walls and crevices of bark. Can tolerate drier conditions than some other species. | Opportunistic |
| <i>Lucilia</i> sp. | Greenbottle fly | Unable to identify to species level | Transect and opportunistic |
| <i>Oedemera lurida</i> | False blister beetle | Open habitats with plenty of wild flowers such as hawthorn and umbellifers, where they feed on pollen and nectar. Larvae develop in dead herbaceous stems. Primarily southern distribution in UK, where it is common. (NatureSpot, 2022a) | Transect and opportunistic |
| <i>Vespula</i> sp. | Social wasp species | Unable to identify to species level | Transect |

Table 12. Miscellaneous other terrestrial invertebrates recorded at the Royal Canal in Phibsboro.



Fig. 8. Aquatic insects recorded at the Royal Canal in Phibsboro: a caddisfly larva in its case, the jewel reed beetle and a juvenile water scorpion.

4. DISCUSSION

4.1. Summaries of the Survey Transects

For the purposes of these summaries, the title “Transect X” represents each section of the site walked by the author to carry out visual surveys, the vegetation along the transect which was sampled using a sweep net, and the section of canal alongside it which was accessible by river net extended from the canal banks.

4.1.1. Transect A

Transect A is located on the north side of the canal, stretching from Cross Guns Bridge on Phibsborough Road (R108) northwest to the National Famine Way Shoe Stories marker. The towpath on the first half of the transect is bordered on one side by short grass and manicured hawthorn hedgerows, while the other side is bordered by the stone edge of the canal without any vegetation.

Three out of the six pitfall traps in the survey were placed under the hawthorn hedgerow (RC4, RC5, RC6) with the aim of finding ground beetle species that might be affected by the shadow of the Cross Guns development on the opposite side of the canal, or by the removal of hedgerows for the construction of the new Metrolink station. Only two ground beetle specimens were captured in the survey, both of which were found in these traps. The two species, *Nebria brevicollis* and *Pterostichus madidus*, are common and have general habitat preferences. The dry weather during the survey may have affected the activity of ground beetles, resulting in low numbers being caught in the traps. The location under the hawthorn hedgerows is also exposed and lacks the dense vegetation, dead leaves, and other debris that many ground beetle species require.

Two aquatic beetle species were discovered using a river net in this section, on the opposite side of the canal from the proposed Cross Guns development site. *Haliphus lineolatus* is red-listed as Near Threatened in Ireland, with a distribution from Kerry to Ulster but appears to have disappeared from much of the south and east of Ireland, potentially due to diffuse pollution. This species feeds on hydrozoans, sponges, and algae in lakes and canals. The other beetle, *Haliphus flavicollis*, is common (Least Concern) and prefers clean and clear stagnant or slowly running water in lakes, ditches, canals, and pools with abundant vegetation. Both species were found in the same sample, among short aquatic plants with a mossy and calcified appearance growing on the stone side of the canal.

The second half of Transect A extends beyond Lock 6 to the curved section of wall where a shoe sculpture on the National Famine Way is visible. Along this stretch, the vegetation alongside the canal is abundant, tall, dense, and diverse in herbaceous species. The 2-spot, 14-spot, and 22-spot ladybirds were found here. Two visually interesting beetle species, *Cantharis cryptica* (a soldier beetle) and *Oedemera lurida* (a false blister beetle), were recorded in this area. *Cantharis cryptica* preys on flower-feeding insects, while *Oedemera lurida* feeds on pollen and nectar, with its larvae developing in dead plant stems. Both species are supported by the diversity of flowering plants, including umbellifers and hawthorn, and of vegetation structure found in this location.

Male and female damselflies of the species *Ischnura elegans* were found in Transects A and C. While this species is widespread and can tolerate some pollution, it prefers well-vegetated water bodies such as the ones present in these parts of the canal.

The presence of the hoverfly *Meliscaeva auricollis* on this transect is noteworthy. It is typically associated with forests. However, it can adapt to various habitat types, including suburban gardens, as its larvae feed on aphids and psyllids. The species overwinters as an adult, often under ivy on walls, and its range in Ireland is expanding due to the warming climate. On the other side of the path from the canal, there is an old wall. Behind the wall, there are shrubs, trees, and areas of calcareous grassland with varying sward height and density. This type of grassland habitat supports common field grasshoppers (*Chorthippus brunneus*), which can be observed and heard in this area, and the shrubs and trees may help to support the hoverfly *Meliscaeva auricollis*.

During the visual transect along this stretch, several bee species were abundant, including *Apis mellifera*, *Bombus lucorum* agg., *Bombus terrestris*, and *Bombus pascuorum*. While these bumblebee species are common and widely distributed, and data on honey bees is insufficient to make an assessment of their conservation status, the fact that the vegetation in this area provides forage for pollinators is significant.

4.1.2 Transect B

Transect B is on the north side of the canal, and runs from Cross Guns bridge on Phibsborough Road in a southeast direction along the towpath towards Drumcondra, ending at Lock 3. The towpath is bordered on either side by heavily maintained grass. Between this and the canal there is a well vegetated, and very steep bank near the bridge. This part of the bank was too steep to descend for aquatic sampling, but it is here that the possible sightings of emperor dragonflies (*Anax imperator*) occurred, though their identity could not be fully confirmed from a distance. Aquatic sampling was possible further along, where vegetation is less abundant

and part of the bank is augmented with a short boardwalk. Larvae of *Anax imperator* were found here, along with the diving bell spider.

Sweep samples and a visual survey of the transect produced only a list of very common species, such as earwigs, green shieldbugs, 14-spot ladybirds, common carder bumble bees, greenbottle flies and wasps. A red admiral butterfly was seen flying above the towpath. An exploration of the steep section of the bank near the bridge may yield more ecologically significant results if access can be achieved. More diversity and structural variety of canalside vegetation and less frequent, rotational, mowing of the grass would provide more habitat for insects here.

4.1.3. Transect C

Transect C runs along the south side of the canal, between Dakota Court Apartments and the Cross Guns Bridge on Phibsborough Road. A habitat feature of particular interest here is the gradual slope of the canal bank in certain areas of this section, and the gravelly or sometimes muddy nature of the substrate along these edges. The roots of trees and pondweed in the water here provide nooks and crannies where invertebrates can shelter from the faster flowing water. These types of habitat are essential for many aquatic or riparian invertebrates.

The water beetle *Helophorus brevipalpis* was recorded only at this section. While it is common and abundant in many habitats, it needs exposed muddy edges of pools and streams such as these for breeding. Another water beetle, *Haliphus immaculatus*, was recorded here and in the canal alongside Transect D. Its red list status is Least Concern. It can live in manmade stagnant water bodies, even with pollution.

Three of the survey's six pitfall traps were set along the canal bank here, as it was expected that the habitat features might support some interesting, uncommon ground beetle species. No ground beetles were caught in the traps, but 21 beetles from other families were caught and have been stored.

Ten individuals of aquatic hemiptera (*Gerris* spp.) were also caught in one of the traps. One of these, the water skater *Gerris odontogaster*, was recorded only at this transect. Its presence reflects the well vegetated habitat. It overwinters in tussocks of grass, and nearby green spaces such as Villa Bank Garden could provide such a resource.

Some other aquatic hemiptera of unusual appearance, which may be of particular interest to the public, were recorded here: the water scorpion, water stick insect, and water measurer. The water measurer was also seen at Transect D on 25th April 2023, but the other two were recorded only at Transect C. The water stick insect (*Ranatra linearis*) is a recent newcomer to Ireland and still relatively uncommon but expanding its range.

4.1.4 Transect D

Much of Transect D runs along a tarmac path between an old wall and the solid edge of the canal, with very little vegetation. An adult cinnabar moth was recorded here. Ragwort, the larval food source of the cinnabar moth could not be seen by the author at this location on the transect. However, there is an abundance of hawthorn, red valerian and other flowering plants growing at the top of the remains of a bridge that once connected the old mill to the railway line, and also along the top of the old wall. These may provide the cinnabar moth and other pollinators with a source of nectar.

The author has observed the caterpillars and eggs of cinnabar moths on ragwort at the nearby Villa Bank Garden and St. Anne's Road Pocket Park. These urban sources of their larval food plant are important, as ragwort is routinely eradicated from farmland where it can be toxic to livestock when mixed into hay or silage.

In contrast to that bare path, there is a strip of canalside vegetation at the northwest end of Transect D, in front of the Shandon Park housing estate, which is wider than the vegetation along each of the other sections covered by this survey. This habitat is buffered by Shandon Park, a wide green space with trees and pollinator planting, on the other side of the path.

A number of larger moth species were found here. The mother of pearl moth feeds on nettles, available in abundance here. The adults of the angle shades moth are attracted to light and feed on flowers of common reed and other grasses (Butterfly Conservation, n.d). These two were found in sweep samples. A ruby tiger moth was found by a school pupil on an outing on 25th April 2023. The presence of this species is notable as it is mainly associated with coastal and inland heaths. It is widespread but rarely abundant. Several of its larval food plants are available along the Royal Canal, including ragworts, plantains, dock and dandelion. The small magpie, common white wave and beautiful China-mark moths were also found on school outings in June 2023. All three are common, but the beautiful China-mark is noteworthy for its aquatic larvae.

The dense vegetation and herbaceous diversity makes this a good site for shieldbugs and ladybirds too, providing plenty of sap for the former, aphids and mildew for the latter, and overwintering sites for both. Green shieldbugs and hairy shieldbugs were found in abundance both in 2022 and during school outings in 2023. The 22-spot ladybird was found during the survey, the damp habitat producing mildew for it to eat. It was observed again in April 2023, along with the 14-spot, 7-spot, 10-spot and harlequin ladybirds. The harlequin may have a negative impact on local ladybird populations. Its spread appears to be causing the decline of the 2-spot ladybird in the United Kingdom. It is well established in Ireland and there is little that can be done to prevent it from spreading, but provision of as much suitable habitat as possible for Ireland's native species will give them the best chance at surviving the effects of invasive species. The combination of trees and herbaceous vegetation at Shandon Park is important for supporting ladybirds such as the 2-spot and 10-spot. A green lacewing was also observed in the vegetation. These are voracious predators on a wide range of garden pests.

Aquatic sampling along Transect D brought up one of the scarcer species of water skater, although it is not rare. *Gerris argentatus* is widespread in the north of Ireland but scarce in the south. It likes still water bodies with plenty of emergent vegetation and can tolerate brackish conditions. Another water bug of note for its interesting appearance was recorded at this transect on 25th April 2023. The water measurer, *Hydrometra stagnorum* is found at the reedy edges of water bodies where the current is slow.

The two water beetle species found along Transect D, *Anacaena limbata* and *Haliphus immaculatus*, are both red listed as Least Concern. Both live in still water bodies, even those that are eutrophic or polluted. An abundance of diving bell spiders (*Argyroneta aquatica*) were also found here, during the survey and on 25th April 2023, both at the well vegetated end of the transect and in front of the Cross Guns development site, even in extremely short calcified vegetation on the submerged stone side of the canal.

Several jewel reed beetles (*Plateumaris sericea*) were observed on buttercups and nettles in the dense vegetation here in May 2023. Like the beautiful China-mark moth, their larvae are aquatic. They feed on a variety of reeds, rushes and yellow iris and develop among the roots.

4.2. Biodiversity in Urban Environments

Understanding and documenting sites of biodiversity value across cities is key to informing urban planning and restoration (McDonnell and MacGregor-Fors 2016). This must be carefully considered as an increasing number of people continue to move to urban environments for employment and education (Seto et al. 2012). This survey demonstrates that the Royal Canal in Phibsboro is an important green space for local insect diversity. Despite a geographically and temporally limited sampling effort, the study and subsequent outings detected 69 invertebrate species. Increasing sampling intensity, using different methods, and extending both the daily and seasonal timeframe would no doubt greatly increase this number.

This diversity is not just of academic interest. High invertebrate diversity reflects the diversity of habitats and vegetation provided by the seemingly simple natural system of the Royal Canal. Studies have clearly shown a link between local biodiversity and human psychological wellbeing, cognitive function, and physiological fitness; people who frequent or are surrounded by high diversity green spaces are overall healthier individuals (Fuller et al. 2007; Keniger et al 2013). The author observed the immediate positive benefits of this resource many times, when encountering interested members of the public while carrying out the survey, and in the enthusiastic engagement of local children with the insects of the canal on their school outings. The Royal Canal is one of the few remaining public green spaces that can provide North Dublin City residents with direct contact with the natural environment.

4.3. Conservation Status and Distribution

The majority of species detected during this survey are common and widespread in Ireland and none of them are rare. However, some species with localised distribution or restricted habitat requirements were recorded and are outlined in this section. Additionally, aquatic or hydrophilic species were well represented, reflecting the importance of the canal habitat in the context of an urban environment. If this water body was not present or was in poor condition, those species would not be present.

Haliphus lineolatus, the Hydravore beetle, is red listed as Near Threatened in Ireland (Foster, et al., 2009). While it is frequent from Kerry to Ulster, it appears to have been lost from much of the south and east of Ireland, where diffuse pollution may be the cause. This species browses on hydrozoans, sponges and algae in lakes and canals. The individual of this species was taken from a river net sample along Transect A. The net was dragged through short aquatic plants, mossy and calcified in appearance (possibly Charophytes), growing on the stone side of the canal, on the opposite side of the canal from the Cross Guns development site. As only one specimen was found, it is not possible to determine whether this specific habitat is supporting this species or if it has drifted in from another part of the canal. Therefore it is unclear whether the Cross Guns development will have any significant impact on it.

All of the ladybird species recorded during this survey are common in Ireland, but the 2-spot, 14-spot and 22-spot are decreasing in the United Kingdom. The Irish range of the 2-spot is expanding (National Biodiversity Data Centre, 2022d). The 2-spot is associated with riverside vegetation and gardens (National Biodiversity

Data Centre, 2022d), meaning that the wetland features of the Royal Canal, and the buffer effect of local parks and gardens, are likely to be important in supporting this species. This species was also recorded at Villa Bank Garden during a survey in the same year, and has been observed by the author at St. Anne's Road Pocket Park in Drumcondra. The proximity of those sites to the canal make them important buffer zones, supporting the populations at the canal and vice versa.

All of the butterfly species recorded during the present survey have a red list status of Least Concern in Ireland and most of them are widely recorded habitat generalists. However, the speckled wood is in decline, and its presence here is noteworthy because its typical habitat is woodland, hedgerow, scrub. It requires tall, damp grass to feed its larvae. Such habitat can be found along the canal, and the nearby trees and scrub may be essential for its other habitat needs, such as feeding on the sugary deposits that aphids excrete on leaves.

Of the moths identified, the cinnabar is of note as its larval diet is restricted to ragwort. Research has shown that while the cinnabar moth's distribution has not changed significantly between 1968 and 2022, their population numbers have decreased dramatically in response to the routine eradication of ragwort from farmland due to its toxicity to livestock (Buglife, n.d.). The presence of the ruby tiger moth at the canal is also noteworthy as it is more strongly associated with heathland. Vegetation in the area may be providing similar structural and climatic conditions as heathland, and along with the presence of one of the moth's food plants, dock, may be enabling it to live here.

The hoverfly species *Sphaerophoria scripta* is restricted to coastal areas in Ireland, unlike elsewhere in its European range. This, among other clues, indicates that it might be a migrant to this island and thus not living all year round or breeding in Phibsboro.

Only the most common, widespread bumblebee species were recorded during this survey, along with the honey bee whose conservation status has not yet been fully assessed. However, as pollinator populations are generally in decline, any habitats which provide forage and nesting sites for bees, hoverflies and other pollinators, such as the banks of the Royal Canal and nearby green spaces such as Villa Bank Garden, are important for their conservation.

4.4. Hygrophilous Species

As could be expected at a canal habitat, a number of insects which have a preference or need for wet or damp habitat were recorded during this survey. The 22-spot ladybird eats mildew, which grows more abundantly in damp conditions. The author has frequently observed this species on damp, herbaceous vegetation growing at the bottom of hedgerows or beside water. The hoverfly species *Syrirta pipiens* also has a preference for damp habitats. Its larvae live in damp, decaying organic matter, such as plant stalks, dung and compost. Another hoverfly, *Eupeodes corollae*, is known to visit the margins of streams, ponds and pools to drink in hot weather. The larvae of the speckled wood butterfly also need damp grasses to eat.

Of the aquatic invertebrate species observed during this survey, the majority have a preference for well vegetated, still or slow-moving waters. The slow pace of the canal and its abundant vegetation provide similar microhabitats to those found in ponds and lakes, enabling species typical of those habitats to find refuge in the canal.

Only two dragonfly species and two damselfly species were recorded. All four are common and have a red list status of Least Concern. The adult dragonflies were seen only in small numbers. The absence of dragonflies from the Royal Canal is of general concern. Dragonflies are considered excellent bio-indicators of water body health (Rocha-Ortega, 2019). Their entire lifespan is intricately linked to water bodies. Dragonfly nymphs may spend several years developing underwater. As such, these charismatic species need continuous high water quality to survive to adulthood, when they then emerge from the water to reproduce. While *Ischnura elegans*, the blue-tailed damselfly, can tolerate some pollution, many species of dragonfly and damselfly are sensitive to high levels of pollution, including rubbish, chemicals, and sediment erosion which harms early life stages by covering and suffocating eggs and nymphs.

While not all invertebrates found in water samples could be identified within the scope of the present survey, the author observed the presence of other, more pollution-sensitive invertebrates, such as multiple species of case-carrying caddisfly larvae and flattened mayfly nymphs, in addition to those which can survive in poorer water quality, such as freshwater hoglice and bloodworms. This suggests that the water quality of the Royal Canal is reasonably good but could be improved to support more sensitive species.

4.5. Interspecies Interactions

It is important to remember that an ecosystem is exactly that: a system composed of many individual interactions that balance across the community. Some of these interactions are mutually beneficial for both species (mutualism), while others have negative consequences for one species (antagonism). The survey conducted in this study revealed several interesting mutualistic and antagonistic interactions among the recorded species.

Many insects are obligate feeders, relying on specific types of plants, insects, or substances for their survival. For example, as mentioned previously, the caterpillars of the cinnabar moth feed exclusively on ragwort. Urban havens for ragwort can be very important for this moth species. Nettle tap moth caterpillars are restricted to nettles, as their name suggests, as are the caterpillars of the small tortoiseshell butterfly. The hydravore beetle (*Halipplus lineolatus*) is a specialised feeder on sponges and hydroids, and the larvae of the jewel reed beetle feed on the roots of certain aquatic plants. These specialised feeding habits highlight the importance of specific plant and prey species for the survival of certain insect species.

Hoverflies and ladybirds play a crucial role in controlling aphid populations. The larvae of the hoverfly, *Episyrphus balteatus*, for instance, are voracious predators of aphids and other insects that can damage plants. The presence of these beneficial species in gardens and canalside vegetation helps to maintain a healthy balance in the ecosystem. Many insects, such as ants and some butterflies, will consume the sugary liquid excreted by aphids when they feed on plants, forming additional ecological interactions within the ecosystem.

The diverse range of flowering plants along the canal provides nectar and pollen sources year-round, benefiting bees, hoverflies, butterflies, moths, and wasps. In turn, these insects contribute to the pollination of these plants, ensuring their reproduction and survival.

Dragonflies and damselflies found along the Royal Canal are generalist predators, consuming various aquatic animals as larvae and catching insects on the wing as adults. They also serve as a crucial food source for many birds, mammals, fish and bats that rely on the canal and surrounding green spaces.

Habitat provision is another important aspect of ecosystem interactions. Many insect species found along the canal require specific vegetation structures for nesting, overwintering, and shelter. Habitats such as dense hedgerows and tussocky grass, although sometimes considered unsightly by humans, provide essential resources for insect species, including bumblebees and wasps. Dead plant stems and other debris in the canal provide hiding and overwintering sites and materials for caddisflies to construct their protective cases.

These examples illustrate the interconnectedness of species along the Royal Canal. Understanding these ecological networks is crucial, as the extinction of one species that supports another can have cascading negative effects throughout the system. Fortunately, this survey did not identify any fragile interactions, indicating a relatively stable and resilient ecosystem along the canal.

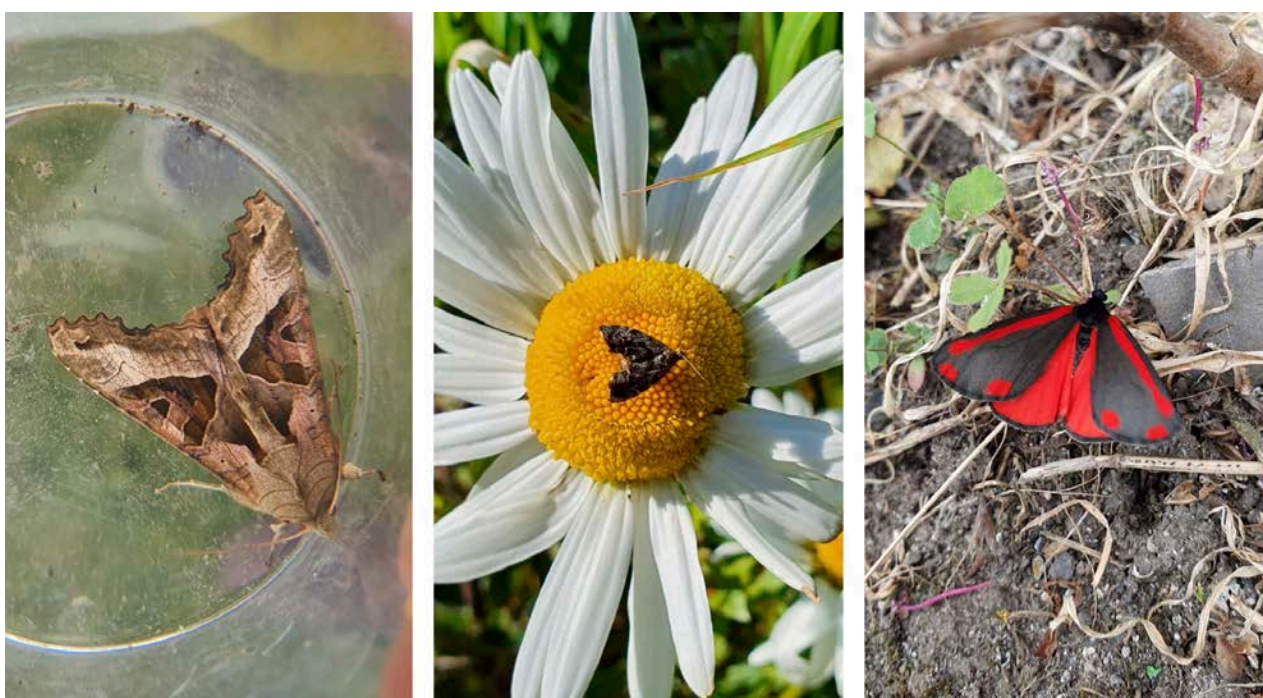


Fig. 9. Moths recorded at the Royal Canal in Phibsboro: angle shades, nettle tap and cinnabar.

4.6. Habitat Heterogeneity

Habitat heterogeneity refers to the variety of habitat types present in a natural or urban environment. Understanding this concept is crucial when considering the potential impacts of development projects on green spaces, as such projects often lead to a reduction in habitat diversity. For instance, a diverse range of vegetation structures creates micro-habitats, including riparian vegetation of different heights, hedgerows, trees, herbaceous plants, tussocky grass, leaf litter, and dead wood. These micro-habitats provide nesting sites, hunting grounds, shelter from dry weather, and food sources for insects in both their larval and adult forms. The habitat heterogeneity along the Royal Canal enables the existence of many species recorded in the survey, as the following examples demonstrate.

Several aquatic species associated with well vegetated lakes and ponds (e.g. *Gerris argentatus*) are present in the Royal Canal. This indicates that the vegetation and slow moving water in this artificial waterway create microclimatic conditions similar to those found in their more typical habitats, which are less likely to be found in an urban environment, and may be unique in North Dublin City.

The ground beetle species *Pterostichus madidus* is typically found in various open and shaded habitats, such as peatlands, lowland pastures, traditional hay meadows, drier woodlands, and dwarf shrub heaths. Its presence indicates that the microclimatic conditions it needs are present along the canal. However, the extremely small number of ground beetles caught in the pitfall traps during this survey could suggest either a shortage of suitable habitats or that the available habitat fragments are too small to provide the necessary conditions. Dry weather during the survey may also have limited their activity.

Edge habitats, such as those along the canal banks, play a crucial role for insects like hoverflies and ground beetles. Dragonfly larvae, for example, live underwater but require emergent vegetation to climb when they are ready to metamorphose into adults. Many butterfly species need sunny and sheltered locations for their larval food plants. The canal banks offer larval food plants, nectar sources, and suitable nesting sites for pollinators, while the presence of water is also vital, especially as the climate becomes warmer.

The hairy shieldbug, *Dolycoris baccarum*, prefers dry and warm habitats, including herb-rich grasslands, low shrubs, and the bases of grassy hedgerows. The presence of this species reflects the existence of habitats along the canal which have not been over tidied.

The hoverfly species observed along the Royal Canal banks during the study mainly consisted of common and widespread species that can adapt to man-made habitats. However, there was a notable absence of common hoverfly species whose larvae live in Hymenopteran nests, in contrast to the abundance of bumble bees and wasps. This could be attributed to the need for additional complementary habitats, such as woodlands, as in the case of *Volucella pellucens*.

While the examples mentioned above focus on the diversity of habitats along the canal itself, it's important to consider the contribution of the canal banks to habitat heterogeneity on a landscape scale. Many insect species utilise different habitat types during different life stages, seasons, or times of the day. This means that although some insect species in the study may also be found in gardens and parks nearby, they may still rely on the unique habitats provided by the canal for some of their needs. The contrasting and complementary buffer habitats found in local gardens and parks significantly contribute to the overall species diversity at the canal.

4.7. Importance of Wetlands for Climate Change Mitigation

There is evidence of changes in insect distribution and abundance in Ireland and Britain due to climate change. Data collected by volunteer moth recorders over 40 years has shown a strong link between warming temperatures and the decline of many moth species restricted to cooler parts of Britain. It has also demonstrated that the resilience of such species can be boosted by retaining more water in river catchments (Horton, 2023).

In Ireland, the holly blue butterfly is expanding its range inland, while the green-veined white butterfly had a population crash following the dry summer of 2018. If our climate becomes dry, moisture-dependent species such as the speckled wood butterfly are likely to be much less abundant in Ireland than they are now (Harding, 2021). Habitats such as the canal, which hold water on the land, provide refuge for such species. Reduced mowing, increased tree cover and provision of ponds in local gardens could help to support insects attracted to the area by the canal.

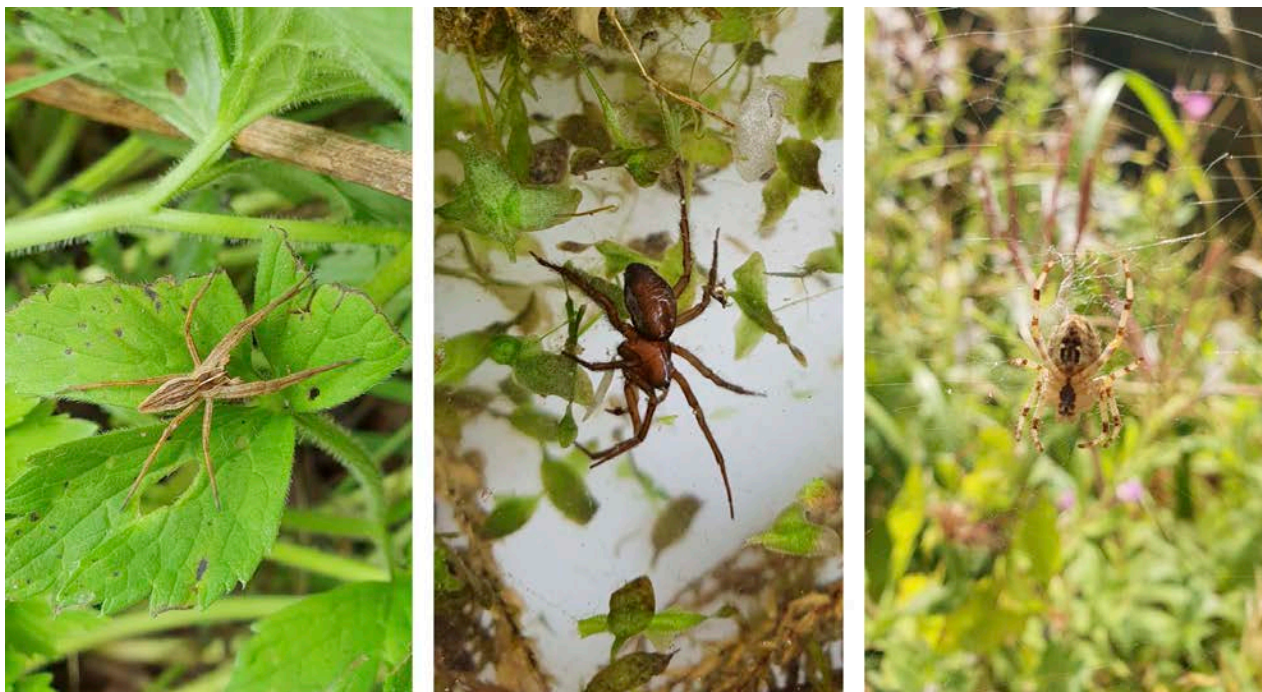


Fig. 10. Spiders recorded at the Royal Canal in Phibsboro: the nursery web spider, the aquatic diving bell spider and the cross spider/garden orb weaver/European garden spider.

4.8. Impact of Development

Changes in microclimate can have an influence on the suitability of small scale habitats for certain insect species. The main concerns regarding the proposed Cross Guns development revolve around the building's height. It is anticipated to overshadow the canal and shade out the banks and parts of the water. The removal of trees for the construction of the greenway along other sections of the towpath further adds to the concerns regarding the level of shade cast on the canal.

The amount of sunlight that an ecosystem receives is one of the key determinants of primary productivity, which itself influences species diversity and cycling of nutrients within the system. Structures can create underwater light contrasts by casting shade in daylight conditions, in turn limiting light availability for plant photosynthesis and growth. There is also evidence that shading can reduce the diversity of aquatic environments both for macrophytes (large plants) (Jusik & Staniszewski 2019) and fish (Nightingale and Simenstad, 2001), with this having knock on effects for invertebrates through a loss of habitat, loss of food resources, and population control effects (Hassall et al., 2011).

Sunlight is an important factor in the early stages of leaf degradation in aquatic environments, although direct sunlight adversely affects the microbes and macrofauna involved in the later stages of vegetation breakdown, such as *Asellus aquaticus*, the water hog louse (Hunting, et al., 2019). The shading can also impact riparian vegetation and therefore terrestrial insect communities through the same photosynthesis-limiting effect, or by lowering temperatures, for example, potentially impacting *Dolycoris baccarum* which prefers warm areas along the canal.

However, it must also be noted that some ecologists suggest that shade may yield more benefits than negatives in a world of climate change, where temperatures are expected to climb over the coming decades and shade can help offset temperature increases, allowing ecosystems time to adapt (Kalny et al., 2017). Shade creates cool areas in the water and along the riparian zone, allowing plants, insects and fish respite from high temperatures while retaining moisture in the system (Johnson and Wilby 2015). The retention of moisture is important for many species found during the present survey. For example, the 22-spot ladybird requires damp conditions to support mildew growth, its primary food source.

Given the advantages and disadvantages of both shade and exposure to sunlight in aquatic and riparian systems, and the specific context of the Cross Guns development, it is crucial to carefully evaluate the potential impact of the building's height and shade on the canal and its biodiversity. Further studies and consultations with environmental experts are recommended to ensure a comprehensive understanding of the project's ecological consequences.

The impacts of artificial lighting at night should be taken into consideration for all three development projects. Studies show that street lighting can reduce moth caterpillar abundance by 47% in hedgerows and 33% in grass margins, compared to unlit sites. It also disrupts the feeding behaviour of nocturnal caterpillars and affects their development (Boyes et al., 2021). Moths were found to be half as abundant at ground level at lit sites compared to unlit sites and species richness was >25% lower. Flight activity at the level of the light was 70% greater, due to moths being attracted to the lights, reducing nocturnal pollen transport (Macgregor et al., 2017). Light-emitting diodes (LED), commonly chosen for their energy efficiency, cause more pronounced negative impacts compared to conventional yellow street lights (Boyes et al., 2021). The impacts of light pollution on insects have knock-on effects for other species, including bats, hedgehogs and birds, which use the ecological corridor of the Royal Canal and rely on insects as a food source.

The Royal Canal Greenway project and the new Glasnevin Metrolink station will likely impact the ecosystem through a reduction in habitat heterogeneity. As we have seen above, habitat heterogeneity drives diversity. Following the removal of native or well established trees or other vegetation and their replacement with pathways and cycleways, there is an inevitable reduction in habitat diversity. However the proposed location of the Greenway predominantly impacts the grassy sections of the Royal Canal banks, which represent the most abundant habitat type locally. This means that any invertebrates using these habitats should easily find additional resources nearby, suggesting this project should have a limited impact.

While the construction of the Glasnevin station will entail some removal of hedgerows, its impact will be low provided the damage does not extend beyond the kayak club. Beyond that point there is an area of calcareous grassland with scrub and trees which provides habitat to the grasshoppers found during this survey. While it was not within the scope of this survey to examine that particular area thoroughly, it is likely that

further searching would reveal additional species of interest. Ideally, any damage to this habitat should be avoided.

The severity of the impact of these two projects is difficult to ascertain without a repeated monitoring program, but this current survey serves as an important baseline and source of information from which we can begin to consider potential impacts and precautionary measures which can be taken. By addressing these concerns and conducting thorough assessments, it is possible to strike a balance between urban development and environmental conservation, fostering sustainable growth in harmony with the surrounding ecosystem.

5. RECOMMENDATIONS

While the presence of a Near Threatened water beetle, *Haliphus lineolatus*, in the Royal Canal is notable due to its decline in the south and east of Ireland, none of the insect species recorded in this survey are uncommon in Ireland. Therefore, neither of the two project developments (the Cross Guns apartment building and the Royal Canal Greenway) require specific species conservation action plans or strategic impact mitigation.

However, the diversity of invertebrates found during this survey, as well as others commissioned by Phibsboro Village Tidy Towns, indicates that the Royal Canal serves as a local refuge for plants and animals, exhibiting high species diversity and highlighting its overall importance in maintaining functional urban ecosystems. Considering the significance of this diversity and its potential benefits for local communities, it is important to explore ways to preserve it. Below are some recommendations.

1. Carry out further monitoring.

The absence of rare, endangered, or specialist species in the present survey does not exclude the presence of other such invertebrate species that may be found using different sampling techniques, sampling at different times of the year or by targeting different insect groups. Insect populations fluctuate annually, so a survey conducted over one year provides only a snapshot of the insect biodiversity at a site. Although a single survey has inherent limitations, it serves as an important resource for understanding long-term diversity changes. It can establish baseline information for the Royal Canal and contribute to the broader knowledge base of urban biodiversity studies in Dublin.

Continuously tracking biodiversity changes is crucial, especially considering the increasing pressures of climate change and land use. Repeated surveys enable the creation of a temporal series, allowing for inferences about the future of Royal Canal ecosystems. Conducting a more thorough investigation of true bugs (Hemiptera) and spiders (Araneae) along the canal banks could be beneficial, as a great diversity of these invertebrates was observed during the survey. A more comprehensive survey of freshwater invertebrate indicator species can also be used to assess the health of the canal.

Monitoring invasive species, such as the Harlequin ladybird, can help track their impact on native species populations. Little can be done about the spread of this species, but providing as much suitable habitat as possible for Ireland's native species will enhance their chances of survival.

Additional species might be found in undisturbed spots which were not accessible during this survey, e.g., the remnants of the bridge that once connected the old mill to the railway line, the steep bank close to the Cross Guns bridge, and the calcareous grassland and scrub behind the old stone wall at the Famine memorial.

2. Increase and preserve local buffer zones, corridors, and networks.

Preservation of urban residential gardens and local green spaces such as Villa Bank Garden and Shandon Park, which comprise significant habitat areas, plays a vital role in supporting biodiversity. Recognising the role of green spaces like the Royal Canal as ecological networks and wildlife corridors is crucial for the conservation of flora and fauna across urban settings.

3. Follow general recommendations for the protection of freshwater habitats.

Consider potential threats to the canal habitat and implement appropriate measures. These threats might include eutrophication from plant nutrients or diffuse pollution such as herbicides, pesticides, fertiliser, sewage, airborne contaminants from industry and traffic, and runoff from roads and paved areas. The use of pesticides and herbicides along the canal should be avoided altogether. While some of the species found during the present survey can tolerate some pollution, cleaner water would allow more sensitive species to utilise the ecosystem. This is where collaborative conservation work with Tidy Towns groups further upstream could be particularly helpful.

Recreational activities such as boating and fishing can disrupt and damage wildlife and spread invasive species such as the zebra mussel, posing a threat to native flora and fauna. Use of the canal and its banks can result in littering and dumping, especially if suitable waste disposal facilities are not provided nearby. Continuing the litter pick-ups already carried out by Phibsboro Village Tidy Towns' volunteers can significantly reduce plastic pollution. It is important to leave natural biodegradable debris in situ during these cleanups, as it provides microhabitats for invertebrates. Water abstraction and flood alleviation can alter the hydrology of wetlands, with negative effects on wetland species. Additionally, the structure of water edges is very important for many species. The more natural, gradual slopes of some areas of the canal banks (particularly along Transect C) enable a particular assemblage of aquatic species to exist there.

4. Maintain habitat heterogeneity.

Maintaining vegetation heterogeneity and transitional areas between microhabitats is essential for insects. Reducing the extent of manicured grass and allowing for more natural vegetation to grow is recommended. Managing vegetation along the hawthorn hedgerow at Transect A less heavily would be beneficial. Increasing the height, density, and diversity of the grassy areas and promoting the natural formation of grass tussocks and leaf piles could provide more shelter and overwintering habitat for ground beetles and pond skaters such as *Gerris odontogaster*. Abundant, tall, dense, and diverse vegetation along the canal banks should be maintained. Excessive disturbance or clearing that could negatively impact floral diversity should be avoided.

Protecting the diverse sward height of the calcareous grassland behind the old stone wall is important to continue supporting grasshoppers. The presence of a variety of native herbaceous species, trees, and scrub will support a wide range of insects that forage on nectar and pollen, or whose larvae eat these food plants. These insects, in turn, will provide a food source for predatory invertebrates, which are a food source for birds, bats, and other larger fauna. Abundant aquatic vegetation found along the canal should be maintained to support the aquatic invertebrates found during this survey, as well as muddy banks for certain kinds of beetles. Preserving trees and pondweed that provide shade for invertebrates is also important.

5. Preserve long established habitats and natural processes.

Old stone walls, such as those along Transects A and D, can host a wide range of biodiversity, such as ferns, lichens, and mason bees. Long-established, undisturbed habitats can be useful to certain specialised invertebrate species. Ephemeral habitats influenced by natural processes, such as the rise and fall of water levels, can be important for others, including certain ground beetles and aquatic beetles.

For these reasons, the structure of the edges of the canal should be left as natural and undisturbed as possible. Any clearing of vegetation or dredging which must be carried out should be done in sections, not all at once, and some sections of vegetation should be left completely intact and undisturbed.

6. Continue to support pollinators.

Preserving the vegetation along the canal and managing it so that it provides plenty of forage for pollinators, including bumblebee species (*Bombus* spp.) and honey bees (*Apis mellifera*), and food plants for butterflies and moths, is crucial. Avoiding the use of pesticides in the area is necessary to protect the health of pollinating insects. Allowing dense, tussocky vegetation to form along the banks and under hedgerows will provide nest sites for bumblebees.

7. Engage in collaborative conservation efforts.

Collaborative efforts for environmental protection are essential, given the range of stakeholders along the Royal Canal, including local residents, businesses, fishermen, commuters, walkers, academics, and government bodies. This presents an opportunity for collaborative work on protecting the canal. Education and awareness campaigns can extend beyond a single area, and biodiversity surveys can encompass the entire length of the canal to identify areas of high biodiversity value.

Engaging the local community in monitoring easily identifiable groups such as ladybirds can contribute to our understanding of the impacts of habitat change and climate change on species distribution and abundance.

8. Promote place-based education and awareness of local biodiversity.

The results of this survey can be highlighted to local schools and community groups as an educational resource to raise awareness of the significant role that the Royal Canal and high-floristic garden spaces like Villa Bank Garden play in conserving insects and serving as urban habitats. Phibsboro' Village Tidy Towns has already commissioned the author to carry out workshops with two local schools in conjunction with the Heritage in Schools scheme, resulting in an increase in the pupils' knowledge and appreciation of their local biodiversity and the addition of a number of new records to the species list.

Another recommended approach is the use of interpretive signage (information signs/boards) to enhance visitor experiences. These signs play a crucial role in providing information to visitors, improving their knowledge and understanding of biodiversity and conservation during their experience of the canal environment. When designing such signs, consideration of elements such as layout, typography, colour, graphics, contour, and the inclusion of a multi-sensory flip-panel can be beneficial (Mutiaru et al., 2021), as well as the environmental impact of materials and placement.

These signs can effectively showcase the area's diversity and generate interest among local stakeholders. Moreover, they can promote actions that community members can take to support biodiversity. For example, signage can highlight specific flowering plant species that gardeners can incorporate to enhance resource availability for pollinator species. By selecting native flowering plants, pressure on pollinators can be alleviated while simultaneously improving the aesthetics of the area. Many species found in this survey provide benefits for local gardens. Ladybirds, hoverflies, dragonflies, and green lacewings are predators of garden pests. Bees, hoverflies, moths, and butterflies are some of the many pollinators found here.

Signage can also serve as a means to gather financial support from the community and organisations dedicated to environmental protection. One common practice is to include QR codes on posters, allowing donors to scan the code and be directed to a donation page focused on local biodiversity conservation and the improvement of green spaces. This approach encourages community participation and helps fund initiatives aimed at safeguarding the environment.

9. Minimise the impact of developments along the banks of the Royal Canal.

Careful consideration should be given to the potential impacts on canal biodiversity of changes in light availability caused by overshadowing by the Cross Guns development, removal of trees for the greenway, or installation of new street lighting.

Modifications can be made to LED street lighting to reduce its impact by dimming, using filters, situating it away from important habitats, and limiting the hours during which they are switched on. The vegetation along Transect D between the canal and Shandon Park appears to support a diverse range of moths and is a good example of an area where street lighting should be minimised as much as possible.

Avoiding the destruction of the green area between the stone wall and the railway line which runs from Cabra Kayak Club at Lock 6 to Lock 7 will preserve patches of calcareous grassland and scrub which provide habitat to grasshoppers and other species of interest. This area also provides a valuable buffer zone which supports the biodiversity of the Royal Canal.

By implementing these recommendations, it is possible to improve habitat quality, protect species diversity, and contribute to the conservation of local ecosystems along the Royal Canal.



Fig. 11. Common field grasshopper at the Royal Canal in Phibsboro.

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